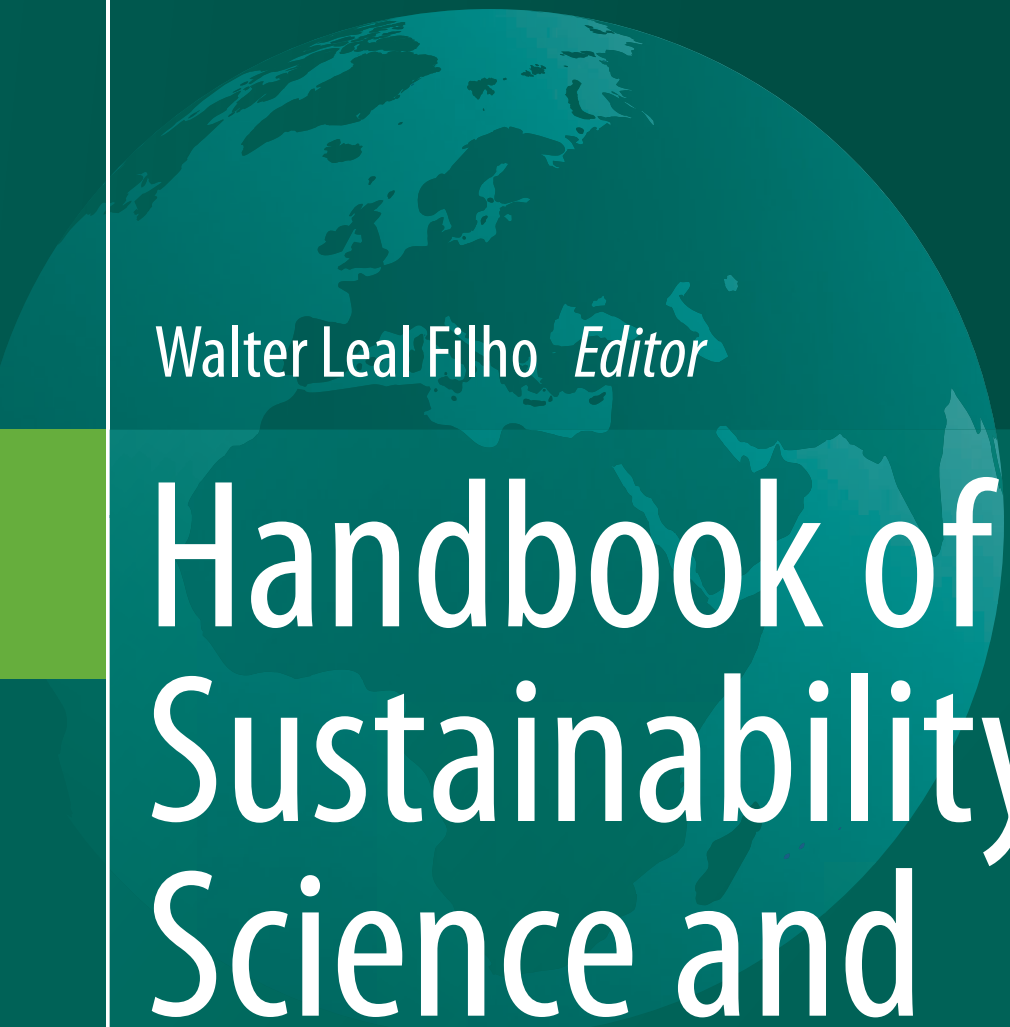
World Sustainability Series



Walter Leal Filho *Editor*

Handbook of Sustainability Science and Research

Springer

World Sustainability Series

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Handbook of Sustainability Science and Research

Springer

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Preface

The United Nations Summit, held on 25–27 September 2015 in New York, adopted the post-2015 development agenda and a set of Sustainable Development Goals (SDGs) which are outlined in the document "Transforming our world: the 2030 Agenda for Sustainable Development". This Agenda, according to the UN, is a plan of action for people, planet and prosperity, which seeks to strengthen universal peace in larger freedom. It contains 17 Sustainable Development Goals and 169 targets, which demonstrate both a vision and an ambition. It seeks to build on the Millennium Development Goals and complete what these did not achieve. The document "Transforming our world: the 2030 Agenda for Sustainable Development" also clearly shows the need for an integrated handling of the three main dimensions of sustainable development: the economic, social and environmental.

There is a world consensus in relation to the fact that Sustainability Science—i.e. a branch of science concerned with an integrated view of the three main dimensions of sustainable development—can provide an important contribution in order to achieve the Sustainable Development Goals. Even though in the past, the potential of Sustainability Science has been largely overlooked—some say underestimated—it is clear that it can provide a key contribution to the implementation of the Sustainable Development Goals (SGS) and, more specifically, the realisation of the vision set at the 2030 Agenda for Sustainable Development.

It is based on the perceived need to explore and present concrete case studies which illustrate how Sustainability Science and Research can help to achieve the many goals listed in the document "Transforming our world: the 2030 Agenda for Sustainable Development", that the "World Symposium on Sustainability Science and Research: Implementing the 2030 United Nations Agenda for Sustainable Development", that this "Handbook of Sustainability Science" has been prepared.

The book contains a set of papers presented and discussed at the first "World Symposium on Sustainability Science: Implementing the UN Sustainable Development Goals", jointly organised by the Hamburg University of Applied Sciences (Germany) and Manchester Metropolitan University (UK), in cooperation with various UN bodies, government offices and authorities, universities, enterprises, NGOs and grassroots organisations from across the world.

This book is structured in three main parts. Part I addresses the political, social and economic dimensions of sustainable development, and provides a

comprehensive overview of the many influences these areas provide to the global sustainability debate.

Part II is concerned with the environmental, social and technological dimensions of sustainable development. Here, an emphasis is given to the connections between environmental technologies and environmental protection efforts on the one hand, and the social implications of their implementation on the other.

Part III focuses on holistic approaches, stakeholders engagement and education for sustainable development, combining three important elements sustainability science, and illustrating how effective they may be. One chapter, prepared by the team working at the UN Development Goals Secretariat in New York, describes how Private–Public Partnerships may assist in the implementation of the Sustainable Development Goals, with experiences from the SDG Fund.

A short, final chapter, presents some perspectives on sustainability science and introduces the World Sustainable Development Research and Transfer Centre, outlining its activities for the period 2017–2030. All in all, this handbook provides a timely contribution towards fostering awareness and offers basic knowledge on sustainable development, and on both individual and organisational sustainability and responsibility. We hope this may prove useful in supporting organisations to pursue one or more of the Sustainable Development Goals.

We thank the authors for their willingness to share their knowledge, know-how and experiences, as well as the many peer reviewers, which have helped us to ensure the quality of the manuscripts.

Enjoy your reading!

Hamburg, Germany;
Manchester, UK
Winter 2017/2018

Prof. Walter Leal Filho
B.Sc., Ph.D., D.Sc., D.Phil.,
D.L., D.Ed., D.Litt.

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Political, Social and Economic Dimensions of Sustainable Development

Lessons Learned for Decision-Makers During a 5-Year Research Period on Sustainability Problems at the Galileo University in Guatemala

Nelson Amaro

Abstract

The findings outlined in this paper have two core audiences in mind. The first are decision-makers with interest in sustainable development, and who can use the information to shape policy. The second are sustainable universities that may provide the needed research for the monitoring and evaluation on what is proposed. Between 2009 and 2013, Galileo University administered Renewable Energy and Climate Change sample surveys to entrepreneurs, university personnel, government officers, and civil society leaders in Guatemala. Qualitative and quantitative analysis was then conducted by the Galileo University on the collected survey data for this time frame. The analysis revealed weaknesses, that if not addressed, are capable of halting sustainability efforts in all Guatemalan sectors—academic, private, government, and the general public. Specifically, the research identified five sustainable development gaps which can serve, not only as important and foundational lessons for all surveyed participants, but also addressed by academic institutions and decision-makers to formulate appropriate actions. These gaps are the following:

(1) The divorce/disconnect between research and teaching;
(2) The lack of balance between specialized fields and multidisciplinary perspectives;
(3) The absence of internal (within the university) and external (larger society) alignment in addressing sustainability problems;
(4) Deficits in coordination within and between public, private, NGOs, and academic organizations;

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(5) And finally, the lack of time linkages (short-, medium-, and long-term) which will postpone decisions until the end of the century or later and ultimately, paralyze decision-makers.

All these sectors—academic, private, government, and the general public—should strengthen their own capabilities by making respective internal changes to address these gaps and by forming "smart" strategic alliances. The implementation of "Quadruple and Quintuple Helix Innovation Models," involving decision-makers, applied to these weaknesses appear to be the best policy decisions. These models emphasize collaborations, alliances, and networks. Then and only then, can these sectors address the challenges ahead: the academic sector would strengthen their offer to the larger society and avoid the consolidation of "clusters," which mean confinements; entrepreneurs will be able to embrace their social responsibility; governments accept networks and horizontal relationships, while civil society may adopt common objectives moderating their dispersion of activities and resources. Universities will then become more sustainable and larger society more resilient.

Keywords
Sustainable development · Renewable energy · Climate change · Networks

1 Introduction

From January 2009 to December 2013, a multidisciplinary team from the Sustainable Development Institute (IDS by its name in Spanish) of Galileo University in Guatemala was able to carry out a series of investigations, co-sponsored by the Alpha III Program of the European Union. Two different projects were carried out: The so-called "Joint European-Latin American Universities Renewable Energy Project" (JELARE) and the "Network of Climate Change Technology Transfer Centre in Europe and Latin America," (CELA), (Consorcio del Proyecto JELARE 2011 and Consorcio del Proyecto CELA 2012; Network of Climate Change Technology Transfer Centre in Europe and Latin America CELA 2012). Despite having different themes, the two projects and the observed results have a close link due to the impact of fossil fuels in the generation and impacts of greenhouse effects, GHE, due to emissions (Amaro 2012, 2014; Amaro et al. 2012). Carbon dioxide, a by-product, of burning fossil fuels, represents around two-thirds of the gases that may cause extraordinary climate changes on earth (Castellanos and Guerra 2010). The Intergovernmental Panel on Climate Change, IPCC (2007, 2013), warns that if the human component that mainly generates this phenomenon is not presently regulated, the rise in temperature left to its own evolution in time would cause huge catastrophes whose threats could not be moderated, unless their effects are

addressed properly in advance. In fact, these concerns were the main subject of COP21 recently held in Paris.

It has been claimed through thorough research, involving the analysis of 11,944 scientific articles published between 1991 and 2011, that 97% of experts in the field find the evidence of human-induced climate change, (CC), highly probable (Leiserowitz et al. 2013). Nevertheless many politicians, corporations, and citizens at large, do not believe in it. For example, a survey conducted recently found that 63% of Americans had the conviction that global warming is happening but only 49% understood that its main cause was human activities (Cook et al. 2013). This is in line with Giddens (2009) findings when he says

> The politics of climate change has to cope with what I call 'Giddens's paradox'. It states that, since the dangers posed by global warming are not tangible, immediate or visible in the course of day-to-day life, however awesome they appear, many will sit on their hands and do nothing of a concrete nature about them. Yet waiting until they become visible and acute before being stirred to serious action will, by definition, be too late. (p. 2)

These statements go beyond climate change and encompass the concerns of the classical definition of sustainable development first outlined by the Brundtland Comission (United Nations 1987). Following this definition, the main objective of this paper is to appeal to all parties involved in making decisions related to climate change, sustainable economic, social and environmental policies, thinking that leaves future generations a blueprint for a sustainable resilient planet. The academia, private corporations, governments, and civil society are the main actors as decision-makers when the larger society is considered. Universities are part of this network, but all institutions have to be prepared to make internal changes to make themselves resilient and simultaneously seek the goal of a sustainable world. Research that was the basis for this article went beyond technological and climatological aspects, to encompass the decisions of a broader portion of society constituting these main stakeholders. Surveys, based on personal interviews and meetings with the aforementioned stakeholders, made possible the gathering of the data presented. The fundamental question this paper wishes to address is the following: *What is possible to change and/or, on what basis can decision-makers change the current and apparent status quo thinking on sustainability, characterized by postponements, delays and lack of mindfulness, as constructed on the information gathered in this analysis?*.

2 Methodological Aspects of the Investigation: Characteristics of the Two Different Samples About Renewable Energy (RE) and Climate Change (CC)

The studies mentioned used qualitative as well as quantitative methods. The latter also explored secondary data scattered in many official reports. Qualitative methods were used to build the questionnaires such as focus groups that its results were

added to the analysis later. Also, next sections summarize well-known reflections of higher education, public and private sectors institutions in Guatemala, that are familiar to all incumbents. Again, our main objective is to illustrate to decision-makers the needed internal and external changes that are urgent to make sustainable the development pursued in the near future. For this reason, we will use only those results that are strategic to prove the arguments advanced. In doing so, the objective is not so much to advance particular areas for further investigations, but to stimulate new research through monitoring and evaluation in a way, which could detect to what extent gaps observed in sustainability efforts are filled, dangers prevented and resiliency institutionalized in the weaknesses detected.

The quantitative studies targeted three specific populations, through a survey adjusted to each group and to each sample. Those groups were the following:

- **Top managers from private and public companies** in the area of RE and CC, mainly considering those corporations having a greater impact on citizens and the market. With regard to RE, hydroelectricity generation industries were selected from a list provided by the Guatemalan Ministry of Energy and Mines. In the case of CC, the sample was drawn from a non-exhaustive list of enterprises that covered the biggest corporations in agriculture and the industry provided by their respective chamber associations that represent them. After selecting these mainly private enterprises, managers answered questions through interviews and a structured questionnaire. In the case of the survey related to RE, we were able to have a list of enterprises, from the Ministry of Energy and Mines of Guatemala. Our interest in both samples was to gather data from the most relevant corporations having the greatest impact on the market. This fact is highly correlated with the size and production volume of each firm. For this reason, we relied on the selection of these cases in three judges that were characterized by their acquaintance with the activities of these corporations.

  They had to rank, in the case of RE corporations, all these enterprises by their relative importance giving a score from 1 to 3 points to them, being the latter the highest. As a result, corporations varied between 3 and 9 points for the RE list (the result of multiplying the number of points x the number of judges). The original one had 121 companies listed. Since the most relevant companies had our interest, we selected 51 cases with the highest scores and dismissed the rest. With regard to the CC sample, we did the same with some small differences. We ask our judges to rank between 1 and 5, therefore the highest score was 15 and the lowest 3. Once this was done, we selected 80 enterprises out of 1,376 listed, each one stratified by agriculture (40 cases) and industrial sector (another 40 cases). For all surveys, we had 80% or more of questionnaires completed.
- Teaching and administrative staff in careers and courses from Galileo University related to RE and CC. Galileo University was the only university selected in the RE survey because our interest for decision-makers was concentrated here. All cases were interviewed which is equivalent to a census. On the other hand for the CC sample, that was more a universal problem, we included the personnel that belonged to the main universities of Guatemala (seven were identified),

including UGAL and from an exhaustive list of 157 professors, 64 cases were randomly systematically selected and interviewed.

- **Decision-makers**: Managers, at the top of coordination offices or other units from different universities that have initiatives in the field of RE or environment, were included. The RE random sample covered four universities including UGAL. For the CC, we designed a stratified sample. There we could identify and add top managers belonging to government offices and NGOs that were in charge of specific activities in CC. For this category, we were able to identify seven universities, including UGAL. For the selection of NGOs, a similar methodology of judges that were used for corporations was applied.

Altogether, a total of 287 questionnaires of personnel from such populations and universes were gathered and completed. For the RE sample, 81 questionnaires and for CC, 206 cases were completed in the two surveys. In both instances, these interviews represented stratified samples belonging to each of the groups and subgroups described above. With regard to the RE sample, we were able to complete 51 interviews who were top managers of productive RE corporations. The questionnaires also considered teachers for their application. Most of them performed administrative duties (20). Finally, interviews were done to top decision-makers in four universities that were managing either research or teaching career programs (10). In the case of the CC sample, the following were surveyed: agricultural managers (32); industries (39); teachers (64), and finally different decision-makers from universities and public institutions (40) and NGOs (30) (Equipo Técnico y de Supervisión 2009, 2010, 2012a, b).

For the two RE and CC surveys, knowledgeable judges, based on official listings of companies and NGOs, selected, from a much broader list, those that they considered had the greatest impact on the market and on civil society. For teachers, exhaustive lists were identified, almost equivalent to a census in the case of UGAL, and with randomly selected cases for the main universities in the country. From these lists a random systemic sampling was made. As for decision-makers other than NGOs, respondents were randomly selected through comprehensive carefully prepared lists. The Statistical Package for Social Sciences (SPSS) was the program used for analyzing the data.

- **Limitations of the findings and suggestions made**. One has to be aware in advance that possible shortcomings of the analysis and the implications for decision-makers, may affect the issues selected and the measures advanced to fill those gaps that are suggested in next sections. Long-term periods are usually not a strong trait of politicians. Further research and changes in the academy largely depend on needed resources and donations which are markedly absent in developing countries. Civil society often looks irrelevant when their strongest groups have a monopoly of the influence to make effective lobbies that successfully prevail over the rest of citizens. Finally, the private sector may only aim to increase their earnings in a free market, relinquishing their social responsibility. Then, actual trends will tend to persist.

3 Results: Where the Changes Are Needed

Now, it is possible to make a summary of relevant results gathered to make decision-makers aware that sustainable present trends may not be sufficient, if detected weaknesses persist. From the research made, it was possible to distinguish five gaps that stakeholders from academia, the private sector, government and civil society (NGOs) need to close and ideally collaborate in its demise in order to effectively address present sustainability challenges, derived from social, economic, and environmental areas. Examples would be advanced particularly from the RE as well as the CC areas in Guatemala. It also could serve as a guidance that might be applicable to other countries with similar characteristics. The first two refer to sustainable universities and the other three put emphasis in the way that the knowledge and training those universities provide in this area may institutionalize in alliances and networks that could strengthen sustainability to all stakeholders in the academy, public, private, and civil society sectors.

4 First Gap: The Separation Between Research and Teaching

The presence of common features in the universities of Guatemala in the research was identified, such as few administrators handling many temporary professors in recently incorporated subjects like RE, CC, and the environment in general. The marked emphasis on teaching in these results makes evident the lack of research activities either as a generator or as a recipient of scientific databases among universities. This situation exists in many higher education institutions in Latin America. The research comes up as a great absent, compared to teaching which has almost the complete allocation of resources. Many observers, as well as professors themselves, put a sense of humor in this scenario. In Guatemala, names such as "Taxi Professors" have risen due to the constant traffic of teachers from one university to another. A somewhat irreverent, but sociologically relevant joke is told, which asks the question: "How does God compare to a temporary professor?" and the answer is that "both are everywhere, at the same time but nobody sees them."

The recent creation of careers related to RE also brings attention to the fact that few teachers have long periods of time being linked to the institution in which the career has been opened as it is observed in the quantitative surveys mentioned. The number of courses taught in this cycle versus the ones taught in the past one is relevant for extending this analysis. Regarding professional performance, an obvious preference from teachers toward training and education emerges. This is particularly relevant when compared to other areas of the value chain. The teaching staff aims to this new area (RE), due mainly to previous academic background, but also guided by a previous relationship to that productive sector of the labor force or motivated by their interest in these innovations. Among the sectors, where the staff said they worked before, the hydraulic sector is presented in a relevant manner,

which is highly correlated with the potential for electricity generation of Guatemala in this field (Equipo Técnico y de Supervisión 2009, pp. 1–20). Hardly less than 10% of their potential is actually used.

Power generation, as main occupation, in comparison with distribution, commercialization, transport, and other activities, has also greater preference among the teaching staff. Consistent with the above, the interest in receiving training is centered on hydraulic and biomass energy, even though wind, solar, and geothermic energy receive special attention as well but with less emphasis. Related to this, the need to access a scientific database also arose. However, to lesser extent, significant percentages favoring a greater operational link to the RE industry and the need of updated capacities in this field were expressed (Equipo Técnico y de Supervisión 2009, p. 61).

The inquiry made to teachers at the Galileo University also covered research activities, funded by the RE market, including industries as well as governmental and international cooperation agencies. In general, these efforts were very moderate according to the data collected. In addition, the need to forge a greater link between students and professors to the practice of the industry through more exchanges, internships, or supervised practices, contributed to this gap. Moreover, a greater preference on the part of respondents, regarding the requirements of training per sector was observed. The upper strata of professors, measured through seniority were inclined to receive training of different kinds of energy such as hydraulic, geothermic, and solar, while the middle and lower strata tended to prefer biomass (Equipo Técnico y de Supervisión 2009, p. 29). Similar results were obtained in the survey on climate change (Equipo Técnico y de Supervisión 2012a, p. 82). Nevertheless, the common characteristic among all incumbents was precisely the wider gap between research and teaching activities.

5 Second Gap: Lack of Links and Synergies Between Specialized Disciplines and the Multidisciplinary Nature of Environmental Studies

In light of this gap, a strong need arises for curricular reform, which will evaluate and suggest content for courses, in a transversal manner as the effects of RE, environment, and CC are related to different careers like architecture, law, information technologies, communication, engineering, human sciences, and others, particularly those energy-related careers. The survey specifically asked decision-makers, about the CC knowledge that the people dependent on their programs had. It was significant that among the courses related to RE, while the topic of environment was often mentioned, the issues of climate change were not (Equipo Técnico y de Supervisión 2009, p. 73). This can also be applied to the results of climate change. In this sample of teachers, the majority of university decision-makers mentioned that among the professors that taught environmental

studies in their related careers, their "understanding of climate change was vague" (regarding CC) (Equipo Técnico y de Supervisión 2012a, p. 90).

On the other hand, practice dictates that the groups that work in RE often have a weak connection with those implementing the environmental subject and, as previously mentioned, the issue of CC often becomes something marginal and distant. Furthermore, the stakeholders involved in environment courses have not fully realized what CC means, showing a vague awareness of the subject. This divergence is also noticed in the lack of coordination that exists between the Guatemalan Ministry of Energy and Mines and the Ministry of Environment and Natural Resources. In terms of CC, this tension largely influences the separation of mitigation and adaptation policies. In the case of Costa Rica, a neighbor of Guatemala in the Central American area for example, these public policies belong to one single Ministry that calls itself "Energy and Environment."

6 Third Gap: Lack of Synergies Among the Various Sectors to Which the Different Stakeholders, Who Tend to Segment Their Activities, Belong

From the year 2007–2008 on, a greater openness to public–private collaboration and multidisciplinary activities is noted. Nevertheless, it is also perceived that it is still necessary to expand the connection among the first mentioned sectors as well as their link among their institutions, RE, environment, and CC. Practices related to new teaching schemes in the RE field have occurred mainly since 2008. This coincides with the oil crisis, whose prices in global markets were then over US $147, which is a historical amount for that year. It is common among university units in Guatemala that such practices lack a research component that feeds and updates teaching. However, our informants in the research, mentioned greater openness to public–private collaboration and interdisciplinary programs or toward the use of the "know-how" of experienced staff on subjects different to RE, CC, and environment. Nevertheless, there still is a considerable margin on which to deepen this needed tendency in multidisciplinary teaching and practices. For example, according to our interviewees, barely half of the organizations surveyed focus their activities using a strategic plan. In addition, only half of the previous figure (hardly 25%) met their own adopted goals to a high degree, according to their approved strategic plan (Equipo Técnico y de Supervisión 2009, p. 73).

The irreconcilable dichotomy between specialization and multidisciplinary approaches tends to disappear when short-, medium-, and long-term goals are considered seriously. In the short term, technical careers and specializations make an immediate impact on the demand for the offered product in the market. However, in the medium- and long-term, an expansion toward other disciplines would be necessary because of the growing importance of sustainability issues, RE, and CC as national priorities. Then, other problems and related disciplines emerge such as public policies on information technology, new management innovations, social

work around conflict resolutions, and interdisciplinary relationships in both the public as well as the private sector. This aspect has to guide decision-making toward plans and strategic objectives that have specific time deadlines. When this is not accomplished, there is an internal detected weakness externally derived from the lack of inputs coming from alliances among the academy, private, governmental, or civil society sectors. How is it possible to reach these last networks? Next section will attempt to answer this question.

7 Fourth Gap: The Existence of Large Deficits in Coordination Efforts

There is a lack of investment and coordination efforts compared to what is needed. The efforts must match required level of risks found in sustainability, RE, and CC activities. For example, convincing measures have to be adopted that could build an alternative to environmental degradation and GHE effects. This ideal situation fulfills the need for greater internal and external coordination with other agencies and institutions with the same common objectives which is the aim of Fig. 1 for the case of Guatemala.

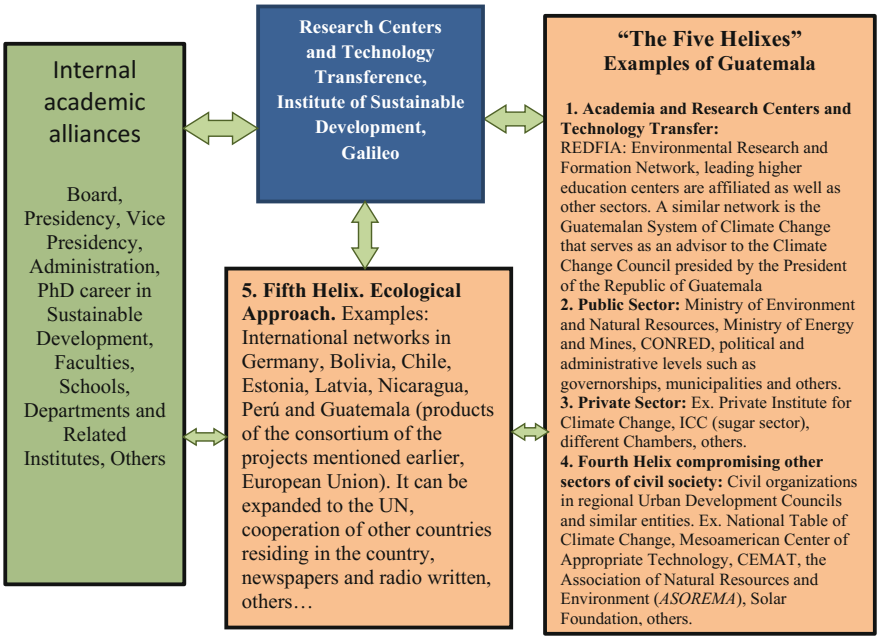

Fig. 1 Partnerships in building a system of action based on the Five Helix approach with examples pertaining to Guatemala *Source* Own design: Galileo University Technical and Supervision Team

This space provides the scenario for using the so-called "Quadruple and Quintuple Helix" approaches, seeking common goals among the academia, the private sector, the government, and civil society. These four sectors constitute the pallets of the helix. The ecological approach constitutes the fifth. The creation of networks that address mutual defined concerns evolve in the light of this concern. The outlined approach has emerged from a teaching–learning process regarding the ideal nexus to the actors that are more capable of making a difference in the evolution of sustainability, RE, and CC. Figure 1 shows this reflection for the case of Guatemala. The right side shows the four pallets of the helix while the one in the middle is an amplified effort beyond a specific country but using the ecological affiliation as the axis for collective efforts. Finally, the column at the left attempts to highlight the importance of internal coordination efforts in the same direction. The last ingredient is provided by the Institute of Sustainable Development within the Galileo University that is at the center of all efforts.

A historical account of these thoughts is warranted here. First, the "Triple Helix" approach was adopted (González de la Fe 2009) in the 60s. This strategy arose from concerns of the US government regarding an intercontinental ballistic missile attack, during the tense moments of the "Cold War." The question to be answered was the following: "How could the US government decision-makers communicate in the face of such an unexpected attack if it occurs?" From this, the Defense Advanced Research Project Agency (DARPA) in charge of maintaining technological supremacy in this field came to the rescue. At this point, only the military and the government were present. They were the seed of further changes that covered the whole society later on.

These activities began to involve the private sector and academia, especially those most interested in a broader society such as entrepreneurial, agricultural, and technological universities. In the end, scholars agreed (González de la Fe 2009) that it was from these sources of innovation that the current Internet and related social networks and corporations emerged. Today, they occupy the first places in this field and are the advances of a new "Knowledge Society." Reflecting on the model, this first coordination effort was called the "Triple Helix," attributing their excellence to the joint collaboration and alliances of the government, private sector, and academia. This approach currently counts with regular meetings and numerous publications. Later, the need is identified to include a fourth and fifth pallet and their scope is amplified to a "Quadruple and Quintuple Helix," therefore encompassing civil society (Helix Research 2013) characteristic of the Quadruple and the ecological approach of the Quintuple elaborations (Carayannis et al. 2012). The team involved in research at the Universidad Galileo considered these last approaches to be more appropriate for developing countries. The concept is graphically described in Fig. 1.

Although Fig. 1 applies to Guatemala, similar elaborations might be extended to other countries. It is possible to generalize that in addition to the often low cooperation among these different pallets and these separate entities by themselves, including the government, coordination and investment in this area is lacking. It can be observed that the RE sector, despite being one of the solutions as an alternative

energy to GHE effects, usually, when examining pensums of different related careers, the relationship is distant or nonexisting at a research, teaching, or technology transfer level. Of the information collected, the lack of internal coordination may also be noted, even within the institutions themselves and within the academic sector in the area of RE as well as CC (Amaro et al. 2014a, b) and between RE and CC.

There are "perverse" organizational trends that emphasize "sectionalism" and building of "fiefdoms." Universities have tendencies of seclusion within their walls, to create "ivory towers," without continuous contact with the rest of society. After all, it was universities that invented the concept of "cloister" to refer to the teachers of a particular faculty which is a concept inherited from medieval times. On the other hand, the government is more open to vertical relationships, often considering itself as the leader of certain areas and having difficulties with horizontal relationships, specifically when they relate to citizen organizations and networks, belonging to civil society. Furthermore, the private sector tends to be oriented exclusively to maximize their rent, neglecting at times their "corporate social responsibility." Finally, the civil society involved in many organizations with different objectives tends to a dispersion that poses the risk of spreading the investment of resources to many areas, forgetting broader priorities. These trends tend to perpetuate actual trends and paralyze any sound intervention in sustainability issues.

8 Fifth Gap: Lack of Linkages Between the Short-, Medium-, and Long-Term that Tends to Postpone Action Indefinitely

This gap prevents gaining awareness on sustainability issues. It contributes to urgent decisions delays and jeopardizes the prevention and proper handling of matters according to specific time periods. It is not only disasters and threats like storms and flooding. It also refers to other factors that may become lasting solutions that need to be addressed today looking for an impact in the long term. Mitigation of GHE, looking for lower temperatures at the end of the century is a case in point. It is then necessary to link the short, with the mid- and long term as inferred, for example, from the storms that have desolated Guatemala in 1998 (Mitch), 2005 (Stan), 2010 (Agatha), and 2011 (E-12). These storms have represented between the 0.63 and 3.4% of the GDP (Amaro et al. 2014a, b). This gap leads us to conceive temporal dimensions in the light of elaborations made regarding the "smart management" of extreme climatic events (Mitchel and Ibrahim 2010). The following temporary dimensions as illustrated in Fig. 2, follows this approach:

Ex-ante event: Preventive measures are called at this point in time, based on the use of early warning systems, announcing the population about the evolution of the event and if needed, the provision of training on these preventive measures they should adopt. Warning systems register the degree of risk in stages. For each degree

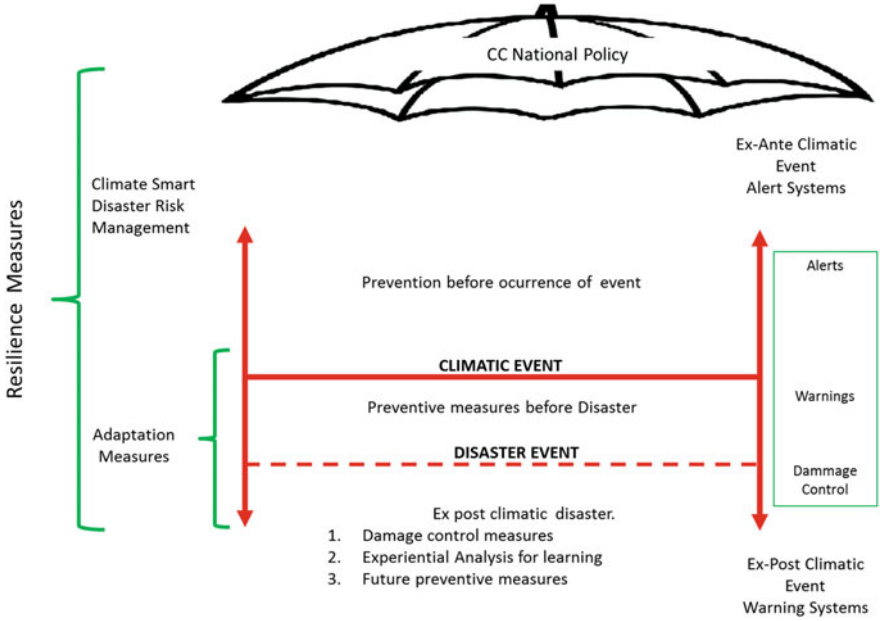

Fig. 2 Approach of a management system for adaptation in relation to the identified risks and disasters. *Source* Own design of the Technical and Supervision Team of the CELA Project

of risk, protection measures for neighbors are developed, including the properties of the people involved.

During the event: When the event occurs the degree of alert changes in order to provide warnings to the population about the impending disasters. In a similar manner to the alert system, these warnings induce the reactions of the community to minimize impact. A communication system keeps the community informed, including neighbors located in the most remote areas.

Ex-post event: After the event, damage control measures develop from which knowledge is obtained for developing preventive measures for the future when similar events break. The suggested resilience system seeks to integrate all the experiences to face the risks of environmental improvements, disaster, reinforce adaptation capacities, focusing on the causes of poverty, population, and territorial vulnerability. This approach is called "Smart Climate Risk Management." Figure 2 makes important distinctions that could be incorporated to a strategic plan (Mitchell and Ibrahim 2010). The graphic highlights components of the strategy to be followed, according to different time periods that start before, during and after the occurrence of events related to environmental threats and extreme climate changes as illustrated in the same figure. This approach should be framed taking into account the following limitations and characteristics:

(a) While there are common findings arising from the different samples, the degree of sensitivity to the threat of climate change differs by territorial areas. Agricultural companies gave to this issue greater importance than in industrial ones in the Guatemalan surveys reported. Meanwhile, teachers regard the issue as a vague dimension of the environmental theme and decision-makers still do not clearly prioritize immediate and mid-term threats to their activities from these unexpected changes. In general, it could be said that in all the populations considered for the surveys: companies, teachers, and decision-makers, there is just an opening to incorporating the subject of climate change to the processes of research, creation of plans, policies, programs, laws and regulations, investment, execution, follow-up, evaluation, and feedback. "Quadruple and Quintuple Helix" activities should be directed precisely to achieving a network system capable of coping with the threats that climate change may bring (Helix Research for the CLIQ project co-financed by European Regional Development Fund and made possible by the INTERREG IVC 2013).

Industrial enterprises are somewhat behind because they have had to face to a lesser extent these threats and realities. Nevertheless, the agricultural companies, in the case of Guatemala, exceed the world average in terms of the degree of importance attached to this variable, while the industrial companies are below the world average (Equipo Técnico y de Supervisión 2012a pp. 48 y 49; Enkvist and Vanthournout 2007). However, the lower the educational level of the staff employed in agriculture, with the exception of senior managers, is a limitation to the introduction of innovations that require a higher expertise. This is observed in the fact that at least some industries have begun to measure their carbon footprint, while the same practice is not present in agriculture. In addition, a growing trend in most industries is to affiliate themselves with organizations that promote corporate social responsibility, although there is still a long way to go for this innovation.

(b) Priorities differ according to the nature of the entities: naturally companies focus more on production, teachers on research and teaching, and decision-makers are concerned with national problems. However in all these cases there are considerable deficits. There are still major specific concerns from businesses in general, as is natural, regarding the chain of production. For example, the fragile road infrastructure that may threaten or interrupt the supply chain, or the problems derived from the pressure of stakeholders regarding the environment that could have an impact in an increase in the costs of production or public prohibitions. Here, reservations came up by managers' firms regarding prohibitions and limitations to the exploitation of natural resources. On the other hand, these concerns are not present to this extent, among teachers and decision-makers from universities, government, and NGOs.

The main actors interviewed pointed out the differential impact to be expected in the future. Agricultural enterprises were very specific in the changes they deemed necessary in order to develop new technologies and methods of plague and disease control. For example, they mentioned programs of planting and harvesting, the design of new crop calendars, and techniques that will allow planting and reaping in unusual dates, the transfer of crops to new altitudes and the introduction of new irrigation systems with more efficient water use. For their part, the industrial managers expressed their concern regarding disruptions on the supply and distribution side. Also they mention the impact of infrastructure damages, but confirmed that their activities were more resistant and can better adapt to climate problems, reporting that there are few cases of frequent and permanent damages in all operational processes at a disaster scale.

There would be room, however, to face the future over CC threats, by industrial companies. For example, they may develop capabilities in green building technologies, clean development mechanisms, including carbon market tendencies, emission reduction technology, risk management, and improvements in energy efficiency. There might be a particular concern also about water management, which is common among both industrial and agricultural companies. Agricultural companies tend to focus more on irrigation problems, while both agricultural and industrial companies are concerned with efficient and productive use of water and preservation of springs. On the other hand, professors are more inclined toward teaching and research as well as to interdisciplinary programs to investigate the effects of vulnerabilities and disasters in the country. It is particularly striking to observe the low priority on needed legal proposals and regulations. On the other hand, decision-makers in the public and non-governmental sector, have more concerns of national character without territorial references when they compare with companies and teachers. Nevertheless, they express their concern for the coordination of their hierarchical structures before any climate threat throughout all the country.

In general, the interaction between the three sample populations had particular traits. Universities have generally concentrated activities within their own campus. In turn, they show less ties (or "bridges" or networks) to other private corporations, civil society, and government. While this aspect may aid the intellectual production per se, their intensity could lead the academy (as a whole) to give their back to national problems and criticisms from the rest of the stakeholders of society that regard universities as "ivory towers." However, in viewing the environment, greater coincidences emerge between decision-makers belonging to the public sector and non-governmental organization, as should be expected. Both entities address citizen issues, and it is from this common characteristic that the frequent association arises between state activities that finance programs that NGOs implement. In spite of this, these alliances could have a lack of transparency derived from the private or non-governmental nature of entities that despite having a citizen orientation possess in great measure a private nature.

(c) Research and technology centers of the academia should have priorities regarding possible adaptation measures that could have the support of agricultural and industrial sectors for "green" solutions, clean development mechanism, mitigation, and energy efficiency. Table 1 summarizes an example of the suggestions given by different stakeholders of the industrial and agricultural sectors, regarding the main needs they have that universities may help. These suggestions are general and specific. Table 1 uses water as an example because it is increasingly becoming a strategic resource. This example is applicable to other strategic areas as well. Necessity suggests making a common practice of the knowledge gained, scaling it up or down according to the challenge presented.

(d) Along these lines, respondents in the survey suggested other activities that may strengthen the alliance of the sector with university activities such as definitions of common research objectives, partners' agreements, networks, internships, supervised professional practices, technical assistance given by specialized university personnel to other sectors and the mutual development of patents. The priorities for these technology centers should then revolve around the knowledge elements highlighted in the following Table 1, using the example of water as a strategic resource.

Table 1 show possible courses with specific concerns of managers related to hydroelectric, agricultural, and industrial plants. The idea of outlining these priorities is the appeal that they represent for decision-makers in relevant careers at the

Table 1 General and specific suggestions regarding knowledge and general management and that of water as an example for other specialized areas

Priority	Industrial	Agricultural
General		
1	Technology for green buildings	Methods and technologies for plague and disease control
2	Clean development mechanisms (CDM), carbon markets	Technology to modify the dates of planting and harvesting
3	Technologies for emissions reduction	Adaptation and introduction of new crops and varieties because of climate changes
4	Risk management	Technology for crop adaptation to different heights
5	Technology for better energy efficiency	Technology and methodology for earth handling
Water management		
1	Technology for water reuse	Irrigation technology
2	Technology for efficient water use	Technology for efficient water use
3	Technology for spring preservation	Technology for spring preservation

universities for designing areas of knowledge and training for these specific groups. Water is just an example. This exercise repeated in other areas may cover public policies, social organizations, administration, human resources, climate sciences, risk analysis, financing, etc. What we should have in mind is that sustainability implies many sectors and disciplines that look at specific transversal issues.

What is required to expand this scope is to engage in a curriculum reform that connects universities with the larger society. Other plans, policies, programs, and projects are possible to devise. In this sense, the term "bridges" is probably more appropriate. These possible "bridges" are the following.

Mutual research ventures that capable of forging alliances among business, academic, public, and non-governmental sectors.

- Multiple agreements and collaboration projects, to be detailed and agreed upon.
- Multiple strategic alliances based on objectives that may build true networks in a given field of interest.
- The creation of internships that could help students gain and accumulate professional experience, by placing university students in other sectors. This way they contribute to these host entities and the system as a whole.
- The encouragement of a Supervised Professional Practice (EPS by its name in Spanish), where Guatemala has extensive experience, created by all interested entities that demand and practice external activities related to the curriculum of the universities. They are assigned to functional sectors as well as territorial entities searching for a decentralized approach.
- The provision of technical services of the universities toward companies, public sector, between universities themselves and non-governmental organizations, while helping these entities to develop more openness to strengthen the alliance and common goals through lectures, forums, graduation thesis contributions, etc.
- The combined development of patents that are derived from the research work carried out by the concerted participating entities.

(e) Specifically, it becomes necessary based on the priorities claimed by those surveyed, to work on research and technical applications to the following adaptation measures with significant curricular reforms. This reasoning would lead to an expansion of Table 1. Respondents suggest including the issue of environment and climate change in the following careers:

i. Engineering and Architecture: Through risk analysis, contingency plans, clean technology, recycling and efficient water and energy use, and the design of "green buildings."
ii. Agriculture: Development of crops and varieties with greater resistance to drought, diseases, and adaptation to these new climatological conditions; reforestation and protection of water resources, new techniques for soil management, irrigation technology.

iii. Economic Science and Business Administration: Risk analysis, contingency plans, clean technology, recycling. Incorporation of environmental variables to national and private accounts.
iv. Information and Communication Technologies: Redundant systems for protection of data, redundant communication systems, and early warning systems.
v. Human Sciences: Social dimensions of early warning systems, organization and planning of risks, public participation techniques in the aforementioned areas, public policy advocacy and conflict resolution.

Finally, managers consider that training on issues related to climate change should be conducted within the company, at work and through distance learning. On the other hand, universities should develop innovative training systems, incorporating those modalities. All the suggestions made will consolidate multiple alliances and activities that will make the universities in Guatemala more sustainable. Many of these innovations may be applied elsewhere in developed as well as developing countries. Consolidated networks will help to face the challenges implied in the sustainable development of all the planets in the future as has been proclaimed by the last 2015 General Assembly in New York and COP21 in Paris.

9 Conclusions and Recommendations for Decision-Making Regarding Renewable Energy and Climate Change

If the suggestions made in this paper become a reality, a vision of the future may emerge in its conclusions. The lessons suggested in this paper would strengthen the sustainability of the university, making her more responsive to corporations that in the process will acquire greater consciousness of their social responsibility. Simultaneously, governments will be more open to horizontal relationships when they realize the benefits of greater formation and share responsibilities with experts in their main fields. Civil Society will increase their participation in public issues, contributing to their organizations to the well-being of all citizens and focusing better their efforts thanks to the new knowledge and training they will receive. Universities will offer professionals in different careers as always, but they will have a common approach exercising their expertise when they will make compatible development (including their socioeconomic components) and environment and a renovated concern with future generations.

Obtained results in these surveys indicate the need to make significant changes in the ways training and formation constitute usual practices at the universities. The challenges that arise under the umbrella of sustainable development request a renovated staff at the decision-maker level at the universities, private sector, government, and civil society organizations.

From the analysis, a first gap arises suggesting that decision-makers in the academia, private sector, government, and civil society must address. It refers to the breach between research and teaching at the universities and its repercussions in the larger society. The lack of investment resources for research, the absence of laboratories in which to carry out these activities, the low offer of specialized personnel that meets the expectations of every university, are limitations to face this challenge. Ideal demands prescribe that teachers write, investigate, and teach. However, difficulties in the access to knowledge and other research institutes, deficiencies in procuring adequate training, lack of specialized publications that acknowledge even the smallest efforts determine little or inexistent generation of patents. In addition, the lack of private, civil society, and public sector interest in providing this platform, among other factors, deepens this gap.

The second gap identified is that which arises from sustainable development issues in general, renewable energy and climate change. Knowledge segmentation is also a distinguishable pattern here. This practice is almost a corollary of the first gap. An absence of linkages and synergies in the curriculum of careers most related to environmental impacts, tend to separate their knowledge from other areas. On the other hand, the groups that work in renewable energy in the labor structure often have little connection with those implementing environmental issues. Particularly, climate change becomes something marginal and distant from the larger society and vice versa.

A third gap that contributes to the latter, relates to specialization as opposed to a multidisciplinary perspective. In the latter, there is reference to the difficulties of inserting other different disciplines than those focused on the detection, design, and exploitation of environmental issues, energy sources, and climate change. When one puts the emphasis in temporary and strategic periods designed to overcoming this gap, the possible tension may dilute, if the teaching–learning process is oriented to specialized knowledge in the short term but giving room to multidisciplinary views in the long-term.

The fourth gap that was mentioned, can also be extended to both RE and CC from a sustainable development perspective. It refers to the deficits in the internal and external coordination within each decision-makers group, including universities and the interaction among the different sectors themselves: academic, governmental, entrepreneurial, and non-governmental groups. This absence prevents synergies that could move both the objectives of the priorities of renewable energy in the country as well as those of climate change and sustainable development in the short, medium and long term. Hence, needed decisions around this gap suggest an innovative approach adopting the "Quadruple and Quintuple Helix," which encompasses an ecological focus together with a close collaboration among different sectors through joint networks involving the academia, private sector, government, and civil society groups.

The fifth gap refers to the lack of perception and therefore connection between the temporal dimensions of short, medium and long term that may link the issue of climate change with the factors that affect it. It is not only about disasters and threats such as storms and flooding but also plans, policies, programs, and projects

that should suggest solutions like the subject of renewable energy as a remedy for this situation. A key aspect to consider is the objective of how to tackle climate change. Its threat is so pervasive that by itself may order and prioritize the entire sustainable development area with its many repercussions, disciplines, and subjects in areas that are normally distant from each other and that contribute to the dispersion of goals and dilapidation of resources. Supporting the existence of the previous five gaps and seeking their convergence is necessary to suggest the application of preventive "smart" strategies in the face of threats and risks of climate change, before, during, and after the event. This appraisal should introduce the short and medium term in addition to the long term, to be effective in coping with this phenomenon. These decisions would force all actors to behave accordingly, dismissing the attitude that influences doing nothing because it is a threat that belongs to the next century.

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Using Design Thinking and Facebook to Accompany Women in Solving Water Problems in Morocco

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Abstract

Environmental issues are complex and malicious problems involving many characteristics, variables, increasing their level of uncertainty. While accompanying groups in solving their environmental problems, it is important to develop collaborative and creative approaches to properly define the problem at hand. In Morocco, flooding combined with climate change is damaging the drinking water supply system. The victims of this problem are searching for adaptation strategies. Design thinking and Facebook were selected as the methods to guide 10 Moroccan women in solving a problem with flooding. Design thinking encourages a needs analysis, abductive reasoning, and rapid prototyping. Digital tools, such as Facebook, can also help with problem definition, discussion, and solution development. Through the use of videos and pictures, the women shared their flood experience on Facebook and together solved the issue of poor drinking water as they were guided through the steps of design thinking. The experience allowed the women to broaden their definition of the problem and prototype

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various water purification solutions that demonstrated potential. The women developed a sense of collaboration and carried out flood adaptation strategies.

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, etc., 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). According to English (1997), **defining** a problem consists of properly formulating it in order to solve it. The advantages of a well-defined environmental problem are varied: having a clear idea of what is sought; identifying relevant information; reducing the sense of disorientation; and, applying effective solutions (Pruneau et al. 2015). Indeed, Stoyanova (2000) posits that while defining the problem, the resolver interprets the problematic situation in his own words, rearranging information linked to the issue, and frames the problem statement a number of times in order to make it clear and identify the challenges and objectives of solving it. In some ways, the resolver is taking personal ownership of the problem and using specific wording to help solve it. This is a difficult task to accomplish. To **define** a problem, the resolver relies on his knowledge, combines ideas, reasons, makes abstractions, questions, synthesizes, evaluates, and visualizes the information that was discovered (Pruneau et al. 2015). Various aspects of environmental problems must be considered: causes, time, actors involved, impacts, duration, the

nature of the problems, and their social and scientific aspects, both quantitative and qualitative (Pruneau et al. 2015). Thus, when we accompany victims of an environmental disaster, it is desirable to follow an **approach that fosters a broadened definition of the problem**.

Moreover, 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 and new practices are needed in today's world: renewable energy, efficient transportation, healthy cities, resilient agricultural systems, etc. When accompanying groups in solving their environmental problems, it is important to develop **collaborative and creative approaches promoting the best possible definition of the situations that may arise**.

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 to 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-Centred Design, etc. 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 synthesized 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) summarize 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 centred on human needs. Prototypes that are developed quickly and without seeking perfection become "playing fields" that foster discussion and learning about certain solutions (Lietdka 2015). As such, the problem and the solutions co-evolve (Dorst and Cross 2001).

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-Centred Design*, and NGOs such as *IDEO.org* and *MindLab*, the focus is on developing processes favourable to the 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, etc.,) 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 summarize 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, etc. (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, 10 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 in this exploratory and descriptive case study 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 Methodology

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 and descriptive case study in Morocco was carried out with women from the remote and impoverished Ourika region. The GIREPSE project is most closely related to three of the Sustainable Development Goals adopted by the United Nations (2015): (5) Gender equality; (6) Clean water and, (13) Climate action. This project involved accompanying the women using design thinking and Facebook, and observing how these two approaches would allow them to collaborate in defining and solving a flooding problem. Ten 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 km 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 7 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, etc.) 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 2-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, etc. 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, etc. 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 analyzed. 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 conceptual framework that prompted the analysis focused on the benefits from the chosen support measures (design thinking and Facebook). Did design thinking—equipped with Facebook—encourage collaboration, a broadened definition of the potable water issue, and creativity in developing solutions?

In order to observe how the women collaborated in solving the main flooding problem and the related drinking water issue, a table was developed using social media participation indicators proposed by Garau (2013): total number of posts over a given period of time; activity type (images, videos, text); mean number of comments per post; and, mean number of "likes" per post.

As a means of analyzing the women's definition (whether broadened or not) of the potable water issue, interview data and Facebook posts underwent a thematic analysis (Paillé and Mucchielli 2008) by two researchers both on an individual and combined basis. The themes identified by the thematic analysis were how the women represented the drinking water issue as well as the types of learning they stated having achieved together.

The creativity behind what the women proposed as solutions to the drinking water issue was evaluated by two researchers (triangulation of analysts) based on fluidity, originality, and feasibility, as proposed by Torrance (2008). According to Amégan (1993), fluidity is the resolver's ability "to have a fast flow of ideas; to think of more things, ideas, and questions; to consider the greatest number of possible solutions in a given amount of time when faced with a particular problem," (p. 25). Torrance and Goff (1999) define originality as the ability to produce new, innovative, and unusual ideas, while Torrance (2008) suggests it is ideas that are statistically rare. Fluidity and originality allow the assessment of divergent production (creativity), while feasibility is used to evaluate the extent to which proposed solutions can be put into practice and solve the problem. To assess the participants' solutions, the researchers—individually and then combined—scored each creativity criteria from 0 to 2. The fluidity score was awarded based on the number of pertinent solutions linked to the requested task. The originality score was awarded based on the novelty of the proposed solutions (as perceived by the researchers). The feasibility score was awarded according to two indicators: achievability (1) and effectiveness (1). Achievability was considered in relation to the local availability of materials as well as human and material resources to develop the solution, while effectiveness was determined by evaluating the potential

improvement in water quality as a result of the proposed solution. The mean creativity score was then calculated for all participants' solutions by taking the total fluidity, feasibility, and originality scores of the eight solutions (44), and dividing it by the maximum possible score (48).

One limitation of this research has been what we generally associate with exploratory and descriptive studies, namely the poor generalizability of the results to other cases or regions. In sustainability research, on the other hand, exploratory or descriptive case studies are recommended by Evans (2011) and Yin (2009) as reliable and useful methods to observe groundbreaking initiatives that highlight the practical benefits to the participants. Another limitation was the result of a budget allowing only a limited number of in-person meetings with the women to build and assess prototypes in a team setting.

2.1 Results: The Women's Participation in the Facebook Group

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.

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, etc.) 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 7-month period devoted to the problems with their drinking water, motivation to participate in 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.

2.2 Results: Collaborative Learning as Reported by the Women

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

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
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
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

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

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

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. Finally, they enjoy sharing what they have learned with their families, friends, and fellow citizens from the village.

2.3 Results: Representations of the Water Quality Problem

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 of 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,

diarrhoea, 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 Fig. 1).

Fig. 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.

2.4 Results: Analysis of the Creativity of Solutions Proposed by the Women

Table 3 displays the research team's assessment of the creativity of solutions proposed by the participants. Recall that three indicators were used to evaluate creativity: fluidity, feasibility, and originality. Given the chosen assessment scheme, the mean creativity score for all solutions was 91.7%.

Given the variety of valid solutions proposed by the participants, the research team gave all solutions a fluidity score of 2/2. Across the eight solutions, feasibility also often received a high score (generally 2/2 with one solution receiving 1/2). All proposed solutions appeared to be more or less achievable with the equipment and human and material resources available in the region, and could effectively contribute to improving water quality. Given the unique nature of the solutions

Table 3 Creativity scores for the participants' solutions as given by the research team

Water quality solutions proposed by the participants	Fluidity score (/2)	Feasibility score (achievability + effectiveness) (/2)	Originality score (/2)	Mean creativity score (for all solutions) (/100)
Find better water sources	2/2	2/2	2/2	91.7%
Build water storage structures to ensure home distribution	2/2	2/2	2/2	
Treat well water with appropriate quantities of chlorine	2/2	2/2	1/2	
Educate the public so they avoid throwing their trash in the river	2/2	2/2	2/2	
Build solid pipes	2/2	2/2	1/2	
Build wells far away from the river and flood zones	2/2	2/2	2/2	
Filter water before it reaches the tap	2/2	2/2	2/2	
Use filters superimposed with sand, rocks, coal, and tissue in plastic containers	2/2	1/2 (2 for achievability and 1 for effectiveness)	1/2	

proposed for the region, most solutions received elevated scores (2/2) for originality, except for solidification of pipes and filter prototypes, which both received scores of 1/2. In fact, the filters did not entirely satisfy the research team even though the participants appeared quite pleased with them. We considered that the women did not really develop an innovative filter, but rather variations of the prototype developed during Workshop number 4. The women essentially rearranged the coal, rocks, sand, tissue, and plastic containers in different configurations.

3 Conclusion

The guided approach with Moroccan participants aimed to broaden the scope of issues under examination through collaboration and creativity. Following the results demonstrated above, we can posit that the approach used (design thinking + Facebook) allowed the women to collaborate on a broadened definition of the main flooding problem and related drinking water quality problem according to their experiences and their needs.

While not necessarily original, the solutions proposed by the women were varied (fluidity), realistic, and with a good level of efficacy (according to them and to us). 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 seem 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, etc., 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 unrecognized 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 realized and perceived by their peers.

Other case studies should be conducted in order to strengthen the results of our study and, over time, identify the steps, instructional interventions, and communication tools that foster the development of effective environmental solutions using design thinking.

However, this research reinforces the idea promoted by the International Telecommunication Union (2015): ICTs could facilitate the achievement of the Sustainable Development Goals (SDGs). They could empower people, particularly women, by reinforcing their capacities to solve their problems and to resist to climate change. Mazman and Usluel (2010), Ajjan and Hartshorne (2008), Barron (2006) and Mason (2006) argue that Facebook is potentially beneficial for interaction, collaboration, information, resource sharing, and problem-solving. 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: summarizing 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 favourably in solving environmental problems, which was not possible in the current research given the novice ICT abilities of our participants.

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A Critical Review of the Role of Indicators in Implementing the Sustainable Development Goals

Simon Mair, Aled Jones, Jonathan Ward, Ian Christie, Angela Druckman and Fergus Lyon

Abstract

The 17 Sustainable Development Goals (SDGs) bring together environmental, social and economic concerns. They therefore have the potential to move society away from the dominant model of prosperity as purely economic toward a more holistic and 'sustainable' prosperity. But, the success of such a transformative agenda rests on its implementation. At the heart of planned implementation of the SDGs is a set of 230 indicators. Indicators have been strongly critiqued in a range of literatures. However, in the context of the SDGs, indicators have been described as 'essential' with little critical assessment of their role in implementation. Therefore, this chapter aims to provide this critical voice. To do this, the

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chapter reviews critiques of indicators from sustainability science, anthropology and sociology and provides illustrative cases of indicators implementation. From this review we are able to draw lessons for the use of indicators in SDG implementation. Specifically, the chapter argues that indicators are reductionist and struggle with contested concepts. Nevertheless, by making the operationalisation of concepts visible and enabling quantified analysis, indicators can have a useful role in SDG implementation. However, this requires that indicator critiques are taken seriously and inform indicator use.

1 Introduction

The Sustainable Development Goals (SDGs) have 230 quantified indicators, described as essential for "the measurement of progress", ensuring "that no one is left behind", and "key to decision making" (UN 2015, p. 12). While indicators are widely perceived as useful for understanding and communicating about sustainability, there is a substantial body of interdisciplinary work that is highly critical of their use (e.g. Bell and Morse 2008; Merry 2011). This critical voice is missing from SDG indicator discussions. Therefore this chapter reviews the literature that is critical of indicators and applies it in the context of the SDGs. In doing so, we aim to (1) highlight potential pitfalls of using indicators in SDG implementation, and therefore (2) develop our understanding of how indicators could be successfully used in implementation of the SDGs.

Before continuing with the chapter, it is worth outlining its limitations and constraints. The chapter is based on a review of the literature that critically assesses indicators. This literature is voluminous, and we do not attempt here to cover it in its entirety. Instead we draw our theoretical arguments from several key texts and highlight specific cases using illustrative case studies.

1.1 The Pros and Cons of Indicator Use

Indicators are central to many sustainability initiatives, because they are a useful way to generate knowledge of, and communicate about, complex issues. Indicators break complex issues into more readily understood chunks of information thus allowing communication between experts and non-experts (Merry 2011; Morse 2016). Likewise, through selecting and measuring a finite set of quantified indicators that approximate the essential elements of a concept, experts can 'measure' an otherwise immeasurable entity (Turnhout et al. 2007). There is a long history of using indicators in this way in the biological sciences, particularly ecology (Bell and Morse 2008) and indicators are applied similarly in sustainability research. For instance, Mair et al. (2016) use four indicators (carbon emissions, employment,

income and profit) to frame their investigation into the sustainability of Western European clothing consumption. Using the four indicators, they examine how the sustainability of the Western European clothing supply chain has changed over time and identify the mechanisms behind these changes. In such cases, indicators can function as an analytical structure, mediating between the nuanced, complex and difficult to interrogate concept of sustainability, and the blunt analytical tools with which complex systems can be investigated.

However, indicators have been widely critiqued. Indicators are reductionist analytical tools and their use risks oversimplification, particularly in highly complex and contested contexts (Bell and Morse 2008; Merry 2011). This can be especially problematic because of the ways in which users interact with indicators. Indicators are often assumed to be objective and complete descriptions of the concepts they measure, but in reality are often value-laden and incomplete (Merry 2011; Porter 1995). Those with different agendas may therefore exert power and lobby to ensure indicators do not challenge their interests. Moreover, indicators help us to construct knowledge and guide decision-making. Consequently, where they inadequately describe a contested concept, that concept may even become redefined in terms of its indicators (Espeland and Sauder 2007). This can lead to policies and strategies that focus on what is measurable rather than addressing less tangible issues. For example, the use of GDP as an indicator of societal progress has led to a reframing of societal progress as predominantly about increased productive capacity of the economy, creating a 'growth imperative' (Jackson 2017).

GDP is a particularly pertinent example of the dangers of indicators. First it is an inadequate measure of societal progress because it misses important factors that contribute to broader conceptions of progress (Anderson 2014). Second, GDP growth is strongly correlated with negative environmental impacts, and the extent to which it can solve social problems is questionable (Victor 2007). Moreover, although such critiques occasionally find a home in political discourse, (e.g. Kennedy 1968; DETR 1999) policymakers have yet to move on from the use of GDP as a proxy measure of progress, and of growth in GDP as the principal objective of most government policies (Victor 2007).

1.2 Indicators for a Better Future?

Given their prominent place in the SDGs, this chapter engages with the ways in which indicators may be used to help imagine, explore and create a better future. The SDGs aim to bring about a world in which "all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature." (UN 2015, p. 2). However, such a vision is highly contested and (given that indicators can be problematic in the absence of a fully agreed definition) the use of indicators in the SDGs should be approached with care.

Therefore, in this chapter we critically engage with indicators, particularly where they have been used in the context of contested and complex phenomena. Based on a review of the sociological, anthropological and sustainability literatures, we

critique indicators as they have been used for various sociocultural projects, with a view to understanding how they may be used in implementing the SDGs.

The rest of the chapter is structured as follows. In the next section we describe the contested nature of the SDGs. In Sect. 3 we highlight that indicators of contested concepts are not neutral, but instead represent a particular perspective on an issue. We then demonstrate the difficulties this raises by comparing the SDG indicators to other Sustainable Development Indicators. In Sect. 4 we elaborate on this, drawing on examples from the cultural projects to highlight how indicators of contested concepts risk oversimplification when faced with the complexity of moral problems. Finally, in Sect. 5 we discuss the implications of these critiques for indicator use, arguing that although they should influence indicator use, they do not altogether negate the usefulness of indicators.

2 Contested Concepts and the Sustainable Development Goals

The idea of a set of 'Sustainable Development Goals' is highly contested—'sustainability', 'development' and even 'goals' relate to issues that are subjective and politically sensitive. Sustainability deals with heavily value-laden issues including the proper relationship between society and the nature and from one generation to another. Likewise, 'development' is an ill-defined term. The SDGs succeed the Millennium Development Goals, which viewed development as a project to be pursued by poor countries, aided by richer countries. The SDGs, however, are referred to as 'universal' and therefore presumably have a very different view of development (UN 2015). Finally, the nature of 'goals' is not clear cut, given different levels of investment in the vision of a particular goal, as well as considerable differences in social and economic power, goals that for some nations are easily realisable, will for others be purely aspirational. As a result, progress towards the Millennium Development Goals, for instance, was "far from uniform across the world" (UN 2006).

As a result, the vision that drives the SDGs is highly contested. This can be illustrated by considering those elements that relate to physical realities, and are therefore nominally less subjective than purely social aspects. For example, the need to reduce damage to the environment. For some, this is rooted in the view that there are 'planetary boundaries' that humanity must avoid crossing in order to remain in a 'safe operating space'. While this idea is grounded in physical science (Steffen et al. 2015), planetary boundaries are constructed in such a way as to preserve current conditions. For example, a biodiversity 'limit' assumes that we value today's biodiversity more than historic or future biodiversity and does not account for the idea that a new biodiversity could flourish under the conditions of a changed environment. Furthermore, the impact of planetary limits on our ability to 'prosper' is highly contested. The 'strong' view of sustainability sees natural and man-made capital as complements, rather than substitutes, and therefore requires us

to be cognizant of physical limits. On the other hand, there is an alternative reading of the impact of planetary limits ('weak' sustainability) which views them as negligible importance in the construction of sustainable policies (Neumayer 2003).

If such issues appear complex, things do not become clearer when we look at other aspects of the SDGs. As we will see, issues such as poverty, inequality and decent work are far from analytical: what counts as 'decent', for example? How do we measure 'inequality'? What do we mean by 'poverty'?

3 Indicators Are Limited Interpretations, Not Objective Descriptions

Contested concepts defy the naïve understanding of indicators as measures of the essential components of a system. In the naïve view, researchers construct new information or communicate about a system by combining and interpreting multiple indicators (Bell and Morse 2008, Fig. 1). This understanding is applicable in objective and well-understood systems. But contested concepts are characterised by multiple, conflicting ideas about the system works and an indicator set is only able to represent a subset of these understandings. Moreover, the differences in system understandings result in different indicators (Meadows 1998; Davis et al. 2015). Therefore, an indicator of a contested system should not be understood as a piece of information about a system, but a piece of information reflecting how an individual or group conceptualises that system (Fig. 2).

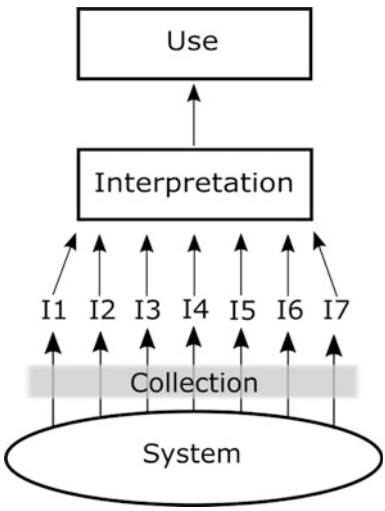

Fig. 1 The naïve view of indicators (I), adapted from Bell and Morse (2008). I1 to I7 are indicators that collect information about the system

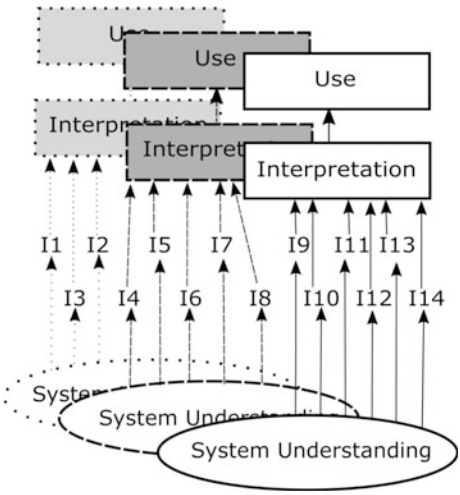

Fig. 2 The concept of indicators as applied to highly contested and badly understood systems. While there are multiple conflicting understandings of contested systems, a given indicator set can only represent one (or a small subset) of those understandings

3.1 Three Different Understandings of Sustainable Development

To illustrate how the ability to represent only a limited perspective creates difficulties for indicators in contested systems, we compare and contrast the SDGs with two other sustainable development indicators sets. The UK (Lofts and Macrory 2015) and the EU (Eurostat 2015) have each developed a set of indicators that should be very similar to the SDG indicator set—all three indicator sets attempt to measure sustainable development and are primarily designed to be used by nation states.

However, there are substantial differences between each of the indicator sets. Not only can these indicator sets not agree on common statistical metrics—*they fundamentally cannot agree on how to frame the indicator sets*. At the most basic level, each set contains a different number of indicators or targets

- SDGs—17 goals, 169 targets, 230 Indicators;
- EU sustainable development indicators (SDIs)—10 thematic areas, 132 indicators;
- UK SDIs—3 thematic areas, 66 indicators.

Looking deeper, there are only three indicators that use the same statistical measure across the three frameworks: (1) GDP per capita, (2) Greenhouse gas emissions and (3) Share of renewable energy. Moreover, there are elements of each of these that are debated. There are only six further indicators that have a common outcome but differing statistical measures: (1) Increase research and development (2) Reduce air pollution (or the impact of air pollution) (3) Increase water efficiency (4) Increase river quality (5) Regulation of fishing (6) Protection of forests. Some of

these differences are understandable, we would expect national and international frameworks to have some different targets (there is little reason for the UK to have a national target relating to rainforests, for example). However, many of the differences are less intuitive.

For example, 'poverty' appears in all three indicator sets, but each uses different statistical measures. The SDGs poverty indicators focus on the proportion of a national population suffering from various dimensions of poverty. Income and monetary aspects of poverty are captured through measures of people living below national and international poverty lines, while more social dimensions of poverty are captured by measuring the proportion of the population unable to access social protection systems and lacking access to basic services. In contrast, the UK's poverty SDIs focus predominantly on the proportion of children living in low income households, where income is defined both in absolute and relative terms.

Indicators both reflect and help construct theoretical perspectives and problem conceptualisations (Merry 2011): the differences in the UK SDI and the SDG poverty indicators represent alternative understandings of poverty. The UK SDIs emerge from a conceptualisation of poverty as a primarily monetary problem, albeit with a role for societal norms around income. Further, the UK SDI theory of poverty sees households with children as the most at risk group (perhaps because they are most likely to be affected, or likely to suffer the most). Conversely, the SDG poverty indicators emerge from a conceptualisation of poverty as a problem that is broader than income alone (hence the inclusion of indicators on societal safety nets); they are based on a view of poverty as a problem for people of all ages (with indicators focused on a range of demographics); and they do not view societal norms as particularly important. Instead the SDGs focus on absolute understandings of poverty and have no explicit indicators for relative poverty.

3.2 Indicators Shape How We View the World: Alternative Indictors Can Lead to Conflicting Outcomes

The differences in the three indicator sets may even drive outcomes that undermine each other. Indicators refocus attention on to the elements of a concept that they measure and away from the elements that they do not. In this way, indicators direct how their users think about and attempt to deal with the concept itself (Espeland and Sauder 2007; Merry 2011). For example, the UK SDIs include a measure of the origin of food consumed in the UK, while the EU SDIs include a measure of imports from developing countries by group of products. Therefore, at the UK level there is a target to reduce food imports while at the EU level there is a target to increase them (albeit from a specific set of countries). Likewise, it seems reasonable to suggest that the UK SDI poverty indicators will result in different policies and outcomes than the SDG poverty indicators. For example, if the UK reduced the coverage of its social protection systems but simultaneously increased the average income of households with children, poverty could get both worse (according to the SDG definition) and better (according to the UK SDI definition)!

4 Indicators Struggle with Unquantifiable, Moral Issues

Indicators are further challenged by the difficulty of codifying and linking important elements of contested concepts. The chief utility of indicators comes from the way they make complex issues more manageable through simplification. By definition, this requires losing information. Often, this information is the contextual and qualitative, discarded because it is hard to quantify, rather than because it is unimportant (Porter 1995). Moreover, indicator sets have typically been developed without explicit consideration of their ethical basis or the moral assumptions embedded in their construction. Fredericks (2014, p. 6) argues that "there is a widespread assumption in modern Western society that technical and ethical assessments are, and should be, completely separable". This needs to be rejected, in her view, on the grounds that "developing indexes without explicit attention to ethics runs the risk of ineffective indexes, or even worse, indexes which drive people away from their vision of sustainability" (Fredericks 2014, p. 9).

4.1 Arts, Culture and Ultimate Ends

Informative examples of this crucial point about the ethical dimension of indicators, and the ways in which indicators struggle with difficult to codify ideas, are found in cultural indicator initiatives such as 'Taking Part'. Taking Part is perhaps the largest and most prominent attempt to provide data on the cultural sector in England. Research using Taking Part data claims to provide 'robust' evidence (DCMS 2014, p. 4) of links between certain kinds of cultural participation and well-being. However, establishing causal links between participation and other outcomes—such as increased well-being—proves difficult. Though quantitative analyses from the UK, as well as Canada, Italy and elsewhere, demonstrate a link between engagement in art and culture, and well-being, for many, "the challenges of disentangling confounding variables and establishing directions of causality remain" (Crossick and Kaszynska 2016, p. 38).

Daly's Pyramid (Meadows 1998; Fig. 3), is a useful framework for understanding why connecting the Taking Part participation indicators to 'wellbeing' is difficult. Daly's Pyramid frames indicators as falling into one of four categories: at the top of the pyramid are Ultimate Ends—the things that we strive for, the high level concepts that together (arguably) constitute prosperity. At the base of the pyramid are the Ultimate Means—the fundamental earth systems without which we could not survive. In between the two are intermediate means (human labour, tools, etc.) which are used to produce intermediate ends (consumer goods, knowledge, etc.). Intermediate ends are tools that are necessary to achieve our ultimate ends.

Taking Part measures intermediate ends, gathering information about participation and engagement in arts and cultural activities. This includes questions that aim to uncover drivers and barriers to participation as well as socio-demographic

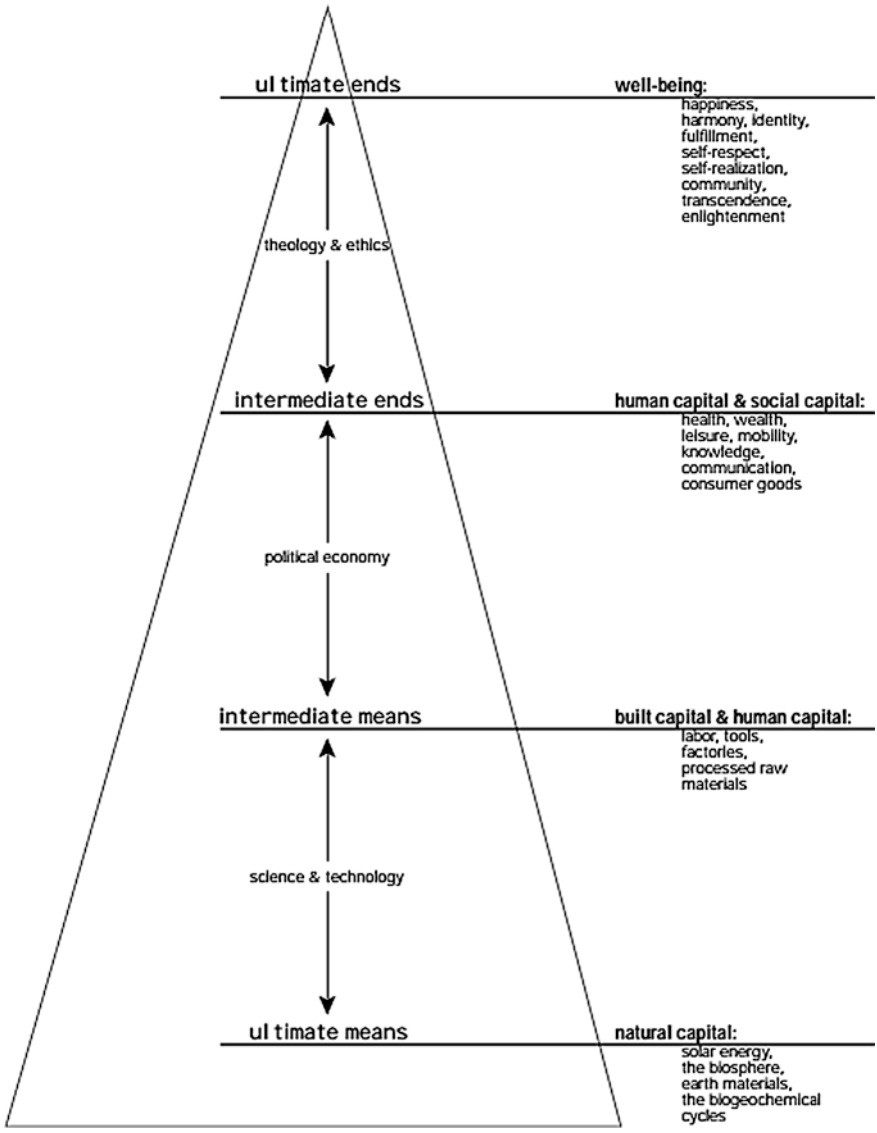

Fig. 3 Daly's Pyramid, taken from Meadows (1998)

data. These data are released at 6 monthly intervals and provide headline figures on participation and engagement (DCMS 2015).

However, 'wellbeing' is an ultimate end, not an intermediate end, and it is in connecting the two that problems arise. The data collected in Taking Part allows researchers to produce models that control for other factors (such as income) and provide a statistical evidence-base for claims about the positive impacts of cultural

activity that speak to government objectives on well-being (Walmsley 2012). But, as Daly's Pyramid makes explicit, ultimate ends indicators are the outputs of ethical and theological frameworks. In other words, they emerge from a process of highly personal interpretation informed not only by quantifiable measures but by emotional and moral reasoning. As Walmsley (2012, p. 329) argues, many of the ways that culture and art influence well-being are personal and intrinsic, taking us "into the immeasurable realms of spirituality and emotion".

It is also worth noting that lack of clarity and difficulty of quantification is not confined to the moral aspects of ultimate ends. It takes considerable effort "to arrange an unruly humanity into uncomfortable categories" (Porter 1995, p. 41). Consequently, arbitrary exclusion and subjective categorisation are apparent even in the more mundane aspects of intermediate and ultimate ends indicators. Efforts to produce indicators for cultural work, for instance, are hampered by unclear boundaries and distinctions that make even counting the number of cultural workers difficult. Taking a sectoral approach to these labour markets includes large numbers of individuals in non-'creative' roles while excluding cultural/creative workers in non-'creative' industries, while approaches that seek to utilise 'creative intensity' ultimately include roles that have little cultural output (Bakhshi et al. 2013).

4.2 Indicators that Ignore Essential Elements Risk Undermining the Concept They Claim to Measure

These issues are particularly problematic because of the power of indicators to shape the thoughts and actions of researchers and decision makers: through indicator use, the more complex and qualitative aspects of ultimate ends risk being lost or ignored. As discussed in 3.2, indicators can come to redefine concepts by directing attention only to those dimensions captured by the indicator (Merry 2011). The act of measuring is not passive; rather, it shapes and defines what it is we are measuring, highlighting aspects to be important and, by omission, defining those aspects that are not important. As a result, indicators that ignore important elements of a concept may lead to policies that either overlook or actively conflict with the original concept as it is more broadly understood. In the arts, for example, Oakley et al. (2013, p. 24) point out that 'well-being-friendly' cultural policy may exacerbate current well-being inequalities.

Furthermore, there is a risk of concepts being redefined at all levels of society. Quantitative measures give the appearance of objectivity and neutrality: numbers often hide the complexity and value-laden nature of the judgements used in their construction (Porter 1995). Where these constructions are very complex it is difficult for non-experts to challenge the indicator (Merry 2011). Even where experts are willing to challenge the indicator, if the only dissenting voices have little political power, it is easy for the indicator to remain neutral in appearance, and the concept to be redefined (Espeland and Sauder 2007).

Arts and culture once again provides a useful example of such risks. Neither art nor culture is included in the UK Office for National Statistics assessment of

well-being, perhaps because they are too difficult to measure (Walmsley 2012). Likewise there are no arts- or culture-based indicators under SDG goal 3 "Ensure healthy lives and *promote well-being* for all at all ages". Instead, this goal opts for indicators that are based on much more easily quantified aspects of health such as maternal death rates and rates of new HIV infections. By ignoring arts and culture, well-being indicators may reduce actions that promote cultural and artistic dimensions of well-being; potentially leading to reduced well-being.

Such issues are, however, not specific to well-being and the arts but also to other 'ultimate ends' central to the SDGs: community, harmony, fulfilment. How can personal growth, helping others or creating something new be measured? There may be proxies for wider social benefits, (such as health outcomes), but there is also a risk that inputs which are easier to measure (e.g. spending on healthcare) do not capture the desired outcomes and, if used as proxy indicators, become the desired outcomes in themselves.

5 Can Indicators Be Useful in Implementing the SDGs?

Despite the problems of indicators described in the above sections, we believe that indicators do have a useful role to play in implementing the SDGs. The previous two sections critiqued the use of indicators in contested concepts on the grounds that they are only able to represent a small subset of understandings of that concept, and that they struggle to deal with messiness and complexity. Here we draw on these critiques and begin to outline how we see indicators being usefully applied going forwards.

5.1 Indicators Can Clarify Political Views and Increase Accountability

While indicators remove contextual information and obscure the process through which this happens, they also force a clarity and rigour that exposes political priorities and beliefs. This is seen clearly in the SDGs which often describe quite broad concepts that are accepted by a majority of global society and are apparently compatible with national sustainability initiatives. However, the SDG indicators reveal very specific perspectives on these problems some of which directly conflict with national perspectives. We have already discussed how indicators reveal very different conceptualisations of 'poverty' in the UK SDIs and the SDG indicators, but this is not the only example of this in the SDGs.

Goal 8 aims to promote "decent work for all", a laudable purpose that few would disagree with. However, the SDG indicators have been criticised for failing to fully encapsulate the concept of decent work (Frey and MacNaughton 2016). The SDGs do not, for example, include any measure of trade union coverage, working poverty rates or working time, all of which are 'main indicators' for decent work according

to the International Labour Organisation (ILO 2016). Moreover, there are no indicators of job satisfaction or fulfilment, reflecting a very different idea of 'decent work' than others where such ideas are central (see Burchell et al. 2014 for examples). These differences only become apparent in the indicators, because even the targets within Goal 8 refer to the contested idea of 'decent work', without making explicit how it is viewed.

This process of making a particular view explicit is, of course, the very same source of difficulty that we discussed in Sect. 3, here reframed as a strength. It is a problem that indicators only represent a partial worldview if they are interpreted by the user as being an objective measure of a system (the naive view). On the other hand, if a user approaches indicators knowing that they are a partial interpretation of the world, then serve a useful purpose—they clarify what that partial worldview is. We must be clear here that indicators are no panacea, they do obscure those political judgments made in the construction of the indicator, but they also allow outsiders to see how concepts are being operationalised. So, instead of indicators necessarily re-conceptualising a problem and enforcing a single narrow view, they can also create a platform for debate and critique of a concept.

In part this is related to the public nature of indicators (Porter 1995). Examining the decision-making processes of the European Union (EU) and the Millennium Challenge Corporation (MCC), Dutta (2015) finds that the use of indicators makes those parts of the MCC decision-making process that use indicators relatively transparent because

> external observers can more easily identify the mechanisms by which decisions are supposed to be made. Such legibility makes a contribution to accountability; where observers can easily discern how a decision was supposed to be made, they can more easily identify deviations in how the decision was actually made. (Dutta 2015, p. 162)

Similarly, Finnerty (2005) argues that the use of indicators in the Irish National Anti-Poverty Strategy (NAPS) allows the government to be held to account and has formed the basis for much of the critique of the program.

Indicators may, then, be usefully used as a way of articulating the political vision that underlies the SDGs. In this way, indicators will facilitate external actors in both critiquing the goals and holding their governments to account. As we have seen, such a process has already begun in the academic literature (Frey and MacNaughton 2016). We see no reason, however, why indicators should not be used to engage a much wider audience in conversations about the SDG program, how best to implement it and where it can be strengthened. That said, for this to work there would need to be an almost unprecedented level of transparency in the public reporting and discussion of the SDG indicators.

5.2 Indicators Facilitate New Understandings of Complex Systems

While indicators may lead us to re-conceptualise issues in ways that somehow lessen or reduce our understanding of an issue, they can also facilitate a helpful

re-conceptualisation of knowledge. For example, Porter (1995, p. 37) argues that the widespread use of quantified indicators helped to create the idea of society by reframing individual problems as societal

> Indeed the concept of society was itself a part statistical construct. The regularities of crime and suicide announced in early investigations of 'moral statistics' could evidently not be attributed to the individual. So they became properties instead of 'society'…Similarly, people sometimes found themselves or people they met to be out of work before this had become a statistical phenomenon. The invention of crime rates in the 1830s and unemployment rates around 1900 hinted at a different sort of phenomenon, a condition of society involving collective responsibility rather than an unfortunate or reprehensible condition of individual persons

By reframing a concept in this way, indicators can help us to consider new options and ways of thinking. Indeed the SDGs have been called transformative because they represent a much broader and more holistic view of societal progress than the current focus on GDP alone (WWF 2016). As a result, the SDG indicators may prove to be tools that can be usefully used to highlight progress or problems. But, such application of the indicators should not be an end point in itself. Instead, this kind of indicator-led analysis should direct and inform a more detailed and context-sensitive analysis. Similar roles have been played by subjective well-being indicators, which often find substantial geographical variation in well-being. Though the measures themselves cannot explain underlying causes, they do highlight potential problems to be explored further (Seaford 2013).

The actual process of selecting indicators can also help understanding. Unfortunately, the SDG indicators have already been selected. Nonetheless, it is worth noting that by engaging in participatory processes, different views can be considered and space can be created for the voices of those who might otherwise be excluded (Fraser et al. 2006; Bell and Morse 2008). By understanding the contested nature of indicators, those indicators selected can be refined and the limitations of any research identified.

Finally, the SDG Indicators will also enable quantified forms of analysis that can enhance our understanding of how the broader SDG targets might be achieved. A key example of this, in our view, is in the use of models. The SDGs operate in highly complex, nonlinear systems, and such systems are difficult to interrogate without models because multiple inter-linkages and feedback mechanisms can result in counter-intuitive emergent behaviours (Sterman 2000). Models can be viewed as tools that mediate between theory and reality, drawing from both theories and the 'real' world, but retaining some autonomy (Morgan and Mary 1999). Therefore, models facilitate learning by allowing users to test and refine their theories, value judgments and assumptions. By manipulating models, we are able to see how the outputs of a model diverge (or converge), from the theoretical predictions or 'real world' observations and explore why this is the case. Moreover, where models are sufficiently representative of some aspect of the real world they can be considered 'surrogate' worlds, and we can make qualified inferences from our model world to the real world (Mäki 2009). Indicators are essential in this process because they provide the mechanism that allows the model world, theory and reality to be compared.

6 Conclusion

This chapter has argued that the use of quantified indicators in the Sustainable Development Goals (SDGs) is problematic because the SDGs are a collection of highly contested concepts. Drawing on critiques of indicators from the sociological, anthropological and sustainability literatures, we showed that the reductive nature of indicators can create problems as they try to simplify and codify complex and subjective issues like those found in the SDGs. Highlighting the case of poverty, it was demonstrated that the SDG indicators only represent a limited understanding of poverty, and one that clashes with national understandings. Building from this example, we argued that any given indicator set (including the SDG indicator set) should be understood as a necessarily incomplete and value-laden view of a concept. As a result, use of one set of indicators may undermine attempts to achieve the same notional objective measured using alternative indicators. Likewise, drawing on an example from a cultural indicator project, we made the case that indicators often arbitrarily strip away relevant information because it is hard to formally codify. We stressed that this is problematic because indicators change how policymakers and other change agents interact with and think about concepts.

On the basis of these critiques, we argued that use of indicators in implementation of the SDGs should be handled carefully, but that there are roles that the indicators can usefully play. The SDG indicators could facilitate new understandings of sustainability and new learning through quantified analysis (such as modelling). However, such work should be the starting point of an analysis, not the end point. We also argued that given a more appropriate interpretation of the SDG indicators, their weaknesses can be reframed as strengths.

Therefore, going forwards we recommend that researchers and practitioners understand SDG indicators as an expression of the political priorities of the SDGs. Framed in this way, we suggest that the SDG indicators be used as a tool to engage citizens in debates about the SDGs, both to increase buy in and as a platform for critique of the SDGs (as is happening with Goal 8 in the academic sphere). Likewise, we suggest that the SDG indicators might be used to hold governments to account, as has happened in other development initiatives. In summary, future work on the SDG indicators, (and indicators more widely) should be used to inform, engage and hold to account policy development processes. SDG indicators should not be the main basis on which to develop new policy.

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A Minor Matter of Great Concern: The Different Sustainability Logics of 'Societal Benefits' and 'Socio-economic Profit'

Johan Hultman and Filippa Säwe

Abstract

Sustainability science research is characterized by its high transdisciplinary ambitions. However, despite claims to urgent social change, important sustainability principles—including social complexity issues such as learning and knowledge sharing among stakeholders—are not fully contextualized and understood within the general framework of sustainability science research. To explore possible synergies between sustainability science research and social analysis, this chapter uses a qualitative method to account for the theoretical and practical implementation of a transdisciplinary research process. Through one example of a change in Swedish natural resource management policy, the paper demonstrates how a top–down and bottom–up conflict in natural resource management was dealt with by the creation of an innovative environmental governance constellation. This was done by the mobilization of the theoretical concept of 'boundary objects' to develop and maintain coherence over time between stakeholders and social worlds sharing a common sustainability interest but with conflicting stakes. It is concluded that 'boundary objects'—here, a new communication platform—can facilitate cooperation between stakeholders regarding the complexities of social–ecological systems governance and policy.

Keywords

Sustainability epistemologies · Boundary object · Qualitative analysis · Fisheries management

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1 Introduction

The realization of the UN sustainable development goals will require modes of planning, cooperation, knowledge sharing and societal change implementation in joint efforts between funding bodies, researchers and educators, policy makers, practitioners, NGOs and citizens (Charlton 2016). Such innovative constellations of actors go beyond traditional academic practice and result dissemination, but within sustainability science a number of examples and efforts of new governance constellations are being documented and analyzed (Polk 2014). This chapter wants to contribute to the discussion by an analysis of a policy change process connected to sustainable development goal 14 (Conserve and sustainably use the oceans, seas and marine resources) where both authors were directly involved in an action research project. This project (Doing sustainability through markets? Coastal communities and economies embedded in place) was designed to understand why stakeholders in Swedish fisheries governance experienced recurring breakdowns in communication, specifically why fishers expressed their inability to make sense of micro-management from central authorities (Säwe and Hultman 2012). The chapter aims to illustrate the pressing issue of what counts as legitimate knowledge in the development of sustainability science as an integrated field, or as Shahadu (2016) calls for: an umbrella science of sustainability. For this explicit purpose, the argument focuses on ontology and epistemology in transdisciplinary research. From this, the chapter outlines implications concerning how epistemologies and what counts as legitimate scientific knowledge potentially affect and shape social reality.

From the understanding that sustainability science is a transdisciplinary field of research with the ambition to genuinely integrate all dimensions of sustainable development, the chapter adopts its definition of transdisciplinary from Polk (2014: 440, emphasis in original), stating that

> …*transdisciplinarity* refers to different types of knowledge production for social change which are based not only on the integration of knowledge from different disciplines (interdisciplinary) but also on the inclusion of values, knowledge, know-how and expertise from non-academic sources

This definition is in accord with how Wittmayer and Schäpke (2014) argue for action research as a suitable method for sustainability science, as action research is a 'collaborative production of scientifically and socially relevant knowledge, transformative action and new social relations through a participatory process' (p. 484; also Wittmayer et al. 2014).

2 The Epistemological and Ontological Challenge of Transdisciplinary Research

Sustainability science research demands engagement with diverse disciplines and non-academics to work with complexity, uncertainty and under conditions where normative considerations have high priority (Lang et al. 2012). In the literature this

is discussed in terms of the balance for researchers to deal with the tension between scientifically generated problems and real-world problems (Wuelser and Pohl 2016). The challenge can be expressed as giving voice to and include multiple perspectives and kinds of knowledge while at the same time ensuring the validity and legitimacy of research (Lang et al. 2012; Ziegler and Ott 2011).

While results provided by a wide range of scientific disciplines are acknowledged as important (knowledge from different disciplines is needed to understand the range of institutional, social–ecological and technological aspects actualized in the UN development goals), there is not an equal amount of attention given to the need for greater understanding of how legitimate knowledge is produced (epistemology) in relation to understandings of how the world works (ontology) (Fazey et al. 2017). Epistemology and ontology are the lenses through which complexity is researched, but arguably they also limit a full understanding of sustainability problems (Hultman and Säwe 2015; Evely et al. 2008). Sustainability science is in this regard biased towards epistemology and ontology developed within science, with weaker foundations in social science and the humanities (Shahadu 2016; Olsson et al. 2015; Scott 2015).

Epistemology has profound implications for how people understand their own position, the way research and scientific practice are conducted, how sustainability problems are interpreted and how solutions are identified and implemented (Evely et al. 2008; Miller et al. 2008). Acknowledging the implications of epistemological effects on real-world problems is particularly important for sustainability science and research. Understanding complex interactions in the Anthropocene requires engaging with multiple and equally valid perspectives. Fundamental differences in epistemology and ontology can result in different outcomes of change when researchers engage with the political and ideological dimensions of specific problems. This concerns not only real-world political normativity but also the normative claims made by different scientific disciplines (Fourcade et al. 2014; Hultman and Säwe 2013). Sustainability transdisciplinary researchers, therefore, must be aware of how epistemologies of their own research and the research of others reflect how the different actors involved have impacts on the practical outcomes and solutions expressed (Säwe and Hultman 2016).

The analysis in this paper problematizes knowledge claims made with the basis in social sciences (sociology and human geography) and economics respectively. The different epistemologies of these disciplines illustrate different understandings of how a sustainability problem is best solved. It is shown how social science promotes the concept of ‘societal benefits’ for increased natural resource management sustainability, while economics suggests ‘socio-economic profit’ with the same aim.

3 The Sustainability Problem of Fisheries Governance: A Transdisciplinary Process

The empirical framing of this paper is a particular instance in Swedish professional fisheries strategy making, regulation and management. It took place during a time period (2015–2016) when Swedish fisheries policy—following a reformed EU Common Fisheries Policy (CFP) in 2013—experienced drastic change. Fisheries are an area of natural resource management where the stakes are high in terms of the potential loss and gain of social, economic, environmental and cultural values. The CFP is legally binding for member states, but this trans-national policy must also be expressed in national legislation. Fisheries are big business embedded within a massive regulatory framework. Fisheries management is a contested area, where governance strategies must encompass conflicting interests. As other environmental conflict areas, fisheries sustainability has so far primarily been discussed from ecological and economic perspectives with a progressing bias towards market-based solutions to environmental problems (Anderson and Libecap 2014; Gómez-Baggethun et al. 2010; Mansfield 2008 for general overviews; Säwe and Hultman 2014; Mansfield 2007 for fisheries examples), often without sufficient consideration of the wider societal consequences. In the case of fisheries management, research is biased towards ecological and resource economics modelling, eventually aiming at an optimized match between the biological status of stocks and profitability for fishing firms (Schreiber et al. 2016; Holm and Nolde Nielsen 2007). It is almost without exception based on a systems approach where parameters expressed in metrics have precedence, a fact that has been criticized for resulting in a limited sustainability understanding (Quinlan et al. 2016).

Such is the setting of this account of a transdisciplinary process where both authors became involved in an action research project. The specific instance of analysis concerns the formulation of a Swedish national strategy for professional fisheries to be operational 2016–2020. Two kinds of knowledge were in play in this sustainability transformation: abstracted modelling competence and social–ecological, place-bound competence. National central authorities drew upon resource economics modelling, while a coalition between parts of the fishing industry, local authorities (county administrative boards, CABs) and coastal municipalities argued from social science sustainability competence. Both kinds of knowledge thus had basis for their claims in different parts of academia.

Since a strategy is one way to express the ambition to shape the future, the differences between the competences in play can also be expressed as different principles for dealing with uncertainty. The economics modelling competence aimed to make the future manageable and predictable by translating a range of sustainability values into measurable parameters. The social science sustainability competence strived to acknowledge real-world contextuality and unpredictability (Hodgson 2013).

4 Boundary Objects: Theory for Transdisciplinary Research

The action research outcome of how the national strategy was finally framed and articulated was a new governance constellation between local authorities, coastal municipalities and social science sustainability research (see Sect. 7 in this chapter). The objective of this constellation (ÖF2020, in translation Baltic Fisheries 2020) was the creation of a new communication platform—or 'boundary object'—in the shape of a national, annual conference. This boundary object aimed to mobilize a wide range of fisheries stakeholders in an ongoing effort to operationalize the concept of 'societal benefits' in relation to the national strategy.

A boundary object is a theoretical tool developed within the field of social studies of science to give analytical traction to a conflict and power approach in a multi-stakeholder context (Leigh Star and Griesemer 1989). There are two key characteristics of how the concept was originally conceived (Leigh Star 2010) that makes it applicable to transdisciplinary research: *That boundary objects are actively pursued constructions for a specific purpose, and that they must be managed over a period of time to fulfil this purpose*.

The creation and management of boundary objects aim to develop and maintain coherence between social worlds sharing a common interest but with conflicting stakes. The boundary object—in this case the ÖF2020 annual conference—aimed to give voice to equally legitimate claims in a situation where stakeholders commanded different communicative assets, kinds of knowledge and power. It was designed to be recognizable for all stakeholders and was an arrangement with the ambition to allow different groups to work together without consensus in practice.

5 Methods

Following and participating in the shaping of the fisheries strategy was a process spanning 2015–2016. The discussion in this article draws upon a heterogeneous body of data: strategy drafts, official documents, officially available e-mail correspondence from CABs and personal communication with authorities and practitioners. Undocumented but systematically generated data such as e-mail and communication is not always easily referenced, but is none the less important material in qualitative research (Silverman 2007). The actual analysis uses two documents, a strategy draft that was discussed in a large advisory group and the final version of the strategy. These documents are subjected to a micro-level analysis where discursive elements are examined and compared. To the knowledge of the authors, this is not an established qualitative method in sustainability science but is a form of critical discourse analysis used in qualitative research into real-world problems (van Dijk 2001). It is applied here to illustrate the importance of wording and rhetoric to understand problem formulations and suggested solutions aiming for sustainability. Words are important not only because of what they

denote, but also because of where they come from: what knowledge and logic form the basis for argumentation? Here is an opening for illuminating epistemologies and ontologies and make these issues a subject for reflexion. This kind of qualitative analysis is also proposed as an example of how the micro-level of social interaction can be connected to the macro-level of societal change (Mason 2006).

Transdisciplinary research is fundamentally different from traditional academic work. To engage in real-world problems demands research strategies different from articulating your own research problem and then presenting it as socially relevant. The collection of empirical data is systematic but also opportunistic. The researcher is involved in and affects the process and the results. This has potentially far-reaching consequences for social change. A real-world change process might be messy to account for in terms of cause and effect. One way to handle this while preserving academic credibility is transparency. For the purposes of this study, transparency takes the form of a detailed analysis on the level of individual words, and a chronological narrative of the ongoing process and the creation of a boundary object that was the result of how the fisheries strategy was finally articulated.

The limitations of the argument and analysis are twofold. First, they concern wordings and rhetoric and not, for example, socio-technical innovation or real-time social–ecological causes and effects. Although it is proposed that the analysis is one way of aligning causality between micro- and macro-scales, it obviously must be connected to a range of other disciplinary and transdisciplinary methods and knowledge to attain its full explanatory potential. Second, while the sustainability effects of different epistemologies are problematized, the authors have chosen not to question their own potential influence on the process accounted for. This is not in order to dis-acknowledge it, only a pedagogical manoeuvre to streamline what is arguably an under-researched issue in sustainability science.

6 A National Fishing Strategy: A Diversity of Stakes

Swedish national fisheries governance is divided between two central authorities, the Swedish Agency for Marine and Water Management (SwAM) and the Swedish Board of Agriculture (SBA). SwAM is responsible for fisheries control, environmental monitoring and the allocation of the fish resource. SBA is responsible for the promotion of coastal and small-scale fisheries, and the coordination of fisheries management efforts with those related to rural development. CABs act as the implementing authority in local contexts. During 2015 and the beginning of 2016, the development of a national professional fisheries strategy rested with SBA. The process followed a bottom-up working mode. The organization had SBA as a coordinating body. An advisory group with a large number of fisheries stakeholders, CABs, NGOs, representatives from coastal municipalities and SwAM, and researchers regularly convened and discussed the strategy's text. The authors were involved as researchers, and also because they were chairperson and secretary for a regional coordinating body of professional, recreational and subsistence fishers in

Öresund, southern Sweden. In addition there was a small steering committee with members from SBA, SwAM and CABs.

As the strategy work progressed and a final version was being discussed in the advisory group, the consensus-driven process took a sudden top-down turn. SwAM unexpectedly stepped in and claimed shared ownership for the strategy. This move coincided with a change of wording in the vision and central resource allocation goal for the strategy. It was a change that had neither been discussed in the large advisory group, nor presented for the CABs in the steering committee. The version of the strategy that was sent out for a final round of remittance opinions—and which eventually became the official text—featured this vision and central goal that had been inserted top-down, not previously openly discussed.

So what does the vision proposed by central authorities look like, and how does it compare to the initial vision? In the following sections, we will argue that the initial proposal secures the integration of all three sustainability dimensions in, whereas the final and official proposal fails to do so.

6.1 A Change of Wording from Societal Benefits to Socio-economic Profitability

The initial suggestion, put forward by CABs, coastal municipalities and social science action researchers, had been agreed upon in the advisory group. This proposal focused on the concept of 'societal benefits' (The Swedish national strategy for professional fisheries, draft February 2016, authors' emphasis and translation):

> Swedish fish resources are allocated and utilized in an environmentally sustainable way that creates *the greatest total societal benefits* from social and economic perspectives.

Attached to this proposal, members of CABs, the coastal communities and social scientists articulated the following definition of societal benefits:

> A well balanced fishing fleet with daily landings, which as far as possible strive to attain profitability from the quality of the catch rather than the prioritization of quantity, creates conditions for long-term regionalized management; a growing national service sector; rural development; consumer access to fresh fish; values associated with tourism and recreation; and a balance in the respective strengths offered by smaller and larger vessels. Such a fleet ensures continuous environmental monitoring as well as national food security. Societal benefits can thus be understood as the way in which different activities in an industry become mutually reinforcing for the benefit of surrounding communities.

The SBA and SwAM, disregarding previous discussions in the advisory group, substituted this consensual proposal for the following wording in the strategy's vision and central resource allocation goal (Swedish Board of Agriculture and Swedish Agency for Marine and Water Management 2016), authors' emphasis and translation):

> Swedish fish resources are managed, allocated and utilized in an environmentally sustainable way, and in a way that within these limits strive to attain *the highest possible socio-economic profit*.

Both proposals prioritized environmental sustainability, fully in accord with the reformed CFP. However, what is noticeable is that the SBA/SwAM version embedded social and economic dimensions within a concept that was new to the context of shaping the strategy. These two dimensions became combined in 'socio-economic profit'. A definition of 'socio-economic profit' was attached, implying a specific interpretation of social and economic sustainability, one that was conditional upon measurable parameters:

> A socio-economic profitability assessment means the attempt to measure welfare effects resulting from changes in the management of the fish resource, its distribution, and other measures. In other words, it is a socio-economic calculation that also includes assessments of relevant effects that has not been possible to quantify or valued in monetary terms.

This definition implied an economic logic. The focus was put upon measurability and calculability. As explained by research in economic sociology, in traditional economic theory functioning markets presume that the range of values important to society and individuals must be made commensurable. This is done through assigning a monetary value to the different kinds of value that have to be weighted against each other in any situation where resources are limited (Aspers and Beckert 2011).

During the discussions that followed the insertion of the top-down vision, it became clear that SwAM found the concept of 'societal benefits' too vague and too political in the sense that it pointed towards the need for future judgements between different societal and social values and goals. The central authority did not interpret their instructions to include such political considerations. Instead they preferred to rely on their resource economics competence. Paradoxically and interestingly this definition of socio-economic profit includes both measurable and non-measurable effects in its calculations: '…also includes assessments of relevant effects that has not been possible to quantify or valued in monetary terms'. The definition seemed to predict that effects that until now had not been possible to value in monetary terms would soon become calculable. From the discussions, this can be interpreted as an institutional ambition to de-politicize a complex issue by making incommensurable values commensurable.

6.2 The Proposal that Secures the Integration of All Three Sustainability Dimensions

What are the differences between the two visions that from a first glance might seem quite similar? In the version put forward by central authorities the word *managed* has been added: 'Swedish fish resources are allocated and utilized in an environmentally sustainable way…' was changed to: 'Swedish fish resources are *managed,* allocated and utilized in an environmentally sustainable way, …' (authors' emphasis).

The word *managed* is positioned as significant. The word indicates that something has to be governed by a managerial body. The original bottom-up version did

not invest in this particular dimension, instead indicating a more heuristic process: '…that creates the greatest total societal benefits…'. The formulation 'that creates' has connotations different from that which has to be managed. Instead this wording proposes an open-minded process towards something negotiated and future-oriented. Compare this formulation to the one preferred by the authorities: '…, and in a way that within *these limits* strive to attain the highest possible socio-economic profit' (authors' emphasis).

These limits refer to the former passage 'in an environmentally sustainable way'. In other words, this way of wording indicates that the environmentally sustainable way is already defined and carefully delimited. Compared to the original suggestion that was future-oriented, inclusive and open-ended, this wording is more grounded in the past in an agreement upon parameters already defined and positioned to be maximized through the 'strive to attain the highest possible…'.

The wording 'strive to attain the highest possible…' can be understood as an estimation, something that can be more or less obtained, while the formulation 'that creates the greatest total' is indicative of an intention combined with the judgement 'the greatest'. What is valued as 'the greatest' is directed to something yet to come and a definition that is conditional upon an agreement between stakeholders; nothing that can be estimated or foreseen a priori, without contextualization.

'The greatest total' is referring to the concept 'societal benefits'—a way of wording that can be understood as an ambition to secure the integration of all three sustainability dimensions, including present and future ecosystem services. The official proposal instead ended with 'the highest possible socio-economic profit', while the initial proposal connected 'the greatest total societal benefits' to other values embedded in a surrounding community. The text by the authorities was restricted to values only associated with the management of the fish resource itself.

Words in the initial proposal were 'the quality of the catch', 'creates conditions', 'and a balance', 'ensures a continuous environmental monitoring', 'food security', 'mutually reinforcing', 'the benefit of surrounding communities'. The proposal that eventually became official in the national strategy instead used the words 'socio-economic profitability'. This embodies a different kind of connection and understanding between social and economic sustainability dimensions, one that relies upon measurable parameters: 'the attempt to measure', 'changes in the management', 'calculation', 'also includes', 'that has not been possible to quantify or valued in monetary terms'.

If the economics principle of profitability is the strategic direction for future resource management, allocation and access, central authorities must—to be able to function—discard other kinds of knowledge and logic. The final strategy text itself repeatedly states the intention to manage and allocate the resource according to the three acknowledged sustainability dimensions: environmental, social and economic. However, the final national strategy version—embedded in ecological sustainability—favours a maximized economic growth criterion. Social sustainability is implicitly expected to follow from this. This is arguably in contradiction to European fisheries policy (EC 2013, authors' emphasis)

> When allocating the fishing opportunities available to them … Member States shall use transparent and objective criteria including those of an environmental, social and economic nature. The criteria to be used may include, inter alia, the impact of fishing on the environment, the history of compliance, *the contribution to the local economy* and historic catch levels.

The CFP is explicit in its legal and normative policies that fisheries management should implement and develop principles of inclusion, future orientation and openness for a multitude of perspectives and knowledges.

7 Connecting Science to Real-World Problems

From a social science sustainability understanding, the outcome of the strategy work was unsatisfactory. One of the sustainability science objectives is the integration of social, economic and environmental dimensions of real-world sustainability problems. The final strategy text did not fulfil this ambition. For this reason, CABs, coastal municipalities and social science created a boundary object, ÖF2020 (Baltic Fisheries 2020), to allow for reflexions and potential knowledge sharing among all interested fisheries stakeholders. Considering the lack of consensus over central issues in Swedish fisheries management, this boundary object had to be designed as an open but structured situation. It was also important that it became an arena for accountability on part of the central authorities whose decisions and regulations often appear opaque and under-explained to other stakeholders. The main purpose was to create an opportunity over an extended period of time to communicate and make sense out of a contested solution to a sustainability problem. The boundary object conference was built around different perspectives on how to allocate and utilize the fish resource towards an environmentally sustainable way that creates the greatest total societal benefits. Thus, it was a self-created pathway by the ÖF2020 coalition to further pursue the concept of societal benefits that had, in fact, been rejected by central authorities. Since these authorities had made it clear that this concept was too political for them to handle, the major point of the first annual conference in 2016 was to get national politicians on stage to assure their authorities that the goal of societal benefits had, in fact, political support.

By initiating the conference CABs, coastal municipalities and social scientists created a space to communicate that political support was explicit. ÖF2020 also used the space to articulate the tension between a bottom-up perspective to empower local economics and the top-down economics paradigm within central authorities prioritizing profitable fishing firms on a macro-level of abstraction. The conference ended by stating a process goal: that the preparation of and participation in future conferences were open for anyone bearing a professional stake and interest in Swedish fisheries policy. The ambition was an annual, pragmatic and action-driven process circulating around the operationalization of the national fisheries strategy, and to make it a practical tool towards a more sustainable future

for fish as a limited and common resource restricted by ecological concerns and at the same time as an important issue of food security.

By framing the conference as a boundary object, the interplay between science and policy was activated and problematized. Social science, science and economics were potentially aligned to ensure a robust connection between research and real-world sustainability challenges. It also worked to create a transdisciplinary environment by knowledge sharing and mutual reflexion among researchers, authorities, policy makers, NGOs and practitioners—giving space to different views of what constitutes reliable or useful knowledge.

8 Conclusion

The analysis in this paper demonstrated how the ontological and epistemological perspective taken to both develop knowledge and find solutions implicitly shaped social reality and the nature of the outcomes. It also serves as a reminder of how research and decision-making are closely intertwined with politics, norms, values and organizational cultures. This involves juxtaposing and possibly linking different approaches to make use of different kinds of knowledge and to increase awareness of the range of complexities and normative considerations involved in doing research and shaping change.

As the analysis and account of the creation of a boundary object have aimed to illustrate, different academic epistemologies create different social realities. For central authorities, knowledge derived from economics counted as legitimate. A social science sustainability argument acknowledging the politics of natural resource allocation was rejected. The real-world consequences of what counts as legitimate scientific knowledge are in this case potentially dramatic. Returning to an economic sociological understanding of traditional economics, Fourcade et al. (2014: 21–22) show that:

> Economists do not simply depict a reality out there, they also make it happen by disseminating their advice and tools./…/ By changing the nature of economic processes from within, economics then has the power to make economic theories truer.

The reason why central authorities in the Swedish national fisheries strategy chose to rely on economics modelling was that the concept of ‘societal benefits’ was interpreted as too political. But as the analysis has indicated, there is a need to recognize that engaging with social change will inherently be political and that this demands high transdisciplinary ambitions to facilitate dialogue over important concepts such as value, ideology, knowledge and power. Otherwise, there is a danger of sustainability science unintentionally helping to de-politicize issues of social equality and democracy or, reproducing exploitive market settings and institutional relations (Fazey et al. 2017).

This epistemological challenge illustrates one obstacle that has to be dealt with in a transdisciplinary process: the views held by authorities, policy makers and practitioners about what legitimate research looks like and how it should be generated and used. This might well lead to resistance. It is what Rayner (2012) calls 'the social construction of ignorance', an institutional strategy to keep knowledge at bay that threatens the self-consistent world organizations have to maintain in order to function and fulfil what they interpret as their instructions.

In conclusion, action research gives the opportunity for academics to fuel and challenge a democratic process by reflecting on the meaning of concepts such as 'societal benefits'. In the case accounted for here, institutional norms and beliefs were challenged during the work with the national fisheries strategy. A boundary object was created to maintain and develop a reflexive process over time. It was a way to theoretically and pragmatically allow a sustainability issue keep on being a focal point for different epistemologies, knowledge and perspectives, and to act as an arena for the uncertain synergies between policy and science.

This was done by literally putting issues on stage that otherwise possibly would have remained back stage. Epistemologies were made into subjects for reflexion instead of black-boxed argumentative foundations. In a sense, this entails placing the social dimension of sustainability on the same level of importance as ecological and economic ones.

While ecological and economic sustainability parameters are often considered quantitatively measurable, social sustainability comes to life through dialogue and knowledge sharing over uncertainty in ever-changing circumstances. This might be a key future issue for sustainability science: to bring forward the political and normative challenges of sustainability by giving them ideological meaning in transparent and democratic processes. Translating such a principle into a generalized sustainability science goal will demand innovative ways of knowledge dissemination that validate transdisciplinary research both inside and outside of academia, and knowledge sharing methods that create trust between researchers, practitioners and the public.

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Corporate Sustainable Strategies in Dom Pedro I Industrial Road Axis, São Paulo, Brazil

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Abstract

Among the challenges to sustainability, urban sprawl and an increasing demand for resources and energy can be mentioned. In the state of São Paulo, Brazil, an intense process of industrialization and urbanization has accompanied the recent expansion of major highways. The study of these impacts is important from a sustainable perspective, as is analysis on how they may indicate socioenvironmental public policies and corporate actions. This study seeks to analyze sustainable corporate strategies to address environmental issues and managerial perceptions in industries located along the road axis Dom Pedro I (SP 65), in the Bragantina Region, state of São Paulo, Brazil. Methodological strategies involve analyses of industries' data and interviews with personnel responsible for environmental departments. Data collected indicate a diversity of environmental management actions already adopted by many organizations and it became apparent that the main stimuli for their implementation are the necessity to reduce operational costs, consolidation of an environmentally responsible image and adequacy to the environmental legislation. Nevertheless, they still need to invest more substantially to implement modern sustainable strategies and

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updated socioenvironmental corporate policies for preservation of natural resources.

Keywords
Environmental management · Corporate sustainable strategies · Industrialization · Natural resources · Socioenvironmental policies

1 Introduction

The current challenge for sustainability on a global scale, according to Seto and Satterthwaite (2010), is caused by the confluence of two global trends: transition to an increasingly urbanized world and global environmental changes.

According to these authors, the world from the twentieth century has undergone significant and concomitant changes such as demographic, urban expansion, high demand for resources, energy and consumption of urban products, transforming terrestrial ecosystems and contributing to increasing habitat and species loss and finally, changes in biogeochemical and hydrological systems.

With urban areas contributing to over 70% of the total power demand and a corresponding proportion of the world's carbon dioxide emissions, it is evident that, when analyzed globally, local processes within urban areas have the potential to affect the Earth system. At the same time, global environmental changes result in significant risks to urban areas and their inhabitants and many of these risks will exacerbate vulnerabilities already existing in these areas (Seto and Satterthwaite 2010, p. 127).

As a consequence, the urban global environmental changes are considered today as the deepest dimension of environmental crisis of the century, as they involve climate and ecological systems, and reduction on existing infrastructure and natural cycles. This may cause damage to social and economic activities, to human health and quality of life, affecting populations of various parts of the planet, more intensely the poorest ones that have more precarious access to services and urban infrastructure (Giddens 2010; Kotir 2010; Patz et al. 2007).

However, more intense extreme events (like droughts, floods, heat and cold waves, hurricanes and storms), in developed regions of Europe and North America, as well as in emerging regions, like South America and Asia that cause economic and human losses, endanger biodiversity and aquatic environments, directly interfering with health, agriculture and hydropower, generated warnings and concern for scientists and governments (Mendonça 2005; Marengo and Valverde 2007; Fuchs et al. 2011; Oven et al. 2012; Black et al. 2013).

In this perspective Koren and Butler (2006), consider that built environment affects ecosystem services, human health and well-being. Urban areas, while offering attractive benefits to residents, such as facilities and access to services, can

impact negatively on quality of life, especially in relation to burden on natural resources and infrastructure in a region. The land usage is strongly affected by urban sprawl, which is often responsible for environmental degradation, changing ecosystem function, resulting in consequent reduction of biodiversity (Cinner and Bodin 2010; Marengo 2006).

According to Koren and Butler (2006), sensitive ecosystems are often fragmented or sacrificed for construction of roads, housing, and industrial parks. The authors draw attention to pollution of reservoirs and groundwater due to discharge of chemicals and pathogens in sewer systems located in urban areas, with numerous adverse effects on human health.

It is worth mentioning that increase in environmental impacts related to urbanization and industrialization processes is part of a historical perspective in which urban growth takes place concurrently with industrialization, usually in neighboring territories, generating, as a result, environment pollution. However, in addition to industrial sectors, urban centers alone generate diverse environmental impacts, considering their high energy consumption, earthworks and soil sealing, deforestation, high levels of greenhouse gas emissions, pollution of water courses and soil contamination (Ferreira and Ferrara 2015).

In an analysis on sustainability, Foladori (2001) criticizes the reductionist view of environmental crisis that restricts the issue to lists in which all environmental problems refer to human impacts, external to production processes. These lists include problems such as destruction of forests, water contamination, desertification, depletion of the ozone layer and global warming, which can be reduced to depredation of resources, pollution due to debris, overpopulation and poverty. Under this conception of environmental problems, relations within the production process are not discussed, but only the effects.

This reductionist view, considering the urban environmental issues and productive activities that take place in one space, can create programs and environmental management actions focused on environmental problems but not on their causes, promoting analysis that excludes basic aspects and would require a more complex approach.

Shutzer (2012) mentions that environmental problems continue to be addressed in separated and fragmented ways and, therefore, cities continue to grow without considering the interests of society in building a healthier environment. Actually, environmental degradation is favored by private economic interests, lack of planning, ignoring potentialities and limitations in the relationship between city and environment. Furthermore, this picture introduces simple solutions, such as waste sorting or planting trees, which in practical terms collaborate very little to recovery or preservation of modified areas, as they do not analyze further problems.

Cities need to import a number of other resources to maintain inhabitants' quality of life, such as water, essential for human survival. In exchange they provide manufactured goods, services, information, technology and forms of recreation. There is constant and massive influx of material to support the cities and as a consequence it generally exceeds their ability to eliminate waste. The problem of large volumes of generated waste has been partially resolved through recycling and

composting programs, or use of biodegradable material. However, for many urban centers they involve expensive and uneconomical industrial processes (Jacobi 2009). Consequently, this entropic characteristic causes many other problems, not only ecological. Urban structures and density, in addition to occupants' activities, also give rise to economic, social, cultural, and political problems (Silva and Vargas 2010).

Regarding this issue, it is worth mentioning that for Silva and Vargas (2010), a city can be understood as an ecosystem, considering the concept in its broadest sense. In other words, an environmental unit within which all elements and processes are interrelated and interdependent, so that a change in one will gradually result in changes in all other components. Thus, the search for sustainability in urban areas should consider a multifaceted reality.

Ferreira and Ferrara (2015) point out that the concept of sustainability includes the idea of reversing current urbanization patterns, regarding treatment of inherited environmental liabilities of late industrialization. It also includes the ability to regulate and organize ongoing urbanization into socially fairer and less impactful parameters, especially in small- and medium-sized cities, where possibilities for changes are still widely possible.

Another aspect to be considered is that with urban and industrial expansion, there is a significant increase in means of transportation which involve heavy consumption of natural resources and generation of various negative impacts such as traffic jams, pollution, and accidents. The study of these impacts, their expansion, and resource consumption levels is important from the environmental and economic point of view and from the perspective of sustainability, to identify the causes and who suffers from these changes and how they are reflected among different social groups.

This article aims to identify and analyze socioeconomic and environmental changes that the Dom Pedro I industrial road axis (SP 65), part of the Viracopos Airport-São Sebastião Port Export Corridor, has been generating, specifically along the municipalities of Atibaia, Bom Jesus de Perdões, and Nazaré Paulista, in São Paulo State, Brazil. It also aims to analyze corporate strategies to deal with environmental issues and managerial perceptions in industries located along this industrial road axis, in the same municipalities.

The methodological strategies involve analyses of actions taken by companies located in Atibaia, Nazaré Paulista, and Bom Jesus dos Perdões through research, systematization, and analyses of secondary database (IBGE 2010), semi-structured interviews with personnel responsible for environmental departments (Richardson 1999) and field work. In addition they will involve correlations between enterprises, projects, and economic activities, emphasizing the industrial ones along the road axis and existing social and environmental problems and impacts.

2 Study Area

The State of São Paulo Government presented the Campinas—São Sebastião Export Corridor Project in 2005, which included the privatization of Dom Pedro I, Carvalho Pinto and Ayrton Senna highways and doubling the Tamoios Highway (Fig. 1). The corridor has the function of transferring import and export products from Campinas region and the entire State of São Paulo and runs through areas of the municipalities of Itatiba, Jarinu, Atibaia, Bom Jesus dos Perdões, Nazaré Paulista, Igaratá, Jacarei, Jambeiro, Paraibuna, Caraguatatuba, and São Sebastião (Braga 2008; Braga and Trevisan 2010). These roads connect the capital and the rest of the state, with Viracopos International Airport in Campinas and the Port of São Sebastião in São Sebastião. The government's proposal also involves duplication of Tamoios Highway and construction of a new access between the municipalities of Caraguatatuba and São Sebastião.

The road corridor will have 260 km between Viracopos Airport and Port of São Sebastião, passing through areas of Cantareira Water Supply System, and close to other reservoirs, and Paraíba Valley region, where logistic terminals will be implemented between Carvalho Pinto and Tamoios highways. These logistic terminals will be intermodal, where cargo imported or to be exported can be relocated and distributed to custom areas or recipients of any city (Braga 2008). The new export line will generate more consistent foreign trade logistics, increasing competitiveness of São Paulo State (Oliveira 2012).

However, it is evident that this significant increase in road transportation will bring significant changes to this axis which, among other issues, include changes in air quality, possibility of accidents in areas of intense environmental vulnerability,

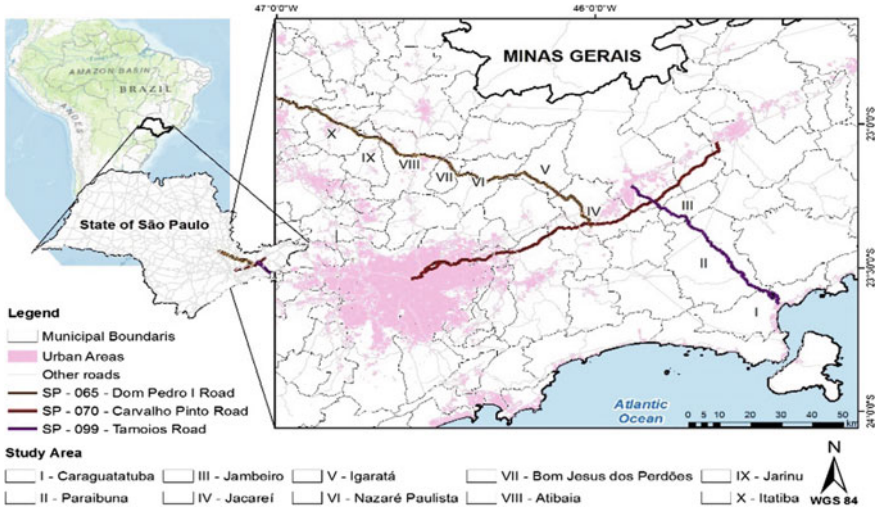

Fig. 1 Road axis—municipalities. *Source* Seixas et al. (2015)

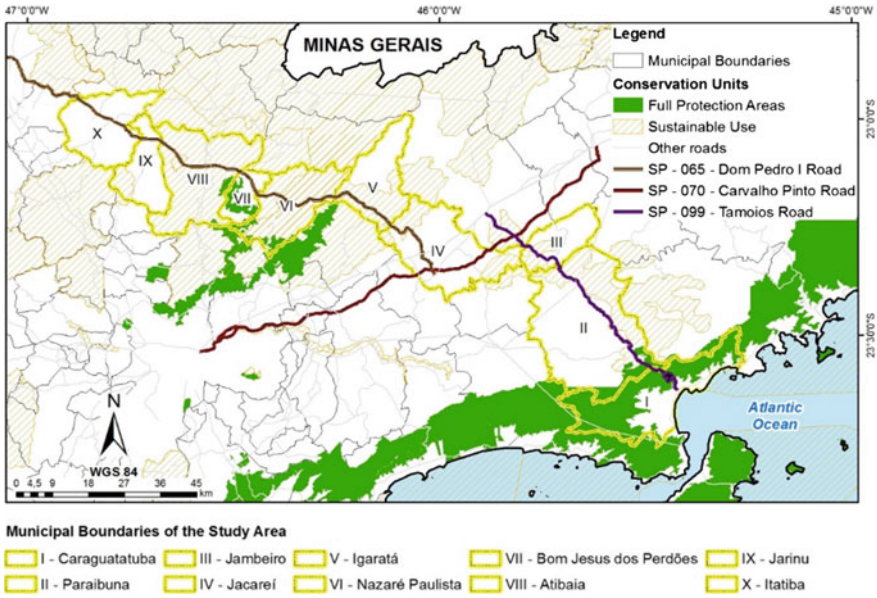

Fig. 2 Conservation units. *Source* Seixas et al. (2015)

increase in urbanization and industrialization processes and even tourism development.

Another significant aspect of the export corridor is the fact that it is too close to conservation units, as for example, state parks and environmentally protected areas, of fragile ecosystems that can go through expressive damage (Fig. 2).

3 Profiles and Actions of Companies Analyzed

The secondary collected data, interviews and field work show intense occupation along Dom Pedro I Highway, in the municipalities of Atibaia, Bom Jesus of Perdões and Nazaré Paulista, by industrial districts and large industrial warehouses. This is stimulated by the economic dynamics of the corridor, which favors the logistics sector, with storage, transportation, and goods distribution (Figs. 3, 4 and 5).

The implementation of these economic centers represents the possibility and expectation of several municipalities along Dom Pedro I Highway Road axis, including, besides Atibaia, Bom Jesus dos Perdões and Nazaré Paulista, the municipalities of Itatiba and Jarinu. Actually, some industrial districts are already being implemented in these municipalities, which will certainly determine a number of changes and new regional dynamics (Hoeffel et al. 2010).

Fig. 3 Location of industrial plants in Bom Jesus dos Perdões. *Source* Hoeffel et al. (2015a, b)

Fig. 4 Location of industrial plants in Nazaré Paulista. *Source* Hoeffel et al. (2015a, b)

Dom Pedro I Highway links Paraíba Valley to the Metropolitan Region of Campinas, allowing a quick connection between these two important industrial centers located in the Anhanguera and Dutra Highways and became one of the main highways of São Paulo state. It was inaugurated in 1972 and the duplication delivered in 1990. Dom Pedro I Highway offers a broad freedom of movement in terms of handling cargo and passengers. Traffic volumes are more intense during weekdays due to transportation of raw materials and goods in the region.

Data collected show that in the municipalities of Atibaia, Bom Jesus dos Perdões, and Nazaré Paulista, real estate speculation has been happening, just as in other municipalities and Metropolitan region of São Paulo, but with accelerated dynamic, and population growth, and this has significantly altered the urban and especially rural areas.

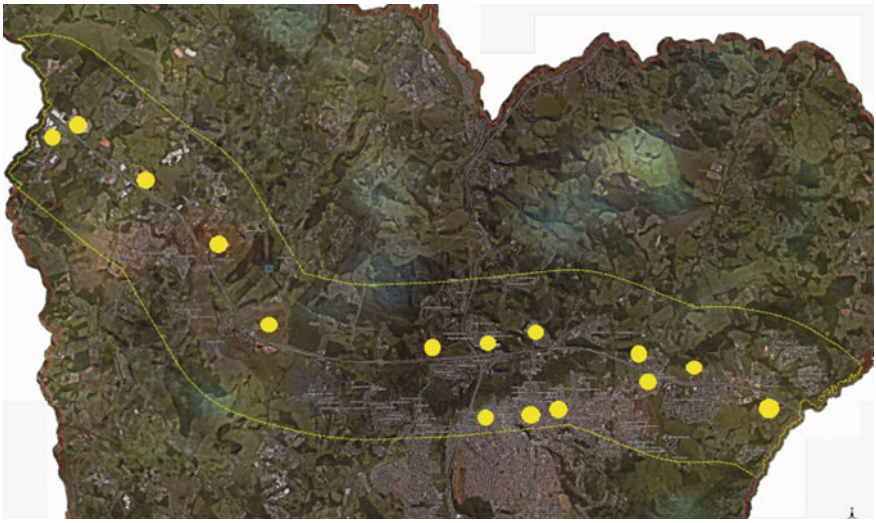

Fig. 5 Location of industrial plants in Atibaia. *Source* Hoeffel et al. (2015a, b)

Data on companies based in Atibaia, Bom Jesus dos Perdões, and Nazaré Paulista were collected in order to analyze expansion and its relationship to the growth of inhabitants in these municipalities. Significant increase has been noticed in the number of companies in Atibaia and Bom Jesus of Perdões and to a lesser degree in Nazaré Paulista. This variation is probably due to the fact that in Nazaré Paulista there is a reservoir of the Cantareira Water Supply System, the Atibainha River Reservoir, which is inserted in two Environmental Protected Areas (EPA)—Piracicaba/Juquery Mirim Area II EPA and Cantareira System EPA and this restrict the settlement of industries.

Through data collected, interviews, and field work, an expressive number of industrial districts and large deposits of industrial products was observed along Dom Pedro I road axis. In Bom Jesus dos Perdões, there are 43 industries located close to this highway and 17 under construction. In Nazaré Paulista, a municipality with severe environmental restrictions as mentioned above, there are eight industries and in Atibaia 45 large industries. A total of 66 industries were analyzed (Table 1).

The data shown in Table 1 indicate that only 11 of the 66 companies analyzed, are certified ISO 14001. From the 10 in the automotive companies, eight were certified, probably due to requirements of car manufacturers. The other sectors with certified companies were electronics industries (two companies) and metallurgical (one company).

The companies' environmental certification is related to development, implementation, and evaluation of environmental management system (EMS) that requires a set of interrelated activities in the company's administrative and operational framework, in order to avoid, minimize, or solve various environmental

Table 1 Industries analyzed in Atibaia, Bom Jesus dos Perdões and Nazaré Paulista

Production area	Number of companies	Certified ISO 14001?		Environmental licences			Main waste	Main environmental management actions
		Yes	No	Yes	No	No data		
Food	1		1	1			Solid waste; liquid effluent	Waste and effluent management
Automotive	10	8	2	9	1		Solid, electronic and chemical waste; liquid effluent; environmental interest residue	Waste and effluent management; environmental interest residue management
Construction	7		7	6		1	Solid waste; liquid effluent; environmental interest residue	Waste and effluent management; environmental interest residue management
Electricity	1		1	1			Liquid effluent; electronic and solid waste; environmental interest residue	Waste and effluent management; environmental interest residue management
Eletronics	3	2	1	2	1		Solid and electronic waste; environmental interest residue	Waste management; environmental interest residue management **Goal**: landfill for non-recyclable
Metallurgical	26	1	25	15	7	4	Solid waste; environmental interest residue	Waste management; Environmental interest residue management
Chemical	9		9	5	1	3	Solid and chemical waste; liquid effluent	Waste and effluent management; 1 PET post use recycling
Textile	5		5	2	1	3	Solid waste	No data available; 1 PET post use recycling
Timber	1		1	1			Solid waste	Waste management
Paper	1		1	1			Liquid effluent; solid waste	Waste and effluent management; post use paper and cardboard reverse logistics
Cargo	1		1			1	Solid waste (tires); gas emissions	Waste management; emissions control (mainly CO_2)
Glass	1		1	1			Solid waste; liquid effluent	Waste and effluent management; water recirculation
Total	66	11	55	44	11	11		

impacts caused by productive activities. In this process, some criteria must be met, such as being in compliance with legal environmental requirements and have an ongoing evaluation process, which in a way helps to understand the performance of companies operating in the Corridor Dom Pedro I. The inexpressive number of certified companies agrees with Amato Neto (2011) analyses, according to which in Brazilian context the issue of sustainability in regulatory framework is still in its infancy as compared to other more developed countries. In Amato Neto (2011) perspective business initiatives are located in specific areas and much of the population has little awareness and perception of such initiatives.

Seiffert (2011) stresses that the arising of ISO 14001 has provided general guidelines for the implementation of Environmental Management Systems, but also that the vast majority of organizations have primarily focused on complying and monitoring environmental laws and specific regulations.

In this context, it is important to emphasize that part of the Atibaia River Basin which is located inside the study area, presents a noticeable contrast between natural areas relatively preserved and extremely urbanized areas. Demanboro et al. (2013) in their studies conducted in this area concluded that the watershed is in intense process of environmental degradation. It is, therefore, essential that companies in Dom Pedro I Corridor, in addition to the ISO 14001 certification, present environmental management systems that are also concerned with water issues, maintaining people quality of life and local ecosystems and their own industrial activity that depends on water.

High degree of human intervention in the water basin, high levels of water consumption and domestic waste dumps, which promote deterioration of watercourses have contribute to this picture.

Although 11 companies are certified, on the other hand, of the 66 companies analyzed 44 were appropriate for the environmental licenses required by the environmental agencies in the state of São Paulo, 11 were in irregular conditions and for 11 it was not possible to obtain data. This table indicates a non-significant compliance with legal requirements, if the location of these companies is considered.

Irregular companies can compromise the quality of environmental resources in the study area, stimulating water, soil and air contamination, the imbalance of ecosystems and removal of riparian vegetation, among others. Therefore, it is important to mention the role of public environmental management regarding development, planning and control of productive activities in the area.

Another aspect to consider is the waste generated, basically solid and chemical, liquid and chemical, electronic, waste classified as environmental interest and gaseous emissions that require proper disposal. As environmental management actions, basically the legally required as wastewater treatment and waste have been noticed.

A focus present on some companies analyzed was the introduction of energy efficiency management system. Thus, a company analyzed presents a universal system to support manufacturers and users of machines that have three purposes: to serve based recommendation for operating industrial companies, be used for the

development of energy-efficient solutions for the mechanical engineering sector and optimize the company's own products.

This system works as an energy savings consultant. It helps to analyze not only individual components, like adapting the energy system to the real needs of specific machines, but also the system as a whole, finding relevant opportunities for energy optimization and savings.

One of the companies mentions working with suppliers so that they minimize usage of hazardous substances with a focus on reducing pollution. Another one states that they continuously invest in technological development, prioritizing preservation of natural resources. With this focus, all processes are planned and executed within the strictest control on the issue and handling of waste and effluents.

Another company participates in a conscious disposal program, in agreement with waste programs created by the State of São Paulo Environmental Department, which requires that manufacturers, importers, distributors, traders, and consumers act together to promote the reverse logistics of lubricating oil filters used in the automotive sector by promoting their collection, recycling, and adequate environmental disposal.

Given the actual socioenvironmental reality in this area of study, it can be said that although there are actions, programs, and proposals aimed at the corporate environmental management, it is still necessary to invest in a more significant way in this perspective. The actions are mainly focused on management of solid waste and effluents, which shows a focus on pollution control. According to Barbieri (2007), this approach refers to a reactive attitude of the company focused on the negative effects of their products and production processes by point solutions, aiming to meet the legal requirements and pressures of the communities.

For the author, exclusively targeted solutions for pollution control, even if they are fundamental, are also inadequate because they are directed only to one side of the problem, the pollution. Barbieri (2007) presents two other approaches that go beyond this perspective: prevention of pollution and strategic approach to environmental problems.

On prevention of pollution, in addition to solid waste management actions, some companies mention working with suppliers so that they minimize use of hazardous substances and installation of solar panels in order to replace fossil fuel in industrial processes.

In this approach, companies seek to take actions to prevent pollution, which requires changes in processes and products in order to reduce or eliminate waste at source (Barbieri 2007). Thus, it has been possible to notice improvements in some companies regarding proposals for environmental management focused previously only on pollution control.

Another company analyzed presents a system to support manufacturers and machine users in reducing electricity costs and increasing productivity, including the environmental issue as a marketing opportunity and also as a measure that can neutralize future environmental threats. In this case, beyond control and prevention of pollution, the company treats environment as a strategic approach.

Considering the expansion of industrial activities in Dom Pedro I road axis, for companies to expand their activities related to environmental issues, public policies are needed so that more efficient command and control measures exist in the region. It is also necessary to consider incentives for the perception that environmental conservation can be a competitive advantage and innovative strategic approaches, combined with measures for preventing pollution.

Seiffert (2011) highlights this issue when considering the great potential that exists for implementation of cleaner production approach, since losses in the process, which generate pollution, also reduce profitability that might be achieved by the product.

Curi et al. (2016) mention, as an alternative, several proposals for environmental management that can prevent and reduce potential environmental impacts, such as responsible action, cleaner production, eco-efficiency, eco-design, among others, that can be adopted by organizations, and besides determining sustainable actions, can be seen as business opportunities for companies.

In view of the above, although some companies present environmental certification (11) and others are in accordance with the law (44) with respect to environmental licensing, actions and environmental management programs are still necessary in Dom Pedro I road axis. These should surpass the simple reductionist view of environmental protection in urban areas aiming the sustainability objective.

4 Conclusions

All elements already identified as intensive urbanization, industrialization, traffic, and consequent pollution, point to significant changes in the urban, social, economic, and environmental dynamics of the municipalities analyzed along Dom Pedro I axis road. They have already caused significant pressure on regional natural resources but further analysis and planning are required about the reflections of these changes in this study area (Hoeffel et al. 2010).

The construction and subsequent duplication of the highway resulted in the establishment of company facilities and various economic activities and consequent population growth. This means that there is a significant demand for investment in the urban and environmental planning sector.

Therefore, it is necessary to recognize that cities need a development plan so that expected growth may occur in an orderly manner, given the magnitude of the challenges they face. Current limitations and improvements should be widely discussed and recognized.

The data collected also indicate a wide diversity of environmental management actions already adopted, as waste and effluent management, energy efficiency and emission control, and it became apparent that the main stimuli for their implementation are the necessity for adequacy to the environmental legislation, reduction of operational cost, and consolidation of an environmentally responsible image. As mentioned before the adoption of responsible environmental actions, that tend to

collaborate with regional socioenvironmental conditions and preservation of natural resources, has been implemented, although some organizations still need to invest more significantly in these strategies and establish modern socioenvironmental corporate policies.

Considering the present expansion of industrial activities in Dom Pedro I road axis, for companies to expand their activities related to environmental issues, public policies are deemed necessary to allow and demand more efficient command and control measures. Nevertheless, also incentives to environmental conservation are necessary so that they can be understood as competitive advantage and innovative strategic approach, coupled with pollution control measures.

Finally, both public and corporate sectors need to implement urban and environmental planning processes to promote improvements and social welfare and sustainable actions. The inclusion of environmental issues in the planning mechanisms is extremely important because it will make possible to predict impacts, and implement a zoning so that each activity interferes as little as possible in the surrounding activities and environment. This will certainly improve social and environmental conditions and preservation of natural resources, guaranteeing the basic rights of local residents.

Another relevant aspect to consider from the perspective of sustainability is the importance of environmental management systems, properly implemented, both to improve organizational environmental performance, and for a better quality of life for individuals, both internally and externally to the organization.

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Water Resources in the Context of Global Environmental Change: Some Perspectives for Sustainability

Sônia Regina da Cal Seixas, João Luiz de Moraes Hoefel and Paul Barrett

Abstract

Conservation and management of water resources quality and quantity in a particular region are one of the great challenges to sustainability. Therefore, it is a very important element in the recognition of urban expansion processes and anthropic pressure on ecosystems associated with regional sustainable environmental planning. In the state of São Paulo, Brazil, an intense process of industrialisation and urbanisation followed the recent expansion of its main east road system, which is located near headwaters and ecosystems of important rivers. In recent years, this area was also faced with an intense shortage of water resources due to a severe drought that the southeast area of Brazil faced, along with the lack of effective water resource management and the definition of economic development projects that take into account environmental preservation and regional sustainability. The main objectives of this study involve the recognition and study of such problems, the involvement of surrounding communities in collective actions that

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aim to recognize the regional socio-environmental history and to stimulate an awareness of the importance of regional rivers and their conservation and maintenance, aiming to secure for present and future generations the quality of water resources as a priority for the region's sustainability.

Keywords
Water resources · Water crisis · Global environmental changes · Wales · Brazil

1 Introduction

Conservation and management of water resources quality and quantity in a particular region are one of the great challenges to sustainability. Therefore, it is a very important element in the recognition of urban expansion processes and anthropic pressure on ecosystems associated with regional sustainable environmental planning.

At the same time, water is a key driver of economic and social development. While it also has developed as part of the ecosystem that maintains the integrity of the natural environment. Having said this, water is only one of the number of essential natural resources that we have to take into account and it is clear that issues relating to water are not examined in isolation, although it is water that we will be considering in this paper.

The recognition and study of water-related problems in the higher part of the Piracicaba River Water Basin, the involvement of surrounding communities in collective actions that aim to recognize the regional socio-environmental history and to stimulate an awareness of the importance of regional rivers, their conservation and maintenance are the main objectives of this study. The measures taken to solve water problems on the River Taff, located in Wales, will serve as measures to be proposed to the Piracicaba River Water Basin.

Decision-makers, whether in the government or in the private sector, have to struggle over commitments regarding the allocation of water. More and more, they have to allocate diminishing supplies to ever-increasing demands. Drivers such as urbanisation and climatic changes further increase the stress on water resources. The long-established isolated approach is no longer feasible and we, as authors, acknowledge that a more holistic approach to water management is essential; however because of the nature of this paper, we will only be considering the topic of water here.

There are great differences in water availability from region to region—from the extremes of deserts like the Sahara to the rain forests of South America. And just to quickly paint the background to the River Taff, which is located in Wales, and that in this article will be used as an example for sustainability actions in the high portion of the Rio Piracicaba Water Basin, São Paulo, Brazil, it can be said that

Wales, on the west coast of Britain, has an essentially maritime climate, characterized by weather that is often cloudy, wet and windy but mild. However, the shape of the coastline and the central spine of high ground from Snowdonia southwards to the Brecon Beacons introduce localized differences. While some upland areas can experience harsh weather, the coasts enjoy more favourable conditions and areas in east Wales are more sheltered.

On the whole, water supply is not a problem in Wales and reservoirs have been constructed here to provide water for major cities in England like Liverpool and Birmingham. Due to its marine climate, the variability of supply is normally quite constant, unlike many areas in the world where there is often a great variability through time, because of both seasonal disparities and inter-annual variation.

Frequently, in many regions of the world, the range of variability and the timing and duration of periods of high and low supply are not predictable. This results in an unreliability of the resource which challenges water managers as to their decision-making and to the societies that are obliged to respond to the decisions of these water managers. Most developed countries have, in large measure, artificially overcome natural variability by supply-side infrastructure to assure reliable supply and reduce risks, albeit at high cost and often with negative impacts on the environment and sometimes on human health and livelihoods. Many less developed countries, and some developed countries, are now finding that supply-side solutions alone are not adequate to address the ever-increasing demands from demographic, economic and climatic pressures. As a result, wastewater treatment, water recycling and demand management measures are being introduced to counter the challenges of inadequate supply and we will see some of these measures in the section on the River Taff.

In addition to problems of water quantity, there are also problems of water quality. Pollution of water sources is posing major problems for water users as well as for maintaining natural ecosystems (Davies and Boden 1991). Here also, we will examine some of the measures taken to counter these problems on the River Taff that will serve as measures to be proposed to the Piracicaba River watershed.

In many regions, the availability of water in both quantity and quality is being severely affected by climate variability and climate change, with more or less precipitation in different regions and more extreme weather events. In many regions, too, demand is increasing as a result of population growth and other demographic changes—in particular urbanisation—and agricultural and industrial expansion following changes in consumption and production patterns. Accordingly, some regions are now in a constant state of demand outstripping supply and in many more regions this often occurs at critical times of the year or in years of low water availability.

Most of these concerns, however, had been addressed over a period of around the past forty years, by the time the Living Taff project had been conceived and the idea behind it was to draw attention to problems associated with water supply by highlighting existing schemes and creating new ones, but also attempting to bring communities together that are based on the course of the river in a sustainable way following the Industrial Revolution, in which the area had played a major part.

2 Problems Observed in the River Taff (Motivating Actions)

Three hundred years ago Wales, like Brazil, had some of the purest waters in the world. The population was very small, less than a million, with no large towns or cities. At the end of the seventeenth century, it was estimated that the population of both England and Wales was only about 5 1/2 million and we must remember that even the city of London in the seventeenth century only had about 600,000 inhabitants. There was hardly any industry at this point, although the Industrial Revolution was shortly to hit the country in way that has caused a lasting effect on the rest of the world and a post-traumatic stress on an incredible scale on the population and landscape of this area.

Wales was also, until fairly recently, heavily forested, which prevented the rapid run-off of water and consequent flooding, which occurs in many areas today (Jenkins 1987).

The River Taff is one of the best-known rivers in Wales, especially as it runs through Cardiff, the capital city. The fast flowing valley rivers in this catchment have experienced major changes over the last 200 years. Before the Industrial Revolution, the rivers were noted for their rural tranquillity, remoteness and quality of salmon fishing. They were described by Malkin in 1803 as having:

> perfect clearness, uncontaminated, unless in heavy floods, by the least tinge of muddy soil or any other fortuitous discolouring.

These rivers then suffered a severe degradation due to industrialisation and huge population growth within the catchment. Effluents from the iron and steel works, coal mines, power stations, coke ovens and sewers, poured into the rivers resulting in the Taff being declared biologically dead in the 1970s. At the same time a high rate of unemployment produced attendant effects that are well recognised in countries throughout the world, and experts outline seven major features of unemployment in Wales, where it is continually higher than the Great Britain average. And in the region around the River Taff, it is continually higher than the Welsh average. Changes in the structure of employment in South Wales, the cut-back in steel production at Port Talbot and Llanwern, and the consequential effects on the coal industry, combined with the devastating effects on the manufacturing industry have created an atmosphere that recently brought about huge majorities for Brexit.

Unemployment, especially chronic unemployment, has affected the unemployed in this area in ways other than simply their wallets. It has affected their future ability to find a job and their psychological and physical well-being. Even the employed have been affected by unemployment because the ripple effects impact on the overall economy and the communities where they live.

Just as we pointed out in the introduction, water is only one factor in the sustainable development of an area and, although the river was hardly given any regard by the local population, the founders of the Living Taff project felt that it

could be an important factor in stimulating an awareness of the fragmented community right along the length of the river.

3 Actions That Have Been Developed by the Living Taff Project, Considering the Perspective of Sustainability

Just to clarify what the Living Taff is—the project has been in existence for just over 3 years. It is a Community Interest Company and compared with a charitable company a CiC has: greater flexibility in terms of activities; no trustees and no trustee control; directors who can be paid, but this is regulated; light-touch regulation, but no tax incentives and fewer reporting requirements and administration.

The project receives no funding from the government, receives no grants and all work is carried out on a voluntary basis. The founders did this initially so that they could act as a pressure group as well as organizing and coordinating events together with creating an awareness of the importance of maintaining the purity of the water in the river.

During the post-industrial period the fact that rivers like the Taff in Wales and the Thames in London had been officially declared biologically dead led to drastic actions by river authorities and the Environment Agency. Rapid improvements came about following the 1970s, due to pollution control legislation but also, if we are to be realistic, to the decline in heavy industry. Wildlife, including migratory fish and otters, has now returned to the river. The Taff Trail, a path along the riverside, built by Sustrans principally for cyclists, attracts many visitors who enjoy the features of the catchment, with anglers, canoeists and rowers using its waters for recreation (Davies 1994).

The National Rivers Authority's vision was to manage the uses of the catchment so as to continue this improvement in a sustainable way. Their key objectives are:

the continued improvement in water quality by effective regulation of industry and additional investment in sewage and sewerage infrastructure by Dwr Cymru Welsh Water (DCWW).
to reduce the amount of litter and sewage-derived debris along the river banks.
to manage the water resources to reduce any localized effects of abstraction while supporting the supply of potable water to South East Wales.
to maintain all flood defences in order to protect people and property and to issue flood warnings.
to ensure that any development proposals have no detrimental effect on the water environment. Early discussions with developers and contractors are essential.
to reinstate significant and self-sustaining runs of salmon and sea trout.
to sustain and, where possible, improve stocks of brown trout and coarse fish.
to maintain and improve the nature conservation value of the catchment, and protect the heritage resource.

to ensure that all those who wish to use the catchment for recreational purposes can enjoy doing so with mutual respect and consideration.

It can thus be seen that the sustainability of the river itself is in pretty good hands and that great advances have been achieved vis-a-vis the quality of the water, but the founders of The Living Taff felt that there was a lot more scope for the river to bring communities together and to attract visitors to the area. However, some of the problems they faced were

Traditionally, the river, like the area through which it runs, was perceived by outsiders and locals to be dirty and unattractive due to its industrial past.

Although it rises in the stunningly beautiful Brecon Beacons National Park, the river runs through two of the poorest counties in Britain—Merthyr Tydfil and Rhondda Cynon-Taff—contrasting with Cardiff at its mouth, the capital of Wales, which is one of the most prosperous areas in Britain.

The communities along the river like Tongwynlais, Pontypridd, Abercynon, Aberfan and Merthyr Tydfil rarely visit each other, preferring to travel to Cardiff, which is a short bus or train journey away.

Because some of these communities are less well-off, they are often badly educated and pay very little attention to litter or pollution.

To counteract some of these problems, the Indus television production company was contacted and they produced three programmes about the River Taff, which was first broadcast on BBC Wales in February 2016 and then three times since then —twice on BBC Four, which covers the whole of Britain and once more on BBC Wales. The project has garnered publicity on BBC News, S4C (the Welsh language channel) and in various magazines and newspapers. This has led to increased traffic to the website

To bring communities together a number of circular walks have been organized from the source of the river in the Brecon Beacons National Park down to the port of Cardiff. A series of free jazz concerts have also been organized in venues like castles and churches along the river and a Europe-wide wild swimming event—The Big Jump—was organized in July to coincide with other groups, all the way from Wales through Europe to the border with Syria. Other community events are being planned, like a writing competition held in conjunction with the local train company, Arriva Trains, where people write a hundred words about a place in the Taff Valley that is important to them.

Regarding litter, The Cardiff Rivers Group in conjunction with Keep Wales Tidy and The Living Taff are coordinating local groups to clean up areas along the river in mostly residential areas.

The Living Taff can be said to be a project that has the possibility of developing in many different directions, depending on where the volunteers and local residents feel that it should go, and that can serve as a model to be adapted in other locations and regions. We present in the following item the characteristics and the main problems of our study area, with the aim of bringing actions to be developed in the region, from the rich experience of The Living Taff project.

4 Deforestation, Drought and Crisis Water in the Cantareira Water Supply System

In the state of São Paulo, Brazil, an intense process of industrialisation and urbanisation followed the recent expansion of its main east road system, which is located near conservation areas, headwaters and ecosystems of important rivers (Fig. 1). In recent years, this area also faced an intense shortage of water resources due to a severe drought that the southeast area of Brazil faced, along with the lack of effective water resource management and the definition of economic development projects that take into account environmental preservation and regional sustainability.

The area under analysis in this paper, the Cantareira Water Supply System exemplifies the above-mentioned issues. For the past three decades, it has undergone an intense process of transformation due to the ease of access, which occurred due to the doubling in size of two major highways—D. Pedro I and Fernão Dias, and that has stimulated its current urbanisation, industrialisation and its development as a tourist destination. In several of its municipalities, there has been intense property speculation and increasing tourism potential, a growing number of hotels, inns and condominiums have expanded without planning, and the growth of a population that has a second home for weekends, and holidays, as well as being crucial to the expansion of the construction sector in the region (Seixas et al. 2015a, b).

The methodology for recognition and characterisation of the regional environmental problems involved the collection of secondary data from the various government agencies (municipal governments, São Paulo State Environmental Department and Economic Development Department) and non-governmental agencies (non-governmental associations, public and private universities) operating in the region. Field researches and semi-structured interviews were also carried out (Laville and Dione 1999; Gaskell 2002) seeking to characterize the vision of

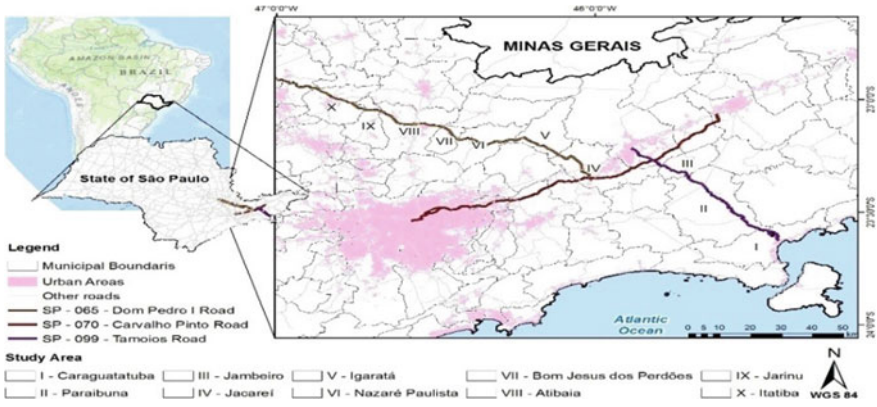

Fig. 1 Study municipalities in São Paulo State and Brazil. *Source* Seixas et al. (2015b)

different social groups on regional issues related to water resources and their conservation.

It was verified, through data collection, that the environmental control system has restricted economic activities without providing the rural population with feasible environmentally appropriate alternatives. This divergence of objectives leaves no options for local communities and they persist in their traditional activities or in activities that bring in increased profits but cause significant environmental impacts. Reforestation with eucalyptus and the sale of their properties to real estate companies that end up subdividing the land into small parcels are some of these activities (Seixas et al. 2012; Hoeffel 2005).

Urban sprawl and tourism development stimulated by the growth of the Metropolitan Region of São Paulo in the direction of this region and the creation of municipal policies for urban development have been intense and are evident in the proliferation of large condominiums that lack proper infrastructure (Seixas et al. 2012).

This scenario reinforces the need for a comprehensive regional discussion about the objectives, characteristics and specifics of conservation units and for the promotion of significant participation not only from the public sector but from the local population as well in the management of socio-environmental and political conflicts in order to implement an environmental protection area effectively (Seixas et al. 2012).

Conservation areas occupy much of the land area of the municipalities that are part of this region, which were created by the State of São Paulo government—Piracicaba and Juqueri Mirim (EPA Piracicaba) and the Cantareira System (EPA Cantareira) Environmental Protected Areas—for its priority to protect biodiversity, its water sources and environmental sustainability (Hogan 1997; São Paulo 2004; Seixas et al. 2012, 2015a, b; Hoeffel et al. 2015).

The Cantareira System that is located in this protected areas supplies water to the metropolitan areas of São Paulo (66%) and Campinas (85%), probably the largest urban and industrial centres of Brazil, which are in continuous conflict over water use. In the study area are located three of four reservoirs that make up the Cantareira System—the reservoirs of the Rivers Jaguary and Jacarei, of the Cachoeira River and of the Rio Atibainha (Hoeffel 2005) (Fig. 2). In this context, the collapse of the Cantareira System is a concern of the state and even federal importance, plus the climate change that has been observed in the state and region, which exacerbates the use of water resources (Coutinho et al. 2015; Nobre et al. 2016).

Since its construction in the late 60s, the Cantareira System allocated two-third of water resources of the Piracicaba River Basin to the Greater São Paulo region, making it possible to consolidate its industrial park, while causing significant environmental impacts in the Bragantina region and other areas of the State of São Paulo that use the same water source. Despite all this, the area where the Cantareira system is located is still covered with considerable remnants of Atlantic Forest, which is one of the tropical forests most in danger of extinction (Hoeffel 2005).

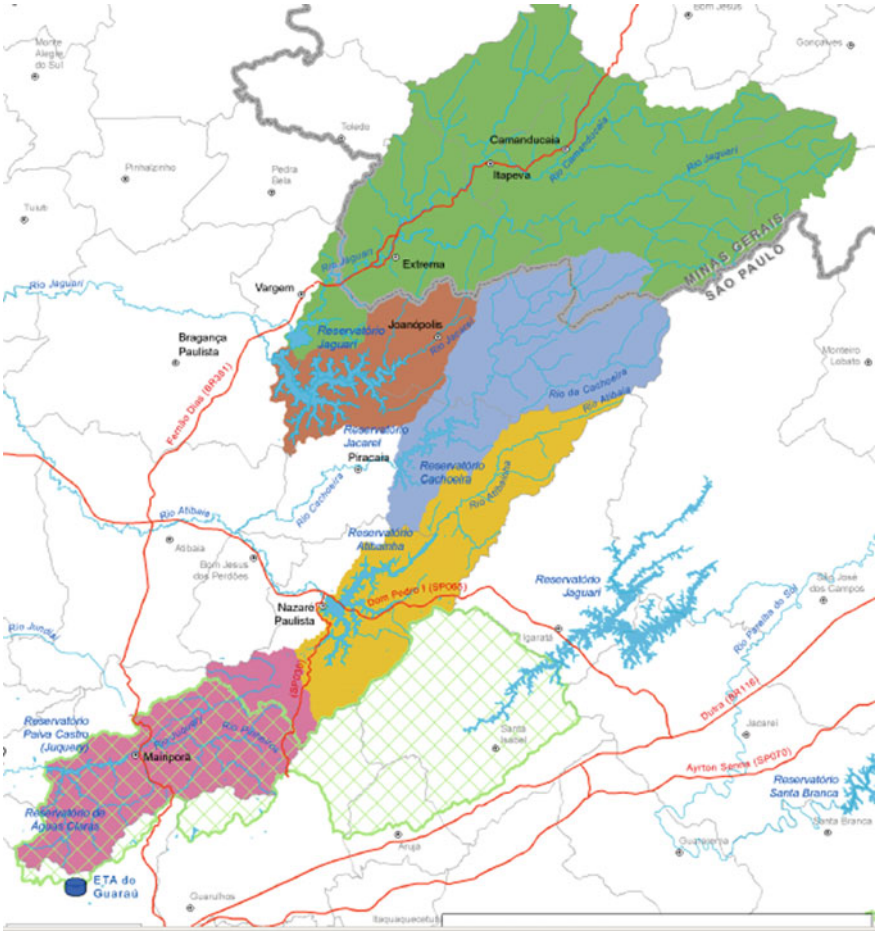

Fig. 2 Cantareira System Water Reservoirs. *Source* Whately and Cunha (2007)

The Atibainha River Basin still covered mostly with remnants of Atlantic Forest, which contributes to the protection of water quality, and includes the headwaters of the Piracicaba River Basin, are priority areas of this paper. The Atibainha River is one of the main rivers that form the Atibaia River and its sources are located in the cities of Piracaia and Nazaré Paulista. The formation of the Atibainha River reservoir, which is part of the Cantareira System, determined the loss by flooding of a considerable part of the agricultural areas of the municipality of Nazaré Paulista. Changes in the quality and quantity of water resources of the Atibainha River Basin will have a direct impact on the Cantareira System and the Piracicaba River Basin (Hoeffel 2005).

In recent years, the increasing restrictions and greater fiscalisation on productive activities considered to impact on natural resources, which now occur throughout the state of São Paulo, increased in areas considered strategic, and among them we can mention the Piracicaba River basin. However, the supervisory action of environmental control systems is not linked to educational and public awareness, which brings about conflict, especially in those regions of important natural resources.

Some examples of monitoring and environmental planning deficiencies, can be highlighted as the intensive and extensive exploitation of nature, from an economic development approach that focuses on the industrial process and the division of soil, without regard to the need for conservation and protection, in sharp detriment to other economic activities, without considering local and regional quality of life and environmental conservation.

In addition, the water resources protection policies do not appear structured to meet the diversity and complexity that this protection requires, characterized by sharing responsibilities between various agencies, with guidance not always consistent with each group, and thus unable to act in the global context of a watershed that extends beyond state boundaries and requires a vision of integration and action among various institutions and levels of society (Hoeffel 2005).

On the other hand, the game of economic interests and existing policy makes the same government that is responsible for the protection policy, in many cases, is also the one that brings about environmental impact practices. The same decision-makers that designates the Piracicaba River Basin as a protected area and of the greatest importance to the state, at the same time stimulate and finance the construction of industrial zones without detailed studies, planning and infrastructure in the region (Hoeffel 2005; Hoeffel et al. 2015; Seixas et al. 2015a, b).

All these aspects highlighted above, coupled with the intense urbanisation of São Paulo state, contribute to a higher encroachment into of areas of vegetation, bringing increasing environmental susceptibility to some sites as well as the increasing vulnerability of the population to problems arising from events like atmospheric phenomena, floods and landslides (Moura et al. 2016), and more recently severe droughts (Coutinho et al. 2015; Nobre et al. 2016).

What has been observed is that this situation, which is already present in large urban centres, can also manifest itself in medium and smaller cities, as in our study area. This fact can be aggravated by being dissected by major highways, which bring about a greater degree of urbanisation to the area, and which can change its microclimate due to the increase in vehicle numbers and pollution. Also the highways are close to environmental conservation areas or fragile ecosystems such as the Cantareira System Environmental Protected Area and the Serra do Mar State Park, which can generate significant environmental changes and impacts (Moura et al. 2016).

Nobre et al. (2016) warned that since the summer of 2014, southeastern Brazil is facing one of the worst droughts in decades. This decrease in rainfall in the region, caused water shortages and a crisis that has affected the population and local economies, especially in the metropolitan region of São Paulo. In January 2015, the main reservoirs had reached storage levels of only 5% of its capacity of 1.3 billion

cubic metres. The causes of dry weather situation were linked to changes in the regional circulation, characterized by locking the upper troposphere average which lasted 45 days.

The complexity and severity of drought impacts observed, along with regional warming, increased the amplitude of the water crisis in the SPMR. Drought during the summer of 2013/14 caused the worst water crisis in São Paulo since 1961. The fact that the 2014 summer season was the warmest for 55 years shows that the crisis in the 2014 and 2015 period is a relevant example of greater vulnerability to climate change due to human activities that cause temperature variations (Nobre et al. 2016).

The water crisis has been exacerbated by a combination of factors such as lack of rainfall and higher temperatures, and the summer of 2014, the hottest and driest of the Cantareira Reservoir Water System since 1951, and the features that were already occurring in the region and pointed out earlier in this article, highlighted the vulnerability of the region (Nobre et al. 2016). The authors' claim, based on historical observations of droughts in the state that occurred in 1953, 2001 and 2014, that SPMR is vulnerable to water shortages. The socio-economic and political situation, including the increased demand for water for a growing population may have exacerbated the situation, causing a sharp and unprecedented water crisis in the state of São Paulo (Nobre et al. 2016).

Another key aspect pointed out by the authors indicates that precipitations below average have already been already present since mid-2013, with a corresponding decrease in water intake. The conditional variance increased steadily even in early 2014, indicating a regime change in progress. The average rate of entry in January 2014 was 15.7 m^3/s, while the output was maintained at 34.3 m^3/s, a very unusual deficit for the rainy season in the region, but the managers of the system only began to realize and lower releases in March 2014, and at a pace that was not enough to bring back the system to normal operating conditions (Coutinho et al. 2015).

However, the National Centre for Natural Disaster Monitoring foresees that the Cantareira System will be below its operating capacity at least until 2016, which makes the authors emphasize that the reservoir management should consider alternative arrangements and avoid a transition to low-volume systems. Not to consider this approach may represent a major problem, which extends beyond the period of anomalous rainfall. Therefore, managers should act with other feedback mechanisms in the system, in addition to extreme events, such as climate change (Coutinho et al. 2015).

Thus, the scenario in the region already has several factors that discourage social and environmental sustainability, considering the problems that it has already faced, it will now have to go forward to deal with new situations, as with the most recent problems of drought and management of the Cantareira System. Of course, not all these questions have only a few simple causes but often there are numerous factors involved, which will require that people have to deal with disasters of various magnitudes together with political decisions and socio-economic development. As pointed out by Nobre et al. (2016), population and managers in the region and throughout Brazil need to increase awareness of the limitations of water resources

so that the present management actions can define water security and the construction of scenarios for a sustainable future (Nobre et al. 2016).

In the next section, we present some examples of action involving popular participation in the management of water resources in Brazil and the United Kingdom.

5 Proposals for Action for Water Resources Management and Environmental Sustainability

After highlighting the most pressing problems that have arisen in the study area and the lack of involvement on the part of the different social players in the development plans focused on the region—especially those related to socio-economic, environmental, cultural, and also climate factors, the result is a management structure which seeks to meet only the interests of specific groups, not the entire community. Because of this we believe it is crucial to develop an action plan that encompasses the participation of all the inhabitants and collectively involves the whole of society in action and management plans.

The main focus of these actions involves the recognition and study of such problems, combined with the involvement of communities directly affected by these problems. There should be collective action aiming, on one hand, to recognize the regional environmental history and, on the other, to encourage awareness of the important regional rivers, their conservation and maintenance. This will then ensure for present and future generations water quality as a priority for the sustainability of the region.

We emphasize once more the key role that the local population and other segments of society must play in the formulation and implementation of environmental conservation policies. This procedure allows proper environmental management and enables the use of natural resources sustainably, promoting both environmental and quality of life for the population (Seixas et al. 2015a, b; Seixas and Barrett 2015).

Some previous studies (Hoeffel 2005; Fadini 2005; Machado 2009, 2014) suggest intervention proposals to the Cantareira System Region that can incorporate environmental planning by river basin, a historical assessment of regional problems and knowledge about the different concepts related to the use of the region, aiming to generate concrete changes in the way natural resources are being used and the use of environmentally sound models (Hoeffel 2005).

Therefore, based on the experience that has been held in Wales, UK by Project The Living Taff, a proposal of actions for the region under study was elaborated aiming the achievement of the proposed goals. In this way, we can highlight the following as relevant, adapting them to the regional reality, in partnership with public agencies (state and municipal) and private action in environmental and water management:

by effective regulation of industry and additional investment in sewage and sewerage infrastructure,
to reduce the amount of litter and sewage-derived debris along the rivers,
to manage the water resources to reduce the intense localized effects of abstraction while supporting the supply of potable water to Bragantina Region,
to maintain all flood monitoring and defences in order to protect people and property and to issue flood warnings, whenever necessary,
to ensure that any development proposals have no detrimental effect on the water environment. Thus, early discussions with developers and contractors are essential,
to involve different users in proposals for environmental and water conservation through effective environmental education programs that includes the diverse aspects and regional vocations.

Just as observed in the project The Living Taff, it is expected that this proposal can generate creative and engaging actions in many directions, from the engagement of various social involved segments. Moreover, it is important to highlight the participation of the population, the local government agencies and state and private institutions and organized civil society.

A significant aspect that needs to be considered in this work are the differences of collective action occurring in the two areas analysed—the higher portion of the Piracicaba River Basin and Taff River as well as the differences in water resource management models. These issues can lead to quite different situations in expected results, but may point out water resources conservation actions and sustainability that express the characteristics of each area.

6 Conclusions

This work makes it possible to recognize, as one of the main lessons from this paper, that from what we have seen in the region of our study two aspects are probably essential for conclusion. First, one should accept that the problems facing the region, in recent decades, are the result of an economic development model that has proven limited in recognising the characteristics of its ecosystem and its social and environmental situation. This was also aggravated by the recent extreme events like the drought of 2013/2015, which if recognised and well managed can be a strong opportunity to improve both the conditions and environmental quality of life for the population.

Second, comparing the experience and results achieved by the project The Living Taff, which we use as an example of collective action, and that will be used as a basis for the environmental intervention, we can say that this opportunity is directly related to the involvement of civil society and the different public and private actors present in the region. The concept of sustainability teaches us that one cannot build an environmentally balanced society and one that is socially just, if the

mechanisms and methods used do not involve everyone. Having as reference a solid project of participation and common goals, we can at the same time, face as future prospects the great dilemmas of achieving effective participation of the regional population in the resolution of environmental problems already detected and co-participation in the management of water resources, besides promoting economic development while stimulating environmental conservation.

Facing these challenges, recognising these problems and the reality of climate change, which will be faced in the near future by Brazil and the rest of the world, this can become a great opportunity to produce better conditions of sustainability for the region and, hopefully, act as an example for other regions in South America.

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Knowledge and Awareness of Sustainability in Saudi Arabian Public Universities

N. Alghamdi

Abstract

On 25 September 2015, the UN General Assembly adopted the 2030 Agenda for Sustainable Development. The Declaration outlined 17 ambitious goals and 169 challenging targets. One of the most substantial goals was raising awareness of sustainable development, particularly within the context of the developing world. The following year, Saudi Arabia launched its Vision 2030; aiming at a "vibrant society", "thriving economy" and an "ambitious nation", through investing massively in health, education, infrastructure, among others. The Vision emphasised the significance of the youth of whom more than half are below age 25. However, to mobilise this precious segment of the Saudi society to achieve a prosperous and sustainable future, there is a need for mainstreaming sustainability, particularly in universities. Universities present a significant medium through which sustainability issues can be imbued in the youth, who are the future leaders. As critical agents of change, students, among other key stakeholders, are crucial enablers for a bright future. This paper investigates the environmental awareness and sustainable behaviour in public universities in Saudi Arabia. It provides an insight into the attitude, knowledge and awareness of sustainability. The main purpose of this research is to highlight the gaps between policy and practice. Therefore, this would be of great importance to help decision-makers formulate evidence-based strategies to 'fill' these gaps. A questionnaire was used to collect data from nine universities; three of which are old, whereas six are recently founded. The number of participants was almost two thousand. Results indicate, inter alia, that the vast majority of students in public universities have little knowledge about the notion of sustainable

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development. Therefore, special attention should be given to raising awareness of sustainability in order to achieve the goals of the Saudi Vision 2030 that is in line with the UN agenda for Sustainable Development.

Keywords
Sustainability · Sustainable development · Knowledge · Awareness · Public universities · Saudi Arabia vision 2030

1 Introduction

There are immense challenges to sustainable development. One of these challenges is implementing sustainability, which has been proven to be not an easy task (Lozano 2006). That is because the environmental issues have become more complex (Lourdel et al. 2005), 'multidimensional, interconnected, and environmental sustainability by its very nature requires an integrated and systematic approach to decisions making, investments and management' (Alshuwaikhat and Abubakar 2008, p. 1778).

On one hand, interest in environmental sustainability within higher education institutions has grown since the early of 1970s (Finlay and Massey 2012). The notion has received more attention in universities across the globe. Yet, the attention given to sustainability has been described as different from one university to the other (Lozano 2011).

On the other hand, the United Nations General Assembly has taken some measures to ensure an integrated and systemic approach to sustainable development. One of which was the UN Decade of Education for Sustainable Development (2005–2014). This initiative sought to mobilise the educational resources of the world to help create a more sustainable future (UNESCO 2005).

The other measure taken by the UN was the resolution adopted on 25 September 2015 named Transforming our world: the 2030 Agenda for Sustainable Development. This universal Agenda is a plan of action for people, planet, and prosperity. The Declaration outlined 17 ambitious goals and 169 challenging targets (UN 2015). In order to achieve these goals and meet these targets, an implementation plan was developed. The plan is believed to be supported by concrete policies and actions for all levels: the national, regional and global.

Some of the most substantial targets that highlight the importance of knowledge and awareness of sustainable development through education particularly within the context of the developing world are:

> By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles… (UN 2015, 21).

> By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature (Ibid, 27).
>
> Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production (Ibid, 27).

The sustainable development challenges are even greater particularly for the developing world (Brandli et al. 2015). As a developing country, Saudi Arabia is investing massively in health, education, infrastructure, among others. On 25 April 2016, the Council of Economic and Development Affairs (CEDA) announced Saudi Arabia's Vision 2030; aiming at a "vibrant society", "thriving economy" and an "ambitious nation" (CEDA 2016). The Vision emphasised the significance of the youth of whom more than half of the Saudi population is under the age of 25 years. Some statements from the Vision that indicate the importance of such precious segment of the Saudi society include:

> Our real wealth lies in the ambition of our people and the potential of our younger generation. They are our nation's pride and the architects of our future (CEDA 2016, 6).
>
> [The government] will take advantage of this demographic dividend by harnessing our youth's energy and by expanding entrepreneurship and enterprise opportunities. [The] Saudi women are yet another great asset. With over 50 percent of our university graduates being female, we will continue to develop their talents, invest in their productive capabilities and enable them to strengthen their future and contribute to the development of our society and economy (Ibid, 37).

The Vision clearly articulates the achievement of environmental sustainability pointing out that

> By preserving our environment and natural resources, we fulfil our Islamic, human and moral duties. Preservation is also our responsibility to future generations and essential to the quality of our daily lives. We will seek to safeguard our environment by increasing the efficiency of waste management, establishing comprehensive recycling projects, reducing all types of pollution and fighting desertification. We will also promote the optimal use of our water resources by reducing consumption and utilizing treated and renewable water (Ibid, 23).

With that being said, the critical question to be raised is how to mobilise this precious segment of the Saudi society to achieve a prosperous and sustainable future. Young men and women in any society are undoubtedly key and strategic enablers of achieving sustainable development.

However, in order to mobilise those youth to achieve sustainable development, there is a need for mainstreaming sustainability through general and tertiary education (Lotz-Sisitka et al. 2015; Ketlhoilwe and Jeremiah 2010; Down 2006; UNESCO 2005). Universities present a significant medium through which sustainability issues can be imbued in the youth, who are the future leaders (UNESCO 2005). 'If higher education does not lead the sustainability effort in society, who will?' (Cortese 2003, 19). As critical agents of change, students, among other key stakeholders, are crucial enablers for a bright future.

The main purposes of the current research are:

- to investigate the environmental awareness and sustainable behaviour in public universities in Saudi Arabia,
- to provide an insight into the attitude, knowledge and awareness of sustainability, and
- to primarily highlight the gaps between policy and practice. Therefore, this would be of great importance to help decision-makers formulate evidence-based strategies to 'fill' these gaps.

This study is part of an ongoing PhD research project that focuses on environmental sustainability in university campuses in Saudi Arabia. The research project was carried out in one-third of public universities in the Kingdom. The ultimate goals of the project are to assess as well as to address environmental sustainability issues in public universities. Having reviewed 12 sustainability assessment tools for universities (Alghamdi et al. 2017), an assessment tool was developed and used in the research project. The main issues evaluated in the PhD research project include (1) management aspects (sustainability indicators, e.g. vision, aims, policy, commitments, supply and demand planning, and investments), (2) engagement aspects (sustainability indicators, e.g. knowledge, awareness, attitude, behaviour and willingness to change), and (3) environmental aspects (sustainability indicators, e.g. sustainable planning and design principles, location, transportation, environmental quality, indoor quality, flexibility and space utilisation). With that being said, this paper presents only the findings of one key part of the research project (sustainability knowledge, environmental awareness and sustainable behaviour). Therefore, the findings of this paper underline some sustainability issues in the Kingdom of Saudi Arabia that policy- and decision-makers have to take into account when developing the implementation plan to achieve the 2030 Vision.

The main method utilised in this paper was a survey. A questionnaire was used to collect data from nine public universities; three of which are well-established, while six are recently founded. The selection was based on certain criteria to ensure representative samples. The number of participants is almost 2000; 1585 students (84%), 202 academics (10%), and 115 supporting staff (6%).

The outline of this paper takes the form of five sections: The following section introduces higher education in Saudi Arabia, highlighting some basic information about the tertiary education's system and institutions. The third section presents the methodology, underlining the research approach. What follows are the results in which the analysis and the discussion parts are presented. The last section gives some conclusions and recommendations, providing some proposed solutions for the Saudi government and the public universities in order to contribute to its Vision 2030. It also presents the limitations of the research paper and highlights the need for further research to shed light on some still unsearched areas.

2 Higher Education in Saudi Arabia

When comparing higher education in Saudi Arabia with other nations, the Kingdom's system is relatively young. Table 1 presents all the public universities in the country. It shows that only four universities are over 50 years old. For almost four decades (1960–2000), the Kingdom was known to have just eight universities established between 1957 and 1998.

Table 1 Public universities in Saudi Arabia ordered chronologically

No	Name of the institution (Code)	Location	Year of foundation	Age in 2016
01	King Saud University (KSU)	Riyadh	1957	59
02	Islamic University of Medina (IUM)	Medina	1961	55
03	King Fahd University for Petroleum and Minerals (KFUPM)	Dhahran	1963	53
04	King Fisal University (KFU)	Alhasa	1964	52
05	King Abdualaziz University (KAU)	Jeddah	1967	49
06	Imam Muhammad Bin Saud Islamic University (IMSIU)	Riyadh	1974	41
07	Umm Al Qura University (UQU)	Makkah	1981	35
08	King Khalid University (KKU)	Abha	1998	18
09	Qassim University (QU)	Buraydah	2003	13
10	Taibah University (THU)	Medina	2003	13
11	Taif University (TFU)	Taif	2003	13
12	King Saud Bin Abdualaziz Uni. for Health Science (KSAUHS)	Riyadh	2005	11
13	Jazan University (JNU)	Jazan	2005	11
14	University of Hail (UH)	Hail	2005	11
15	Aljouf University (AJU)	Skaka	2005	11
16	Albaha University (ABU)	Albaha	2005	11
17	Tabuk University (TKU)	Tabuk	2006	10
18	Najran University (NU)	Najran	2006	10
19	Northern Border University (NBU)	Arar	2007	9
20	Princess Nora University (PNU)	Riyadh	2008	8
21	Shaqra University (SU)	Shaqra	2009	7
22	King Salman Bin Abdualaziz University (KSAU)	Alkharj	2009	7
23	University of Dammam (UD)	Dammam	2009	7
24	Majmaah University (MU)	Majmaah	2009	7
25	Saudi Electronic University (SEU)	Riyadh	2011	5
26	Hafr Albatin University (HAU)	Hafr Albatin	2014	2
27	Bishah University (BU)	Bishah	2014	2
28	Jeddah University (JHU)	Jeddah	2014	2

Today, however, it has 28 public universities in which recently founded universities established between 2003 and 2014, as shown in Table 1. The recently founded universities were in fact satellite or branch campuses of those eight well-established Saudi universities, which in recent years become independent universities. This in turn means that 75% of public universities have been established in the last decade. This high percentage excludes the construction of eight private universities and 20 private colleges. Although all public universities funded by the Ministry of Education, there are some colleges with a technical, industrial, medical and administrative focuses that are managed and financed directly by public institutions rather than from the Ministry itself.

According to the Saudi Ministry of Education (MOE 2015), the enrolled students in 2014/2015 were 1,307,481 students; 1,252,634 Saudis (95%) and only 54,847 non-Saudis (5%). Over 50% of students are female. Almost 350,000 new students (freshmen) are expected to be enrolled in public universities each year.

Other characteristics of the higher education system in the Kingdom are: centralised system of control, gender segregation, funded by the state, free for all citizens at all levels, so citizens do not pay to study, instead they are paid (Smith and Aboummoh 2013).

The government of Saudi Arabia is aiming to transform its education system by investing heavily in the education sector with a special focus on the higher education sector. The investment in higher education sector can be seen through a number of initiatives such as the number of its universities, student enrolment and scholarship programmes. Furthermore, a quarter of the national budget, which is €202 billion, will be spent on education and training this year (2016). That means €46 billion will be allocated to education sector, which is regarded as one of the highest in the world (Alruwaili 2015). Additionally, as education looks set to remain a priority, in 2015, the government merged the Higher Education and Education ministries into one ministry called the Education Ministry to boost education standards. These developments are seen by many as to herald major improvements for higher education system in Saudi Arabia (Jugnoo 2015; Alruwaili 2015; Oxford Business Group 2015).

3 Research Methodology

The methods for this study were a desk study and a field work. The desk study was mainly based on literature review including research papers, websites and existing survey research, whereas the field work involved a tailored questionnaire.

The questionnaire was distributed to one-third of the Saudi Arabian public universities. The sample consists of nine universities in total; three well-established and six recently founded universities. The three well-established universities are King Saud University (KSU), Islamic University of Madinah (IUM) and King Abdulaziz University (KAU), whereas the six new universities are Jazan University

(JNU), University of Hail (UH), Albaha University (ABU), Najran University (NU), King Salman Bin Abdulaziz University (KSAU) and Hafr Albatin University (HAU). To insure fair distribution and representative samples, selection criteria were used. The criteria include: the age of the institution, the size of student body, the size of university campuses and the location in the country (North, South, East, West, and Centre).

The questionnaire was adopted and developed from Student Sustainability Survey by University of Arizona (2014), Sustainability Skills Survey: Staff Questionnaire by Bunting et al. (2012) and Arizona State University Student Sustainability Survey by Arizona State University (2011). The self-administered questionnaire was mainly designed to measure different variables to test the targeted groups about knowledge on fundamental sustainability terms and issues including attitude, awareness, behaviour and willingness to change. It does so by using both closed- and open-ended questions, which both provide qualitative and quantitative data, giving richness and depth of information. This questionnaire is meant to gauge sustainability at the operational level from the point of view of users of the educational facilities including students (graduates and postgraduates), academics (faculty members) and supporting staff (researchers, technicians and administrative employees). The advantage of using questionnaire is to gain large amounts of information collected from a relatively large number of people in a relatively short period of time (Popper 1959; Ackroyd and Hughes 1981).

The questionnaire's distribution and collection techniques were carried out manually, between September and November 2015. The survey was distributed in male campuses only for reasons including physical accessibility to female campuses, logistical support issues and time constrains, given that this study is part of an ongoing research project. After receiving all the necessary permissions, the survey has been handed directly to every participant. Some respondents completed it on the spot; others returned it later in the week. Many academic staff have helped in both processes; the distribution and the collection. They completed the questionnaires and handed them back during their office hours. Other academics, on the other hand, left the completed forms as agreed at their department secretary's office.

For analysing the collected questionnaires, the well-known statistical analysis software SPSS Statistics® was used. First, the data were coded. Second, the data transferred into the SPSS, which took a substantial amount of time and effort. Third, the data were examined by utilising a number of analytical techniques. For example, a cross-tabulation test, known as Pearson's chi-square distribution, was performed to 'explore any relationship between two categorical variables' (Field 2013, 721). Another technique was a multiple response analysis, since there were questions that have multiple choices. Therefore, a multiple response set was created in the SPSS software to analyse such questions.

4 Results, Analysis and Discussion

The research sample represents a population size of 1,436,547 people (as in 2014), which includes 1,307,481 students (91%), 63,363 academics (4%) and 65,703 supporting staff or employees (5%) in all Saudi public universities (MOE 2015). At a margin of error of 2% and a confidence level of 95%, the required sample size is approximately 2400 people. Additionally, if the estimated response rate is 50%, then the number of individuals to be asked to participate is about 4700. However, only 3500 questionnaires were distributed in just nine universities. The total number of returned questionnaires was 1901. The actual response rate, which was 55% at just 12 weeks, is generally higher than anticipated. It is known that 50% is enough as a response rate to scan the population (Babbie 1992). The actual margin of error is 2.25%, at the confidence level of 95%. This, therefore, means that the sample is statistically significant and is representative of the population.

In the questionnaire, there are three targeted groups: students, academics and supporting staff. Table 2 presents the number and percentage of participants per university. The respondents consist of 1584 students (83%), 202 academics (11%), and 115 administrative staff (6%). Large contributions came from KSU, UH, KSAU and JNU, whereas few respondents came from IUM and KAU with no participation from academics or staff.

Table 3 presents the number and percentage of respondents from a range of academic disciplines. Almost 40% of the questionnaires were filled in by respondents from colleges of Science. The second highest responses came from colleges of Engineering with around 30%. The justification of this is because of the fact that

Table 2 Number of respondents from each case study

No	Name of the institution (Code)	Location	Questionnaire			Total
			Students	Academics	Support staff	
01	King Saud (KSU)	Centre	307	17	11	335
02	Islamic (IUM)	North	73	0	0	73
03	King Abdulaziz (KAU)	West	65	0	0	65
04	Jazan (JNU)	South	250	36	10	296
05	Hail (UH)	North	272	37	18	327
06	Albaha (ABU)	South	158	18	1	177
07	Najran (NU)	South	94	25	26	145
08	King Salman Bin Abdualaziz (KSAU)	Centre	258	36	7	301
09	Hafr Albatin (HAU)	East	107	33	42	182
	Total		1584 (84%)	202 (10%)	115 (6%)	1901 (100%)

the majority of new universities have already established and constructed the college buildings of Science and Engineering and these colleges are now completed and in use.

However, the response rates of the rest of the colleges range between 10 and 0.1%, with colleges such as Architecture, Arts, Community College and Languages and Translation having slightly higher percentages of response than other colleges such as Business Administration, Food and Agricultural Sciences, Public Health, Pharmacy, Administration Science, Humanities and Finance and Administration.

Table 4 gives a detailed overview of the number and percentage of respondents in relation to their academic departments. Biology Department is by far the largest with 242 participants which represents almost 13% of the whole sample. Large proportion of questionnaires was completed by people from Electrical Engineering, Preparatory Year, Mathematics, Architecture, Chemistry, English, Civil Engineering and Physics.

Table 3 Number and percentage of respondents based on their colleges

No	Name of the college	Number of respondents	Percentage of respondents (%)
01	Science	712	37.5
02	Engineering	522	27.5
03	Architecture	156	8.2
04	Arts	123	6.5
05	Community college	77	4.1
06	Languages and translation	62	3.3
07	Computer science	48	2.5
08	Dentistry	47	2.5
09	Religion	43	2.3
10	Education	42	2.2
11	Business administration	15	0.8
12	Food and agricultural sciences	8	0.4
13	Public health and health information	7	0.4
14	Pharmacy	7	0.4
15	Administration science	4	0.2
16	Humanities	2	0.1
17	Finance and administration	1	0.1
18	Public health and tropical medicine	1	0.1
	No answer	24	1.3
	Total	1901	100

Table 4 Number and percentage of respondents based on their departments

No	Name of the department	Number of respondents	Percentage of respondents
01	Biology	242	12.7
02	Electrical engineering	187	9.8
03	Preparatory year	165	8.7
04	Mathematics	148	7.8
05	Architecture	140	7.4
06	Chemistry	112	5.9
07	English	108	5.7
08	Civil engineering	88	4.6
09	Physics	87	4.6
10	Tourism and archaeology	60	3.2
11	Computer engineering	59	3.1
12	Periodontics and community dentistry	45	2.4
13	Religion	44	2.3
14	Special education	41	2.2
15	Modern languages	38	2
16	Urban planning	37	1.9
17	Mechanical engineering	33	1.7
18	Law	26	1.4
19	Non-destructive testing (NDT)	16	0.8
20	Management	13	0.7
21	Industrial engineering	11	0.6
22	Health information management	8	0.4
23	Pharmacy	7	0.4
24	Arabic	6	0.3
25	Plant production	6	0.3
26	Chemical engineering	5	0.3
27	Accounting	4	0.2
28	Managment information system	3	0.2
29	IT	3	0.2
30	Nuclear engineering	3	0.2
31	Electrical/electronic engineering technology	2	0.1
32	Dental surgery	2	0.1
33	Plant protection	1	0.1
34	Linguistics	1	0.1
35	Psychology	1	0.1
36	Agricultural extension	1	0.1
	Not applicable (some supporting staff)	112	5.9
	No answer	36	1.9
	Total	1901	100

In contrast, only few people responded from departments such as Management, Industrial Engineering, Health Information Management, Health Information Management, Pharmacy, Arabic, Plant Production, Chemical Engineering, Accounting, Management Information System, Information Technology, Nuclear Engineering, Electrical/Electronic Engineering Technology, Dental Surgery, Plant Protection, Linguistics, Psychology and Agricultural Extension.

The biggest group participated in the research is student group with 1584 questionnaires. Table 5 indicates that junior students (Third Year) were the largest with almost 18%. The second largest was Fourth Year and Second Year students with almost 15 and 13%, respectively. 16% of participated students were either freshmen (First Year) or Fifth Year students. Few participants were senior students Sixth Year and Seventh Year, who tend to be from either Medical or Engineering departments.

Table 6 shows the participants' level of education. It illustrates that the vast majority of respondents hold general education certificate (High or Secondary School), who are currently doing their first degree at public universities. Almost 12% of participants hold postgraduate degrees; either PhDs or Masters. These people tend to be from the academic group and the supporting staff group, which includes faculty members, researchers and some technicians. Around 5% of the participants hold either undergraduate or associate degrees, which include all the academic programs up to the level of a bachelor's degree. Very few people were holding Intermediate certificate and those usually work as employees supporting academics administratively.

Table 5 Number and percentage of students participated in the research

No	Year of students	Number of students	Percentage of students
01	First	152	8.0
02	Second	242	12.7
03	Third	329	17.3
04	Fourth	284	14.9
05	Fifth	150	7.9
06	Sixth	43	2.3
07	Seventh	39	2.1
	Not applicable (academics and supporting staff)	317	16.6
	No answer	345	18.2
	Total	1901	100

Table 6 Participants' profile for their level of education

No	Level of education	Number of respondents	Percentage of respondents (%)
01	Postgraduate (PhD/Msc)	222	11.7
02	Undergraduate (Bsc)	47	2.5
03	Associate degree (Community college/technical college)	49	2.6
04	General education (High or secondary school)	1549	81.5
05	Less than high school (Intermediate education/school)	4	0.2
	No answer	30	1.5
	Total	1901	100

The questionnaire started with the most famous definition of Sustainable Development (SD) introduced by the World Commission (UN World Commission 1987). Figure 1 shows that only a quarter of the sample heard about the SD. This means that more than two-third of all the respondents did not have any knowledge about the SD. This indicates a massive obstacle facing the higher education system in Saudi Arabia in terms of advancing the knowledge of graduates to meet the challenging future of Saudi Arabia and its Vision 2030.

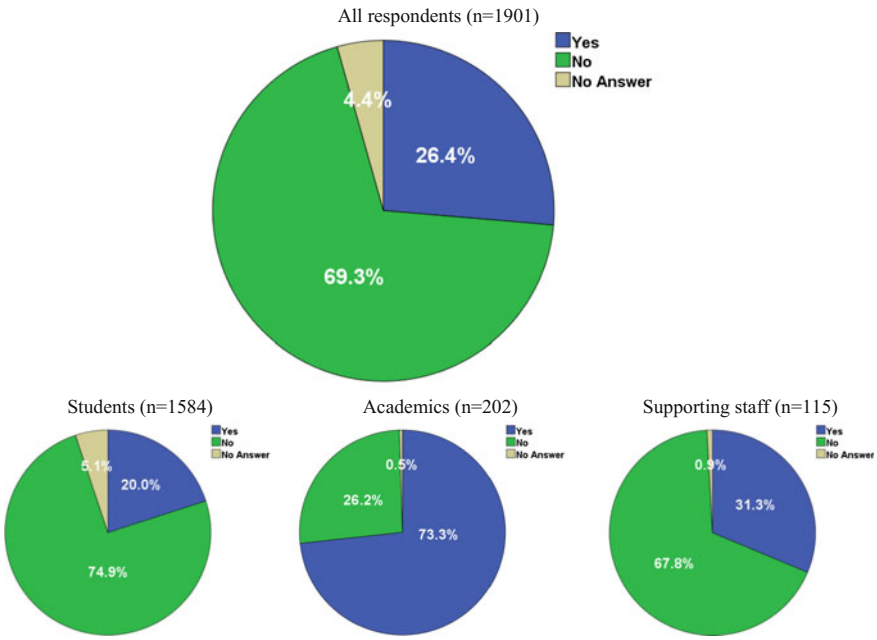

Fig. 1 Percentage of knowledge about the sustainable development

However, when zooming in and looking at the three categories of participants (students, academics and supporting staff), it can be said that some groups do better than others. For instance, Fig. 1 demonstrations that over two-thirds of the academics had the knowledge about the SD, whereas supporting staff and students had little knowledge about the SD, 32 and 20% respectively. Both of these groups, students and supporting staff, show an alarming rate of unawareness of one of the most important and hot topics worldwide; sustainable development.

Across tabulation test, known as Pearson's chi-square distribution, was carried out to highlight if there is an association between the knowledge level of sustainable development and the departments of those surveyed. If the result (the p value) is greater than 0.05, then there is no significant association between the two categories. Table 7 shows that the p value, which is 0.001, indicates that there is a relationship between knowledge level of sustainability and departments that those surveyed belong to. This means that there is a connection between the level of knowledge about the SD and the departments of those participating in the research.

The second question raised in the questionnaire was to name the most important sustainability issues in Saudi Arabian universities. A definition was given before the question to briefly introduce 'sustainable university'. The definition was:

> When thinking about a 'sustainable university', its campus has to consider the implementation of sustainable practices (environmentally, economically, socially and educationally) through its campus life cycle (planning, constructing, operating, maintaining, and retrofitting) through all management directions (top-down as well as bottom-up approaches) on all levels of campus (from classrooms to laboratories, transportation, procurement, housing and other services) in many ways (e.g. energy saving, water conservation, air quality, social equity, waste reduction, walkability, well-being and health) or in many different shapes and forms (e.g. flexibility, multi-functionality, optimal space utilisation).

Table 8 demonstrations the diversity of important issues pointed out by almost one-third of the participants in this research project. The table orders these issues according to their importance. The 10 most commonly mentioned issues include water and energy, buildings, healthy food, housing, labs and classrooms, well-being, social aspects, flexibility, transportation and location and air quality.

The top two issues were water and energy and buildings. It is understandable that most participants would refer to water and energy as key issues in sustainable development, given that such issues are crucial in an environment like Saudi

Table 7 Testing the relationship between knowledge about the SD and departments of participants

	Value	df	Asymp. Sig. (2-sided)
Pearson chi-square	380.853[a]	76	0.001
Likelihood ratio	361.082	76	0.000
Linear-by-linear association	0.800	1	0.371
No of valid cases	1901		

[a]67 cells (57.3%) have expected count less than 5. The minimum expected count is 0.04

Table 8 Sustainability issues in Saudi Arabian university campuses

No	Sustainability issues in Saudi Arabian university campuses	Number of respondents	Percentage of respondents
01	Water and energy	66	3.5
02	Buildings	58	3.1
03	Healthy food	32	1.7
04	Housing	32	1.7
05	Labs/classrooms	31	1.6
06	Well-being	30	1.6
07	Social aspects	20	1.1
08	Flexibility	21	1.1
09	Transportation/location	21	1.1
10	Air quality	20	1.1
11	All what have been mentioned in the definition	18	0.9
12	Shaded car parking	18	0.9
13	Infrastructure	15	0.8
14	Space utilisation	15	0.8
15	Planning	13	0.7
16	Operation services	13	0.7
17	Lack of responsibility	12	0.6
18	Recycling	11	0.6
19	Maintenance	10	0.5
20	Raising awareness	8	0.4
21	Sustainability education & research	8	0.4
22	Landscaping	8	0.4
23	Management	5	0.3
24	Upgrading campus facilities	4	0.2
25	Procurement	3	0.2
26	Lack of smoking zones	1	0.1
27	Lack of sustainability aspects	1	0.1
	No answer	1407	74
	Total	1901	100

Arabia, where 90% of the country is desert. Water, in particular, has been flagged by many participants not only in this study, but also in others (Alhefnawy 2013).

Buildings, on the other hand, are also seen by respondents as key, given that buildings consume a lot of energy and generate a lot of waste. Buildings use about 40% of global energy, 25% of global water, 40% of global resources, and they emit approximately 33% of greenhouse gas emissions (UNEP 2016). Nevertheless, with these challenges come great opportunities. For example, energy consumption in buildings can be reduced by 30–80% using available technologies (Ibid).

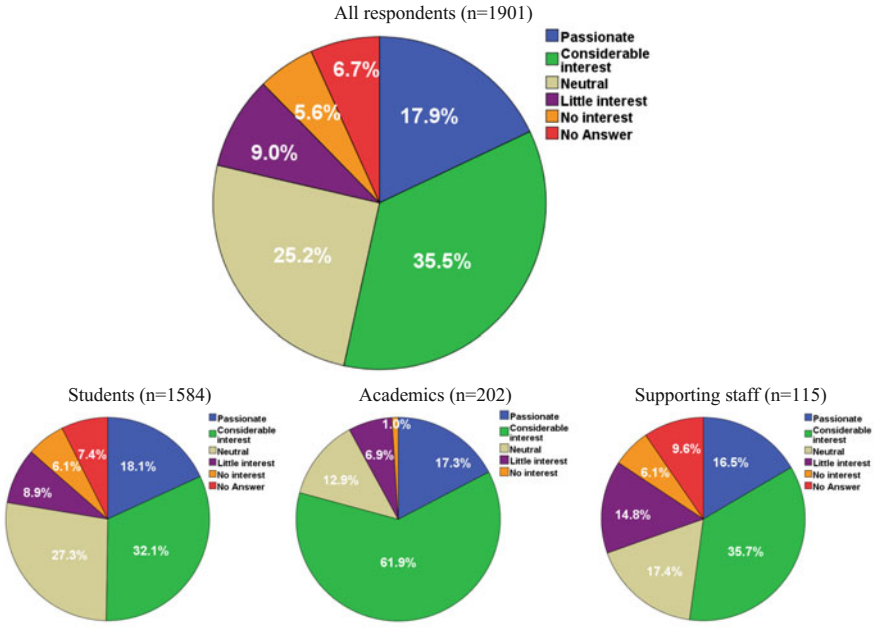

Fig. 2 Level of interest in sustainability in Saudi universities

Figure 2 shows that over half of those surveyed indicated a concern about sustainability; either very passionate or considerably interested, 17.9 and 35.5% respectively. Merely about 6% indicate little interest in sustainability.

Digging deeper into the data highlights that nearly 80% of academics are more interested in sustainability than students and supporting staff. Only half of students are concerned about sustainability. The same goes for the supporting staff. Alarmingly, 15% of students and 20% of supporting staff have shown either little or no interest at all in sustainability. The low level of interest in sustainability among students is also reported in other research. Abubakar et al. (2016) point out that, in general, students showed a lack of interest and willingness to take part in sustainable initiatives.

To check the association between the level of interest in sustainability and the departments of those surveyed, another cross-tabulation test was undertaken. The analysis illustrated in Table 9 demonstrations that the result, which is 0.001, indicates a significant relationship between the level of interest in sustainability and the departments of the 1901 participants.

Among the issues of sustainability awareness asked was the knowledge about whether or not their universities have any facility for renewable energy such as solar panels, wind turbines, hybrid power system (solar and wind), geothermal plant, etc. Figure 3 exhibitions that around 8% of those surveyed believed that there are facilities for renewable energy on their university campuses. However, nearly 88%

Table 9 Examining the relationship between interest in sustainability and departments of participants

	Value	df	Asymp. Sig. (2-sided)
Pearson chi-square	272.580[a]	190	0.001
Likelihood ratio	282.247	190	0.000
Linear-by-linear association	3.143	1	0.076
No of valid cases	1901		

[a]144 cells (61.5%) have expected count less than 5. The minimum expected count is 0.06

of respondents said either no facilities or they do not know, 44 and 43.7% respectively.

Furthermore, when exploring the responses of academics almost two-thirds pointed out that there are no facilities for renewable energy on their university campuses. Additionally, looking at the three groups (students, academics and supporting staff), it can be said that few people in each group indicated that there are renewable energy sources on their campuses. This suggests that the majority of public universities in Saudi Arabia are lagging behind in this regard.

Of those 8% who claimed that there are facilities for renewable energy on their campuses, approximately 2% gave more explanation about these facilities. This can be shown in Table 10, in which the facilities for renewable energy mentioned were

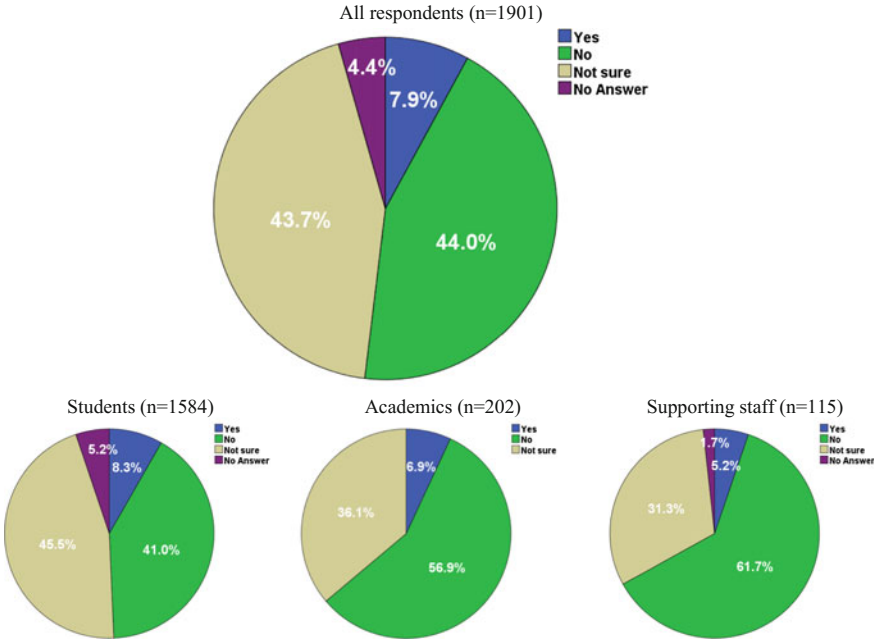

Fig. 3 Knowledge about having facilities for renewable energy on campus

solar panels (0.7%), wind turbines (0.6), and solar/wind hybrid system (0.6%). 10% of the 1901 respondents did not answer this query. This question was not applicable for the majority. This reflects the data in Fig. 3 above-mentioned, in which around 88% of the respondents were either not sure if their campuses have such facilities or their campuses have no facilities.

Another explored aspect was the willingness to use public transportation, university fleet, or to share a car. Figure 4 shows that well over half of the participants are prepared to do so. Around 40% is not willing to use public transportation, university buses or even carpooling. Those who are not willing to use public transportation suggested that they have busy schedules, social reasons (taking family members with them using their own cars) or because public transportation does not exist yet. Furthermore, other claimed reasons include convenience, independence and privacy.

However, among the three surveyed groups (students, academics and supporting staff), three-quarters of the academics pointed out their willingness to use public transportation, whereas just over half of the students are willing and the same goes for the supporting staff.

Recycling and waste collections were also searched. Participants were asked whether or not they have separate collection bins for different types of waste such as paper, glass, plastic, organic, etc. Table 11 shows that less than one-third of public universities in Saudi Arabia have recycling bins. Almost 66% of respondents indicated that either their colleges do not have separate collection bins (53%) or they are not so sure about that (13%).

Participants were asked about their willingness to use the separate collection bins if available. Figure 5 exhibits that the vast majority of those surveyed are willing to separate their own rubbish. Nevertheless, around 8% of participants were not prepared to separate the wastes. All those who are reluctant to separate the wastes did not justify why they are not willing to use the separate collection bins for different types of waste. Among the three groups, almost all the academics are willing to separate their rubbish.

Another explored aspect was issues that act as barriers preventing people from living a more sustainable lifestyle at university and home. The analysis shown in Table 12 suggests that there are three prominent barriers obstructing people from

Table 10 Examples of existing facilities for renewable energy

No	Facilities for renewable energy	Number of respondents	Percentage of respondents
01	Solar panels	14	0.7
02	Wind turbines	11	0.6
03	Hybrid power system (Solar and wind)	11	0.6
	Not applicable	1674	88.1
	No answer	191	10.0
	Total	1901	100

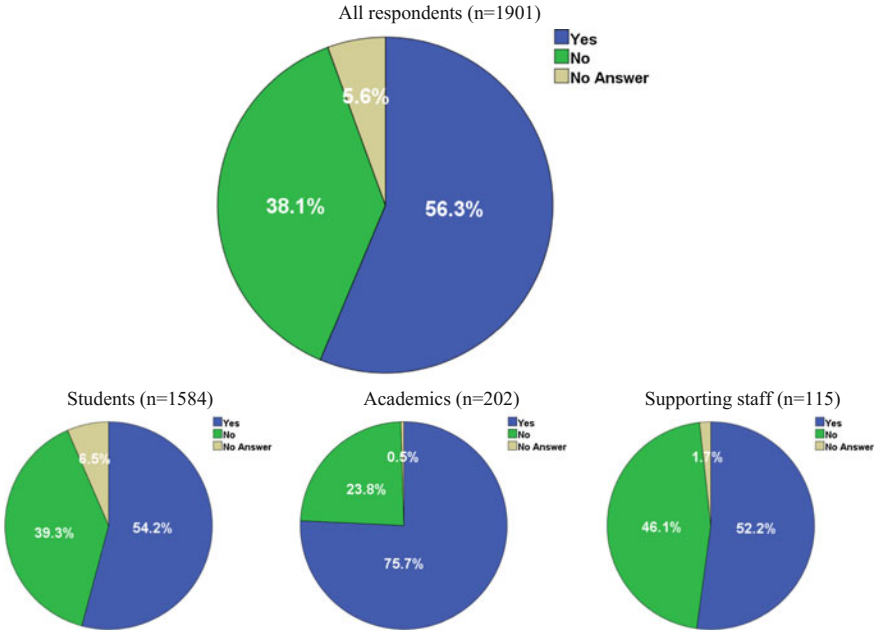

Fig. 4 Willingness to use public transportation, university fleet or share a car

Table 11 Having separate collecting bins

No	Having separate collecting bins	Number of respondents	Percentage of respondents
01	Yes	590	31.0
02	No	1000	52.6
03	Not sure	250	13.2
	No answer	61	3.2
	Total	1901	100

living sustainably. These barriers are: lack of support within our community (43%), lack of collective action to make a difference (39%), and unsure what we should be doing (32%). Other highlighted obstacles include lack of support at our university (28%), and sustainability is not a high priority (23%).

Furthermore, some of the academics have added more barriers than the provided list. They include lack of sustainability culture, society acceptance to sustainability and also lack of commitment from decision-makers at all levels in both public and private sectors.

Some behavioural attributes of sustainability are listed in an attempt to acquire an overall image of participants' behaviours. This question was answered by the majority of participants, which indicates that there is some sustainable behaviour and also some activities being adopted by the majority in Saudi Arabian public

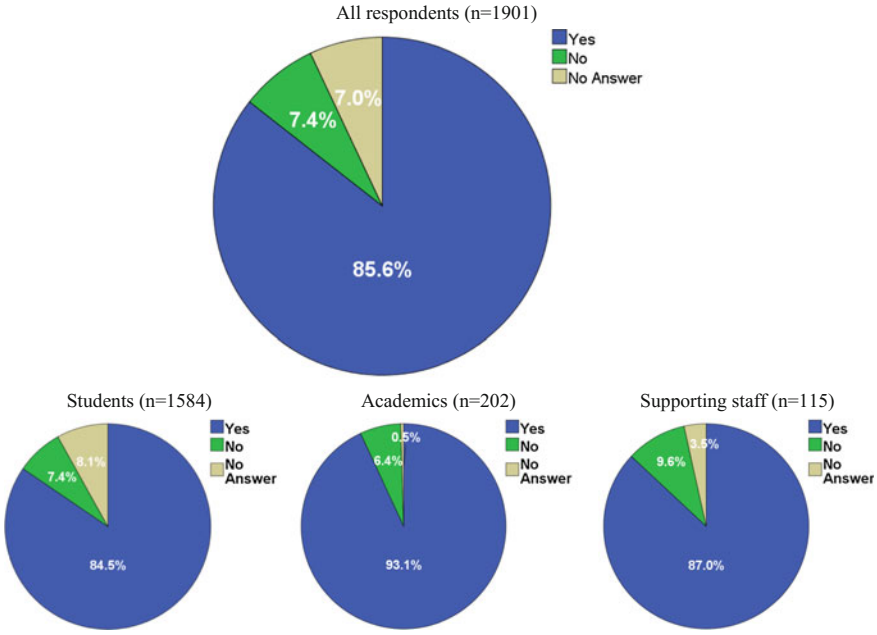

Fig. 5 Willingness to use the separate collection bins

Table 12 Issues acting as barriers preventing living a more sustainable lifestyle

No	Issues	Percent of cases
01	Lack of support within our community	42.80
02	Lack of collective action to make a difference	39.50
03	Unsure what we should be doing	31.90
04	Lack of support at our university	28.30
05	Not a high priority	23.30
06	Too difficult	18.80
07	Too time consuming	17.10
08	Too costly	10.30

universities. Table 13 gives more detailed overview of some sustainable examples. Based on the percentage of cases of sustainable behaviour, the outcomes can be clustered into three groups:

- The most popular sustainable behaviours in public universities in the Kingdom, that were ticked by about two-thirds of the participants, are (i) Donate unwanted possessions such as clothes, furniture, kitchen appliances, and electronics, etc. and (ii) Engage in energy reduction practices such as turn off heat/AC/lights, high-efficiency lightbulbs, etc.

Table 13 Sustainable behaviours

No	Sustainable behaviours	Percent of cases
01	Donate unwanted possessions	65.20
02	Engage in energy reduction practices	64.40
03	Recycle	41.10
04	Refill water bottles	39.00
05	Purchase sustainable products	33.70
06	Have conversations outside of class with faculty, staff, or friends about sustainability issues	26.80
07	Participate in student organisations focused on sustainability	23.20
08	Attend lectures focused on sustainability	23.10
09	Attend a programme/event related to sustainability	22.80
10	Perform research on a sustainability topic	20.70
11	Take a module/course on sustainability subjects from your programme of study	20.30

- Well over one-third of participants marked off a couple of behaviours such as (i) recycle (defined as treating or processing used or waste materials so as to make suitable for reuse), (ii) refill water bottles, and (iii) purchase sustainable products.
- Other sustainable behaviours, which were selected by about a quarter of participants, include (i) Have conversations outside of class with faculty, staff or friends about sustainability issues, (ii) Participate in student organizations focused on sustainability, and (iii) Attend lectures focused on sustainability.

5 Conclusions and Recommendations

The aim of this study was to examine the environmental awareness and sustainable behaviour in Saudi Arabian public universities. It set out to give an insight into the attitude, knowledge and awareness of sustainability. The main purpose of this research was to underline the gaps between policy and practice.

This study has found that the Saudi Arabian's Vision 2030 is in line with the UN 2030 Agenda for Sustainable Development. Both, The Saudi Vision and the UN Agenda, have clearly emphasised the importance of sustainability knowledge and awareness, particularly among young generation.

However, the real challenge for the ambitious Saudi Vision lies in its implementation. This is particularly because of what the findings of this research have revealed. The most significant findings to emerge from this study have shown that:

- the vast majority of students in Saudi Arabian public universities have little knowledge about sustainability
- only half of the students are interested in sustainability
- around half of the students are not willing to change, especially when it comes to using public transportation, university fleet or even share a car.

Other barriers obstructing people from living sustainably on- and off-campus include:

- lack of support within the community and at the university
- lack of collective action to make a difference
- students are unsure about what they should be doing
- sustainability is not a high priority.

The above-mentioned issues, among others, indicate that Saudi Arabian public universities are lagging behind in the knowledge and awareness of sustainability. Higher education institutions should lead the Saudi Arabian society to advance sustainability in the Kingdom. These problems are what policy- and decision-makers in Saudi Arabia ought to address in order to take advantage of its large youth population. Decision-makers have no option but to place sustainability knowledge and awareness top on their agenda, since it will be of great benefit in implementing the Vision 2030. Sustainability has to be prioritised in order to become a culture and a norm. To do so, universities have to take on the leadership role to address these demanding issues towards sustainable future. Thomashow (2014, 3) believes that 'university leadership is our last best hope for addressing the global climate challenge, and campus sustainability initiatives are the foundation of that leadership'. To implement this role, faculty and staff members should be involved. They are believed to be key agents in efforts to achieve lasting progress towards sustainability (Brinkhurst et al. 2011). This study shows that the Saudi academics are enthusiastic enough about sustainability and this should be taken advantage of.

The analysis shows that the more you know about sustainable development, the more you are willing to act sustainably. This has been seen particularly with the academics' group. The question to be raised regardless of the groups surveyed (students, academics or supporting staff) is, will the knowledge be enough to behave more sustainably. This has been answered by Heeren et al. (2016) in which they indicate that 'there are many valuable justifications for educating and training people about sustainability, but that does not mean an increase in environmentally conscious behaviours'. Therefore, to achieve greater deal not only in knowledge and awareness of sustainability, but also in sustainable behaviours, Saudi policy- and decision-makers have to address other aspects such as the social norms, attitudes towards sustainable behaviours and the perceived behavioural control (Ibid).

The significance of this research is that the gaps between policy and the current practices have, to a large extent, been highlighted and what is needed next is action. To overcome these problems and to achieve much of the Saudi Arabia's Vision

2030, the implementation plan or what has been named as Transformative Programs (which are still being developed) should:

- clearly articulate the benefits of sustainable development (Pearce et al. 1990; Rocha et al. 2007; Olsen and Fenhann 2008; Winkler et al. 2008),
- educate, train and inform all stakeholders in universities about sustainability (Robinson 2000; Cortese 2003; Sibbel 2009; Leal Filho 2014; Leal Filho et al. 2015),
- address the social norms and attitudes towards sustainable behaviours (Gatersleben et al. 2002; Leiserowitz et al. 2006; Heeren et al. 2016), and
- invest in sustainability for instance facilities for renewable energy which have to be clearly visible (Wolsink 2010; Dincer 2000). That is to get the message across not only for the campus community, but also for the public.

This study makes several noteworthy contributions to the implementation plan (Transformative Programs) particularly through the higher education sector. The above-mentioned strategies will be of great benefit to help in translating the vision into realty.

Given that there are some limitations in this study, there is a need for further research. First limitation is the fact that the behaviours of participants in this research were not observed, but rather self-reported through the questionnaire. Therefore, research on observed behaviours is required to reflect the reality. Second limitation is the fact that the research questionnaires were only distributed in male campuses for some mentioned reasons. Consequently, additional study is needed to cover both genders. Third limitation is that this study looked at knowledge and awareness of sustainability from the point of view of the end users (students, academics, supporting staff). Subsequently, another research is necessary to explore the understanding of the concept of sustainability from the other perspective of policy- and decision-makers at both levels; the Ministry and universities. This would give a clear overview of what should be done in order to achieve the Saudi Vision 2030 as well as the UN Agenda.

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Urban Agriculture in Cape Town: Building Sustainable Livelihoods

D.W. Olivier

Abstract

Much debate surrounds the economic viability of urban agriculture as a livelihood strategy for Africa's urban poor. This debate appears most polarised in South African cities, where key critiques revolve around urban agriculture's low level of contribution to urban food systems and household income. This study aims to find out what the value of this sector is to those who participate in it, if its economic performance is indeed so negligible. To address this question, the author studied all four non-governmental organisations (NGOs) in Cape Town who promote urban agriculture among the city's poorest households through intensive training and extension services. Using in-depth interviews with the senior leadership of these NGOs as well as the cultivators trained and supported by them, the study finds that direct provision of food and income is far less of a consideration for the cultivators than the body of scholarship makes out. By taking a sustainable livelihoods approach, this study reveals that urban agriculture's contribution is in fact holistic, building social capital and human capital as well as harnessing physical and natural resources, all of which improve economic viability, but not necessarily in traditional economic terms. The study concludes that an emphasis on profit maximisation tends to exclude the poorest of the poor from urban agriculture, while the more holistic sustainable livelihoods approach empowers the economically marginalised.

Keywords

Urban agriculture · Social capital · Sustainable livelihoods · Cape Town

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1 Introduction

Food security is a major focus of urban agriculture research in Africa. This focus emerged with early studies on urban agriculture. It has even been called "one of the 'last frontiers' for increasing world food production" (Niñez 1985: 1). Food and economic security, or the "economic benefits" of urban agriculture, remain central to public and non-governmental organisation (NGO) projects as well as research in Africa to this day (Battersby and Marshak 2013: 453). With funding and public support for increased output and profit, one sees urban agriculture's market share growing in countries such as Zimbabwe and Malawi (FAO 2012). However, while the urban agriculture sector may thrive, its benefits are not captured by the economically marginalised, as it is the wealthy who have the resources to participate most successfully in a profit-driven sector (Frayne et al. 2014).

In reviewing the existing literature, it became clear that few publications on urban agriculture in the region explore alternative indicators of success, such as personal and social benefits (McIvor and Hale 2015). These few publications reveal however that even on a small scale, urban agriculture builds neighbourhood-wide networks from which an array of goods and services are drawn, such as food, childcare and labour (Gallaher et al. 2013). Research in South Africa confirms this, showing that regardless of production scale, urban agriculture is a cohesive force in communities (Slater 2001). Therefore, by striving for profit maximisation in urban agriculture, institutions in Africa have missed what the urban poor consider key benefits of this sector: social cohesion and personal fulfilment (Dunn 2010).

There is therefore a real risk, should economic viability remain the key criteria for monitoring and evaluating urban agriculture-based development programmes, that the economically marginalised will become increasingly excluded from the sector in Africa. This is already a challenge in Cape Town, where local government, although expressing a desire to support the most marginalised, requires a business plan and environmental impact assessment before releasing practical and material support (City of Cape Town 2007).

To date, a handful of studies have revealed the need for a focus on urban agriculture's social benefits among Cape Town's lowest income bracket (Slater 2001; Dunn 2010; Battersby and Marshak 2013), but no study has yet applied a sustainable livelihood framework to understand the complexity of meaning cultivators ascribe to urban agriculture in Cape Town. There is a need for more complex understandings of urban agriculture that go beyond dichotomies such as the social benefits versus the economic benefits (Tinker 1994), and yet few studies have addressed this gap. The sustainable livelihoods framework allows this study to incorporate both physical and social benefits, as well as contributions to the ecology, physical capital and personal development, in order to appreciate the gamut of livelihood capitals urban agriculture engenders and to describe how these contribute to sustainable livelihoods among Cape Town's poorest residents.

To these ends, this study asks the question, "What do Cape Town's low-income urban cultivators value about urban agriculture?" To address this question, the paper begins with a review of key publications on urban agriculture in Africa before focusing in on Cape Town, to provide a contextual framework. The sustainable livelihoods framework is then outlined to provide a basis for interpreting the findings, which are presented and analysed thereafter. Based on this analysis, the conclusion is drawn that African development projects using urban agriculture are more likely to create sustainable livelihoods through the holistic development of a range of livelihood capitals rather than focusing on income generation alone.

2 Trends in Urban Agriculture Research

Early urban agriculture research highlighted traditional farming methods that sustainably produce a high volume and diversity of crops. This research purposed to reformulate these methods into modern development programmes (Niñez 1985). Upon this foundation, a body of research began to grow, the main purpose of which was to prove that artisanal farming presented a viable source of food and income for Africa's urban poor (Mougeot 1994; Redwood 2009; FAO 2012). This viewpoint is taken up by national government in South Africa (Pereira and Drimie 2016), and at the municipal level it informs policy-making for food security in cities such as Cape Town (City of Cape Town 2007).

Some have however challenged the link between urban agriculture and economic gains, as in many cases, urban agriculture fails to provide food and income security in Africa (Webb 2011). For example, in Burundi, where a lack of transport restricts market access for poor cultivators, wealthy brokers force cultivators to sell their produce below production costs (Vervisch et al. 2013). Furthermore, many female cultivators in Africa are particularly prone to exploitation, being doubly oppressed due to their gender and economic standing. In comparison to male cultivators, such women have lower access to investment capital, weaker tenure security and are more vulnerable to harassment and theft (Flynn 2001).

Even in cases where local government or NGOs provide the inputs for start-up, urban agriculture projects may fail (Webb 2011). In South Africa, urban agriculture rarely delivers the economic benefits expected from top-down development projects providing start-up support through input provision (Malan 2015). In an unrestricted market, urban agriculture may flourish among wealthier cultivators who have capital, but it is unlikely to benefit those who are already marginalised (Rogerson 1998).

Notwithstanding these shortcomings, some cases exist of urban agriculture improving quality of life for poor cultivators. For example, in Kenya (Gallaher et al. 2013), Botswana (Hovorka 2005, 2006) and Cape Town (Slater 2001), urban agriculture dramatically improved not only economic wellbeing and food security among the most marginalised but also increased voice, improved access to infrastructure and raised the standing of marginalised people in their society.

Therefore, urban agriculture clearly has the potential to counteract poverty and marginalisation. The key difference between these success stories and the failures referred to in the preceding paragraph is a focus on building social capital, not simply injecting basic inputs for start-up. Therefore, attention to the social benefits must counterbalance economic concerns when promoting urban agriculture for sustainable livelihoods.

3 The Sustainable Livelihoods Framework

The sustainable livelihoods framework (Fig. 1) states that livelihood sustainability increases with access to five livelihood capitals, namely natural capital, human capital, financial capital, physical capital and social capital (Farrington et al. 1999). These capitals enable people to "engage more fruitfully […] with the world" (Bebbington 1999), as they provide the "basis for power to act" (Morse and McNamara 2013).

For example, natural capital includes resources such as grazing land, goods such as water, and services such as nutrient cycling. All of these boost agricultural productivity, and may be freely available. However, accessing them requires some agricultural know-how (Farrington et al. 2002).

Thus, human capital is another important capital. This refers to skills, education and physical health (Nel et al. 2001; Rutherford et al. 2002; Chirau 2012). As natural capitals are harnessed, income can increase. Therefore, human capital is a key determinant of financial capital (cash or commodities) as higher levels of skill, education or physical health tend to increase productivity and thereby income (Jacobs 2009). Financial capital, in turn, makes it possible to invest in physical capital such as land, tools and infrastructure that raise income opportunities by increasing the scale and efficiency of production (Department for International Development 1999).

Finally, social capital or "trust, norms and networks" (Putnam 1993: 167), is encapsulated in the truism, "it's not *what* you know, but *who* you know". Trust is a central aspect of social capital, as some form of trust is prerequisite to forming

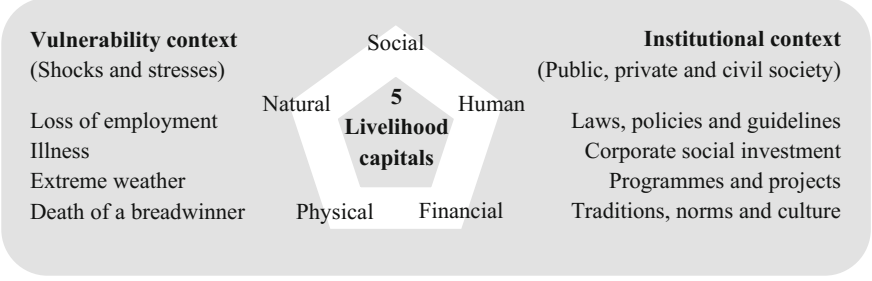

Fig. 1 The sustainable livelihoods framework diagram. *Source* The author

relationship bonds and social networks (Department for International Development 1999). Trust between peers or towards leadership is an important consideration in community development, as the lack thereof can cause a financially sound project to collapse (Misselhorn 2009; Nel et al. 2001). Social capital is foundational to sustainable livelihoods, as it is often drawn on when other capitals run low (Woolcock and Narayan 2000). For example, when food and money supplies slump seasonally, or are lost due to shocks, social capital allows individuals to borrow resources from family, friends and neighbours (Gallaher et al. 2013).

Access to livelihood capitals is determined by the vulnerability context and the institutional context. The vulnerability context refers to external threats to livelihood sustainability. These are referred to variously as stresses and shocks (Murray 2001). Stresses are generally predictable and take place over a longer term, but little can be done to mitigate them. An example of a stress for cultivators may be seasonal water shortages due to insufficient reservoirs (Nel et al. 2001: 9). A shock refers to sudden, unexpected threats to livelihoods. For cultivators in urban areas, shocks generally manifest as incidents of theft, but could also include unexpected extreme weather events or the death of an income-earner (Nel et al. 2001; Rutherford et al. 2002; Foeken and Owuor 2008). A supportive institutional context may, however, provide notable protection from vulnerability.

The institutional context refers to the structures and processes that play a role in livelihood resilience, such as NGOs and government (Department for International Development 1999). Institutions such as local government may increase livelihood vulnerability when they perceive such livelihoods to be illegal (Tinker 1994), or when the model of support is disempowering, as is the modernist needs-based approach that undergirds programme-driven top-down development projects (Kretzmann and McKnight 1993).

A supportive institutional context can, however, go a long way to raising livelihood resilience, as seen in past research. Earlier in this paper, three case studies were identified that exemplify urban agriculture as a successful livelihood strategy among the urban poor in Africa, namely Gallaher et al. (2013) in Kenya, Hovorka (2005, 2006) in Botswana and Slater (2001) in Cape Town. All of these cases have one thing in common: a supportive institutional context. In all three cases, the policy environment favours urban agriculture, while practical training and support are provided by NGOs. These NGOs encourage the development of social capital by facilitating networks and cultivation groups. They also invest in human capital through training and extensions services, and enhance the efficient use of natural and physical capital. Only on this firm foundation of livelihood capitals are cultivators then guided to begin generating financial capital. Furthermore, these NGOs mediate access to power-holders such as government and the free market. By providing foundational forms of all five livelihood capitals, these NGOs facilitate the development of resilient livelihoods among poor urban cultivators. Therefore, urban agriculture can be promoted as a viable livelihood strategy if such interventions are guided by sustainable livelihood parameters.

What is interesting about Cape Town, however, is that although these parameters are in place, the sector contributes marginally to local food security (Battersby 2012). This anomaly warrants further investigation. To these ends, the sustainable livelihoods framework is applied to empirical research in Cape Town to ascertain how NGO-supported urban agriculture performs, and what limits its success.

4 Methodology

The empirical research for this paper originates from the author's experiences while volunteering for an NGO teaching urban agriculture on the Cape Flats. During this time, the author realised that even cultivators generating relatively little output were passionate about urban agriculture. To investigate what benefits urban agriculture held for such cultivators, the author chose to study this sector for his Ph.D. in sociology. Fieldwork took place in 2014 on the Cape Flats (Fig. 2), an area of Cape Town consisting primarily of low-cost housing and shacks, as a legacy of apartheid (Brodie 2015). Social challenges including unemployment and crime draw thousands of NGOs to the Cape Flats (Republic of South Africa 2013). However, extensive desktop research revealed that only four of these NGOs promote urban agriculture among Cape Flats households by training cultivators and providing

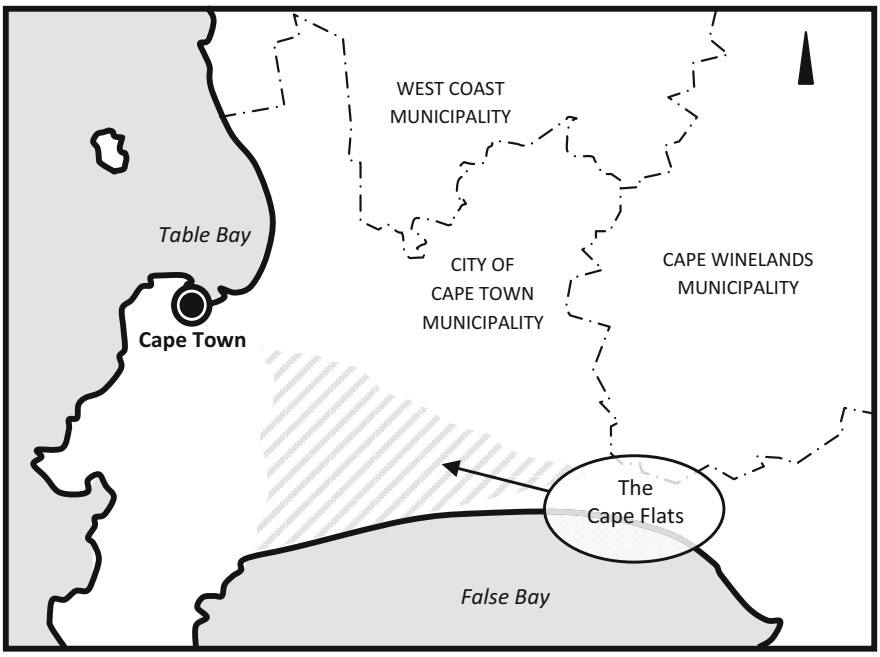

Fig. 2 The Cape flats. *Source* The author

extension services. Together these four NGOs support over 6000 people, according to their membership databases.

Traditional sampling methods such as random sampling proved impossible due to the haphazard distribution of dwellings. Nevertheless, the author found purposive qualitative methods more appropriate, as such methods facilitate deep insight from data-rich cases on how economically marginalised people have succeeded with urban agriculture.

The NGOs, being familiar with the surroundings, helped the researcher to locate cultivators. Participation remained voluntary however and NGO representatives were not present while interviews were conducted. Data collection proceeded by means of a semi-structured interview schedule. Data were gathered by voice recorder. These were transcribed and processed according to the themes that emerged. At the point of data saturation, 59 in-depth interviews had been completed, representing all four NGOs and demonstrating a range of scales of cultivation, from subsistence to commercial. This sample was therefore accepted as adequately representing the key issues surrounding the contribution of urban agriculture to sustainable livelihoods on the Cape Flats.

5 Results and Analysis

5.1 Social Capital

Social capital makes society operate smoothly (Putnam 1993). This is achieved through increased levels of trust and reciprocity, but like all capitals, social capital can be destroyed by high levels of corruption and violence (Vervisch et al. 2013). Thus, while some of the effects of crime, violence and drug abuse may be counteracted by social capital, the presence of these social ills undermines the smooth functioning of society on the Cape Flats (Karaan and Mohammed 1998).

For cultivators on the Cape Flats, social ills affect family life, as well as the community at large. An elderly woman for example describes the abusive childhood she had at home, and the estrangement she experiences from her family. Through joining the local NGO's urban agriculture course, she and a few friends got together to work in each other's gardens. This group became her surrogate family, providing the emotional and practical support she could not get anywhere else. Experiences such as these among many of the cultivators prompt them to call their cultivation groups a family. For example, a middle-aged Xhosa woman said her group is "like one family", because they know each other intimately, and "by knowing each other, you know where to help". Thus, for migrant work-seekers, or those who have left abusive domestic environments, urban agriculture provides an emotionally and practically supportive group.

At a community level, social capital is expressed in the networks of reciprocity and trust that exist between neighbours and colleagues (Putnam 1993). While such relationships may not provide the quality of emotional support that families do,

these networks have other strengths, such as providing opportunities for borrowing and trading (Granovetter 1973). One of the most important ways that urban agriculture builds community networks is through cultivators giving away their surplus. The vast majority of cultivators regularly give away surplus, and in so doing, establish networks of reciprocity that they can draw on during seasonal slumps in productivity. For example, one elderly man who supports himself by farming goats and vegetables explained, "I don't sell it, I give it for free. In exchange, [my neighbours] give me plenty—I am almost saturated with that. One hand helps the other". By giving surplus away, cultivators create networks in the neighbourhood that they can draw on for goods and services without actually exchanging any cash.

Those who wish to become commercial have the support of NGOs to do so, and this support represents another type of social capital: the capacity to engage with power-holders. The lack of such capacity is one of the key reasons why poor urban cultivators are unlikely to raise themselves out of poverty, because they cannot make these connections alone (Vervisch et al. 2013). In Cape Town, NGOs fill this role by acting as mediators between cultivators and powerful role-players such as government or the formal market. An NGO representative explained that, without this assistance, cultivators lack "the wherewithal to make those market connections themselves […] they feel out of their depth and they feel condescended to. […] So, I'm not sure who would be that market link if [NGOs] disappeared". Cultivators confirmed this, and related failed attempts to deal directly with local government. For example, one young man wanted to apply for access to farm public land, but after numerous trips to the relevant offices, remained unable to meet the official in charge:

"I interacted with her office, but I was not fortunate in terms of like, having to talk with her. Each and every time they were referring me to her assistants, which doesn't help. […] We were then giving up on that land."

Some of the cultivation groups had received support from government, but these usually complained that they were waiting for some or other input because the existing supply had run out. Thus, being represented by NGOs appears vital for cultivators to gain opportunities for public assistance or market access. Without representation by NGOs, it seems unlikely that economically marginalised cultivators would have the opportunity to broker these linkages themselves.

5.2 Human Capital

Throughout Africa, cultivators use agricultural experience from rural upbringings to grow food in the city (FAO 2012). This does not apply in Cape Town however, as the soil and climate are so different from the rural Eastern Cape, from which many work-seekers migrate. Migrants who begin cultivating on the Cape Flats without training usually fail (Karaan and Mohammed 1998). Therefore, in Cape Town, NGOs are primarily responsible for training and mentoring cultivators to farm in Cape Town's unique conditions. According to one of the NGOs interviewed, the

majority of cultivators who receive the high-quality training that NGOs in Cape Town provide are still cultivating after 4 years.

Success provides a major boost to cultivators' self-esteem. For example, one woman explains how it feels to see a field full of crops ripe for harvest, and the sudden realisation that all the hard work has paid off: "Your hands work the soil and you see the land is green, and you get this feeling, 'Wow! Is this me?'" Another describes, "…the joy and fulfilment you get from it, you know. You've done it by yourself. That alone is a good reward". Thus, in addition to gaining knowledge, urban agriculture helps people to regain a sense of accomplishment and self-worth.

Many cultivators, wishing to share their success, encourage others to join training courses, or use their newfound knowledge to teach others. A young man who frequents his local library to learn more about agriculture says, "I am a man that wants to learn more so that I can improve my mind and share what I have with other people". Thus, a greater sense of self-worth inspires many cultivators to contribute to their communities.

Other human capital gains include improved physical health. Each NGO's basic agriculture course includes instruction about the health benefits of eating fresh produce. Cultivators unanimously appreciate the healthy food they have access to. Physical exercise is also important for many, particularly the elderly, who find in urban agriculture a reason to get out into the fresh air. As one pensioner said, "I don't want to stay home every day. I want to work".

For younger people, urban agriculture imparts a sense of purpose, particularly if they do not have formal employment. For example, one previously unemployed woman explains, "It takes something out of you if you are not working. You don't feel like getting up in the morning." However, when she joined the training course, she found a new lease on life: "I was waking up early in the morning and watering my garden". This woman subsequently found work and quickly advanced to a managerial position. Thus, the human capital gains urban agriculture provides are more than just healthy eating and basic agriculture education; a far more powerful experience takes place in which people find their sense of purpose.

5.3 Financial Capital

Financial capital is a key focus of research on urban agriculture in Africa (Battersby and Marshak 2013). The popular argument is that cultivators can grow food for their own subsistence and then sell any surplus to generate additional income (Maxwell 1994). While empirical research revealed that a few hundred cultivators on the Cape Flats operate at a full-time commercial scale, primarily with the assistance of an NGO-run community supported agriculture scheme, the majority do not generate any considerable income from surplus. Nevertheless, this does not suggest that urban agriculture plays an inconsequential role in household income.

Cultivators who operate on a relatively small scale use urban agriculture strategically as an investment that can be liquidated when necessary. In a social setting where income-earners are obliged to distribute their incomes among family,

saving money can be seen as miserly (Portes 1998). Urban agriculture is therefore an important investment strategy whereby the initial outlay on seeds provides a considerable return on investment at harvest time. One man explains that after selling his season's crop, he immediately used the profit to replace broken appliances and to buy non-perishable food in bulk. When he came home, his wife asked, "Where did you get this money from?" To which he responded, "I got it from my yard".

Other cultivators forego having to use money entirely. They do so by bartering their surplus for prepaid electricity vouchers, paraffin fuel, teabags, coffee and sugar. Thus, even though small-scale urban agriculture may not reflect any significant financial contribution to annual income, it provides an important economic safety net that is adaptable to suit a variety of livelihood strategies.

5.4 Natural and Physical Capital

The Cape Flats has potential to be agriculturally productive, but much of the investment needed to realise this potential is out of reach for the economically marginalised. For example, one of the most important natural resources for urban agriculture is the Cape Flats aquifer, a natural reservoir holding millions of litres of water just a few metres below the surface (Brodie 2015). Accessing this resource requires the installation of borehole infrastructure as well as the fencing to protect this infrastructure from theft. Accessing this resource, as well as managing soil fertility and pest control through crop rotation, intercropping and mulching, requires a considerable level of support in the start-up phase (Small 2002).

Cultivators in Cape Town receive training in agro-ecological principles from the four NGOs that were studied. This is in contrast to public support for urban agriculture, which tends to take the conventional agro-industrial approach (City of Cape Town 2007). According to all of the NGOs interviewed, the rationale for teaching organic principles is the belief that sustainable and diverse crop yields are only possible by building soil structure with organic matter and by creating healthy ecosystems so that natural predators can keep pest populations in check.

Cultivators easily grasp the logic behind these methods and are able to become independent from the NGOs over time by collecting seeds, composting garden waste and managing pests. By contrast, the local government approach is to provide starter packs with chemical fertilizer, pesticides and seeds (City of Cape Town 2007). One finds therefore that groups supported by local government exhibit a high degree of dependence on these resources in contrast to the relatively independent cultivators who were trained by NGOs to harness natural goods and services.

The agro-ecological principles taught by the NGOs incline cultivators towards stewarding natural resources. For example, one young female cultivator referred to global climate change as "a wakeup call", adding that she "would not be happy to be one of those people that are adding to global warming and climate change". Furthermore, urban agriculture develops a respect for nature in small children,

according to a preschool teacher who cultivates. Her pupils tell their parents "they must not litter [because] they don't like plastic bags around". The value of NGO training is therefore not only in teaching cultivators to use low-tech physical infrastructure to achieve sustainable outputs, but also in the respect that is engendered towards natural goods and services. This model of training contributes significantly to the sustainability of Cape Town's urban agriculture sector.

5.5 Limitations to Urban Agriculture

The results above concentrate primarily on the benefits of urban agriculture, but fieldwork revealed some shortcomings that deserve attention. Many of these relate to the exceptionally difficult socio-economic conditions that cultivators on the Cape Flats operate within. Others relate to tensions within groups and attitudes towards NGOs.

Crime, substance abuse and exploitation are constant challenges cultivators face. For many, these issues are intertwined. For example, one woman related having to kick her drug-dependent husband out of the house and later discovered that he had returned and stolen her wheelbarrow. Another woman who had just started urban agriculture training dropped out of the course after being mugged of her cell phone due both to the emotional trauma and missed communications about the course. Many relate having vital infrastructure such as tools, fencing and borehole systems stolen, which create major setbacks to productivity.

Cultivators are often on their guard against the perceived or real threat of exploitation. In some cultivation groups, members stole produce or group funds. In other instances, members try to lord it over their colleagues, or shun the hard work but turn up to reap the rewards. The suspicion that such an environment creates severely retards development, particularly as cultivators may view NGO leaders with misgiving, and find in every misunderstanding or rumour substance to support their fears.

Some of the greatest challenges to a thriving urban agriculture sector in Cape Town boil down to basic interpersonal relations. The volatility of urban agriculture groups may therefore undermine the economies of scale that working as a group makes possible. For this reason, at least one of the NGOs has given up trying to start cultivation groups and concentrates on supporting individual home gardens instead. Solving these challenges is beyond the scope of this paper, but failing to point them out would paint a disproportionately optimistic picture.

6 Conclusion

This study set out to explore the benefits urban agriculture holds for the poorest cultivators in Cape Town. By adopting the sustainable livelihoods approach, it was found that urban agriculture's holistic contribution to all five of the sustainable

livelihood capitals is more desirable for the urban poor than maximising outputs, which has been the traditional focus of urban agriculture research in Africa. Furthermore, the study presents some important lessons from the Cape Town case.

First, NGOs play a vital role in making urban agriculture accessible to the urban poor. This finding is supported by existing research (Slater 2001; Hovorka 2005, 2006; Gallaher et al. 2013), but what is unique to this case is an additional challenge, namely that Cape Town's climate limits the transferability of agricultural knowledge from the rural areas many residents migrate from. Thus, while Battersby (2012) suggests that the relatively low level of uptake of urban agriculture in Cape Town indicates the unimportance of urban agriculture as a livelihood strategy, this study would argue that urban agriculture is a valuable livelihood strategy, but its expansion is limited by the institutional environment, namely capacity shortages in NGOs and local government.

Second, the social and economic benefits of urban agriculture are interrelated. The body of scholarship on urban agriculture in Africa is dichotomous, expressing benefits in either economic or social terms (Battersby and Marshak 2013). This study found however that the social networks cultivators build within their communities become important channels for trading or bartering produce. At a smaller scale, urban agriculture is used as a form of investment, protecting cultivators' wealth from downward levelling norms that would exploit savings of actual cash by forcing cultivators to distribute savings to family members. Thus, development programmes promoting urban agriculture as an income generating strategy should include social capital considerations in their programme design.

Third, human capital development is vital for harnessing free natural goods and services. While many natural goods and services are freely available, the urban poor typically lack the education to harness these. Thus, a key role NGOs play in Cape Town is to teach cultivators to harness free natural services such as composting, pest predation and soil water conservation, as well as providing basic infrastructure to store or source natural water. While some have criticised this work as creating dependency (Battersby and Marshak 2013), it is in fact doing the opposite. A level of intervention is vital to empowering marginalised people and if handled wisely it can contribute to resilient livelihoods, not dependency. Thus, training cultivators to harness as many natural goods and services as possible, and providing basic infrastructure and resources to assist with this, lays a firm foundation for livelihood resilience.

These findings are relevant for the development context throughout Africa. An institutional environment that rewards maximisation of outputs or profit creates a playing field biased towards those who already have capital to invest, good connections and relatively higher education. Pro-poor urban agriculture has to prioritise livelihood resilience, which is only possible through targeted interventions that develop all five livelihood capitals. The specific structure of such an intervention is determined by the context. A sustainable pro-poor urban agriculture sector is achieved through long-term high-quality support and the rewards are the robust growth of sustainable livelihoods among the economically marginalised.

In the Cape Town context, one of the key limitations to the growth of the sector is institutional capacity. Local government is inadequately staffed to handle the volume of interest by potential cultivators, while NGO expansion is directly dependent on donor funding. The future of urban agriculture in Cape Town should remain stable, as social networks are in place among cultivators and sustainable agricultural methods are the norm, but growth will continue to be slow without increased buy-in from the private sector or streamlined public support.

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Fostering Sustainable Communities and Resilient Cities Whilst Supporting 'Life on Land' Through a Colombian School's Initiative

J. Figueroa Vélez, V. Ruiz Vargas, L.M. Hoyos and A. Prowse

Abstract

'Quality education' features in the Sustainable Development Goals (SDGs) adopted in the United Nations declaration 'Transforming our world: the 2030 Agenda for Sustainable Development' (i.e. SDG 4). Furthermore, Education for Sustainable Development (ESD) can be interpreted as a thread that supports the potential achievement of all the other SDGs. For instance, schools based in cities could help making these more 'inclusive, safe, resilient and sustainable' (i.e. SDG 11) whilst supporting 'life on land' (i.e. SDG 15) on the school grounds. This paper presents an environmental project, which aims to foster the integration of ESD in the curriculum through a tangible conservation and restoration initiative of some of the 70 ha of natural reserve in the Eastern hills of the city of Bogotá, Colombia. First, the paper describes the project and its links to urban ecosystems in the context of city resilience. Second, it analyses empirical data from the project evaluation, which evidences the development of pupils' competencies and impacts beyond school activity. Finally, it presents the challenges faced by educators when adjusting curricula for ESD, followed by some recommendations for the future of the project. The purposes of the paper

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are: to provide insights to improve the project, to evidence the valuable pedagogic outcomes of this kind of initiatives for ESD and to inform and promote the development of similar projects in the region and beyond.

Keywords
Schools · Education for sustainable development · Urban ecosystem services Competencies · Curriculum

1 Introduction

In cities, natural reserves of vegetation cover and forests influence the quantity of available water, urban temperature regulation, noise reduction, air purification, moderation of climate extremes, reduction of surface runoff, erosion control and wastewater pollution levels (Bolund and Hunhammar 1999; Goméz-Baggethum et al. 2013). The conservation of natural habitats in urban settings is also necessary for the survival of pollinators, pest regulation and seed dispersal (Goméz-Baggethum et al. 2013). There is also some evidence that urban ecosystems may provide aesthetic and psychological benefits like spiritual enrichment, cognitive development, reflection and aesthetic experience, and are crucial for people's well-being and for their role in supporting knowledge systems, social relations and aesthetic values (Goméz-Baggethum et al. 2013). Positive effects of functioning urban ecosystems on human health and well-being indicate that the benefits of nature should be used as a setting for other activities such as healing, wellness and learning (CBD 2012). Moreover, they enhance human health and contemplativeness by reducing stress and providing a sense of peacefulness and tranquillity (Kaplan 1983).

In fact, using the local community and the environment to teach may increase academic achievement and may enhance students' appreciation of the natural world whilst creating commitment to serve and to be contributing citizens (Lescure and Yaman 2014). This aligns with the goals of Education for Sustainable Development that aims to enhance the acquisition of the knowledge, skills, attitudes and values needed for a sustainable future (UNESCO 2005–2014). This has been promoted by the United Nations General Assembly (UNGA), who adopted a resolution to implement a United Nations Decade of Education for Sustainable Development (ESD) to integrate the principles, values and practices of SD into all aspects of education and learning (UNESCO 2005–2014). Consequently, schools based in cities can integrate ESD in the curriculum whilst involving the school community in the recovery and conservation of urban ecosystem services in the school grounds, contributing to city resilience and urban biodiversity conservation.

For instance, the Eastern Hills of Bogotá, Colombia, could offer schools in the region a valuable scenario to enhance the development of ESD competencies through interdisciplinary processes involving research and action. These Hills are a mountain belt or system that crosses the city along its Eastern border. Their altitude (2600–3650 m.a.s.l.) is suitable for the development of a variety of ecosystems (i.e. low and high Andean forest, subparamo and paramo) of crucial ecological importance for the region (CAR 2005; Florez 2014). This area was declared a forestry reserve in 1977 due to its environmental importance as a provider of a wide variety of ecosystem services, benefits provided by the biosphere and its ecosystems for human well-being (MEA 2005). These include air purification, habitat for plants and animals, carbon capture, climate, soil and water systems regulation, scenic beauty, sense of place (Wiesner 2006). The Hills are also recognised for their landscape and cultural heritage with viewpoints to appreciate the predominant savanna ecosystems of the region, and peaks with unique scenery (Wiesner 2006).

Despite its great value for the city and the region, this peri-urban area has experienced severe changes affecting its watersheds and contributing to the ecosystem's fragmentation. Issues including strong urbanisation pressures, the presence of considerable areas of non-native plant species in native forest fragments, urban settlements of different socio-economical levels and the presence of mines are threatening this natural and cultural heritage of the city and the region. The city has a few green areas in the urban core, and these cannot supply the same extent of services offered by the Eastern Hills. Consequently, this is an area of conservation priority for the city (Wiesner 2016). Furthermore, these mountains may support significant as yet untapped opportunities to develop ESD for Bogota's schools.

In addition, since 1994, the Colombian Ministry of Education has required that all schools develop Environmental Projects (EP) in order to involve their internal community in the solution of local environmental issues (Torres 1996). The EP is a platform that offers school community members (i.e. students, teachers, parents), time and support to implement strategies and learn whilst impacting positively the school social and ecological context. Despite the enormous potential of school EPs to conserve urban ecosystem services whilst enhancing ESD competencies, conservation and restoration of surrounding ecosystems is one of the least frequent activities of Bogota's private school's EPs (Secretaría de Educación Distrital 2010). Nevertheless, there have been some attempts of schools sharing the same territories (i.e. Bogota's wetland ecosystems) to link their EPs conservation and restoration initiatives and strengthen the local impact of their work.

In Latin America, the attempts to include environmental dimensions of SD in the curriculum have faced many challenges. These might be explained by issues including the rigidity of educational systems in the region, which are resistant to changes and whose focus remains on clearly defined disciplines (González Gaudiano 2007). Moreover, research suggests that despite the increase of programmes and experiences in Latin America, there are few papers that explore systematically their effectiveness in education (Arboleda and Paramo 2014).

Following the Colombian Ministry Education guidelines and the challenges discussed previously, an EP was developed to embed ESD into the curriculum whilst involving the school community in the research, recovery, conservation and enjoyment of a natural ecosystem located in the protected area of the Eastern Hills of the city of Bogotá, Colombia.

Through an empirical analysis of perceptions of different actors involved in the project, the research aims to enhance their role in the project and boost its development. The paper aims to present the project and evaluate which of its aspects are enhancing the development of Education for Sustainable Development (ESD) competencies and what are the opportunities and challenges to embed such competencies into the curriculum through the project. Its purpose is to evidence the valuable potential of this and similar initiatives to enhance ESD whilst supporting life on land in the school grounds. Also it can motivate other schools from the city and beyond to develop similar initiatives in order to foster urban ecology leadership in students.

2 Methodology

In order to implement and evaluate the EP with teachers, students and parents (i.e. only mothers participated in the focus group) an action research project was created. Robson (2002) suggests that seeking to facilitate change, improvement and a participatory approach are key features of action research. In addition, he suggests that focusing on one unit of study, which in this case is one Colombian school, would be the main element of a case study approach. For this project, action research case study is an appropriate method due to the EP's purpose, which is mainly to influence ESD competencies in the schools' activities whilst using as a catalyst for this, ecological restoration in the Eastern Hills.

The sequencing suggested by Robson (2002) was adapted, but broadly followed the suggested action research cycle. Below the stages of the cycle (Robson 2002)

I. Describe the situation
II. Tackling a contradiction by introducing a change
III. Monitoring the change
IV. Define the inquiry
V. Collect evaluative data and analyse it.
VI. Analyse evaluative data about the change
VII. Review the data and look for contradictions
VIII. Review the change and decide what to do next.

3 A School Conservation and Restoration Initiative to Provide Quality Education Whilst Supporting Life on Land

3.1 Case Study Background

The Gimnasio Femenino is a private school in Bogota, Colombia, with over 500 female students and about 50 teachers. The School campus includes a natural reserve of 70 ha in the Eastern hills of the city.

Following government's guidelines, the Gimnasio Femenino School developed an EP to explore how the students, staff and wider community (human and non-human) could find mutual benefits in the ecological, educational, cultural and social dimensions of its natural reserve in the Eastern Hills. The EP's main goal is to integrate ESD into the curriculum through an ecological restoration process to recover the ecosystem's functionality, which has been affected by the introduction of invasive non-native species. The project combines two different educational approaches. First, it aims to develop critical thinking skills in students to become autonomous agents (or learners) who can engage with environmental issues. Second, it promotes specific actions to contribute to the solution of previously identified issues.

3.2 Overview of EP Initiative and Changes

The ecological restoration process has encouraged the involvement in the project of all academic areas through disciplinary, transdisciplinary and interdisciplinary pedagogic practices contributing to the EP's integration to the curriculum. Such integration has increased thanks to the rise of teachers' participation in the EP over time. Additionally, the Environmental Committee (EC) or group of students elected by their classmates to be the classroom environmental leaders, has participated in the investigation and communication of the forest biodiversity using trail cameras, campaigns and contests.

In order to involve the local community in the restoration and conservation of the ecosystem, high school students participated in research projects to discover the history of the spatial' transformation to try fostering people's attachment to the territory, especially, to its natural ecosystems. Additionally, the school encouraged district institutions to coordinate social cartography activities and education programmes that seek to reinforce the engagement of community and increase participation.

Between 2015 and 2016, approximately 3 ha of non-native species were removed whilst about 4000 native plants were planted, and the recovery process of a watershed started (Figs. 1 and 2). Both processes involved the participation of students, parents, teachers, staff, neighbours and students from other schools. Other local and regional agencies were engaged providing financial and technical support: Fundación

Ecotrópico, funded by WWF (World Wild Fund) Russel E. Train Education for Nature Program, and district institutions like Bogotá's Botanical garden.

To enhance the cultural use of the forest, students designed signs for the forest's trails and the school organised several ecological walks involving students, parents, teachers and the local community (i.e. neighbours). This activity helped to surface the cultural services by enhancing the local community sense of place, and the reserve's conservation and enjoyment.

To further enhance this kind of initiative, the Gimnasio Femenino in partnership with two environmental NGOs (i.e. Fundación Cerros de Bogotá and OpePa) created The Hills of Bogotá School Network to promote the school's pedagogic projects aiming to strengthen the functionality and conservation of this urban ecosystem and the citizens' competencies' to ensure this. Considering there are around 74 schools located in the Eastern hills, the network has a valuable potential to contribute to urban ecology within and beyond the schools. It might also have the potential to facilitate collaborative work between private and public schools in the city helping to address the current gap between social classes (Red de Colegios Cerros de Bogotá 2016).

3.3 Evaluation

Four focus groups were facilitated in order to collect evaluative data (Table 1).

Focus groups were used as a research method that allows generating discussions between the different individuals involved as well as interviews (Robson 2002). These were conducted in a semi-structured way, with open-ended questions but also following up on emerging topics relevant to the research. The main goal of focus

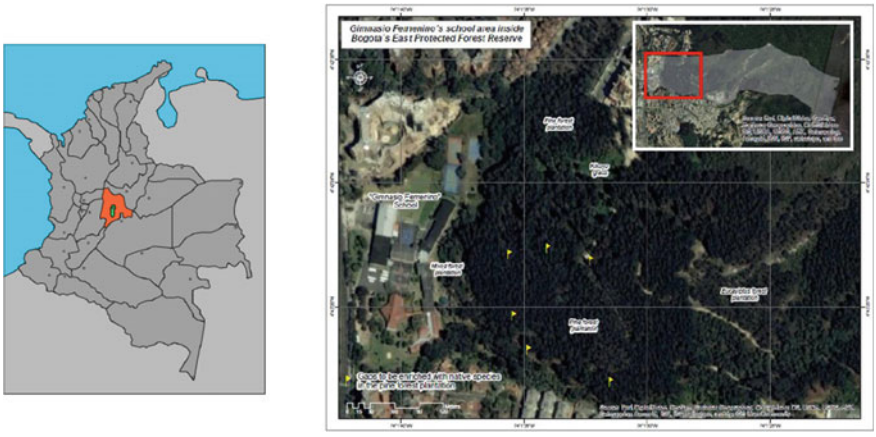

Fig. 1 Geographical location of restoration sites in the Gimnasio Femenino's forest. *Yellow flags* show clearings of pine plantations where the native trees are being planted (Fundación Ecotrópico 2016)

Fig. 2 Clearings inside the plantations, where several native species have been regenerating (Fundación Ecotrópico 2016)

Table 1 Focus groups included individuals engaged in the project at different levels

Focus group	Participants	
1	EC primary school students	EC high school students
2	Not EC primary school students	Not EC high school students
3	Teachers engaged with the EP	Teachers not engaged with the EP
4	Parents of EC students	Parents of non EC students

groups was to analyse how the environmental school project has influenced people, directly or indirectly involved in the process, regarding their perceptions, practices and competencies.

The discussion of all focus groups was transcribed and the themes were created from the transcriptions using inductive thematic analysis (Marks and Yardley 2004) using NVivo 10. Limitations of the work and constraints of the paper include lack of resources which resulted in a smaller and less varied number of focus groups which could otherwise have added depth to the analysis. In addition, the scarce human resources forced the leader of the project to be the researcher which might have biased the results. However, three independent researchers were invited to participate and counteract the potential subjectivity in the analysis. Furthermore the focus groups and the analysis were leaded by researchers not involved in the EP.

4 Results and Analysis

Three main themes were developed from the data analysis to evaluate the impact of the EP and its pedagogic outcomes as understood by the various participants of the focus groups.

The ability to enhance environmental stewardship and the development of ESD competencies.
The EP's perceived impact regarding the adoption of lifestyles or actions that contribute to SD.
EP's perceived strengths and challenges

4.1 Environmental Stewardship and Development of ESD Competencies

- Behavioural changes and ESD Interpersonal competency

The main goal of ESD is to build a knowledge society that through a bottom-up participatory process considers possible changes and implements those that are necessary for SD (Varga et al. 2007). Competencies needed to achieve this goal are those leading to more sustainable life styles (Varga et al. 2007).

In focus group discussion, students and parents perceived they had changed their behaviours in their daily life, which might be a consequence of the development of ESD competencies, particularly in what constitutes appropriate knowledge of SD and awareness of the impact of decisions that do not support SD (UNESCO 2005–2014). Specifically, environmental leaders perceived their role to be promoting and encouraging, in explicit ways, environmental actions with their peers in and outside school.

One environmental leader said her role is to

> … educate those girls who don't understand. To work as a team to recycle, to save water … To do this reciprocally, I mean to start in order to give example. I think our role is to be spokeswomen, because many times you have that feeling that your friends have about something and that feeling will stick to you … so let's turn off the lights and … It is different if a teacher tells you to do something than if your close friend tells you, so I think that role of being spokeswoman is very useful for the others to really understand

This quote reflects the students' understanding of leadership not by telling others what to do but through teaching by her own actions. This is a realisation of the value of peer learning in terms of knowledge and action for ESD and is evidence for the development of interpersonal competency for ESD via communication skills and leadership as discussed by Wiek et al (2011).

Both mothers and students focus groups suggested that the students enact the ability to influence their family's life and behaviours towards SD. Learning

processes in parents could be the consequence of their daughter's SD behaviours and the rigour with which they ask their relatives to adopt SD practices. This may reinforce their leadership and their capacity to teach something in which they feel confident and have legitimacy. The mother of two; a School's student member of the EC and of a younger girl said

> Because we were not taught with this consciousness, at least not me, then they are the ones who are always saying at home "no, you must recycle" or "[…] what about the water?", they are quite strict, both of them, I mean, they tell my husband and me off all the time.

- ESD Systems thinking competency and urban ecosystem services

Students also recognise the EP's impact in the forest and beyond. Students perceive the School forest as an important natural area not only for the school but also for the city evidencing elements of systems thinking in urban ecology and environmental stewardship

> […] to become aware that the forest also helps to remove pollution of the city, helps the water and with that, helps to create awareness about many other things, like by knowing about the forest, if you are already worried about one thing, you start being interested in other aspects, like saving water, turning off the T.V., turning off the lights, not wasting energy

Understanding the way complex nonlinear living systems and human societies function is important in helping people to make sustainable decisions (Kunsch et al. 2007). The previous quote suggests the project might have helped the students to identify some of the urban ecosystems provided by the School Forest, by relating natural system to human systems, and by recognising it as a part of a more complex system; the city.

ESD system thinking competency refers to the ability to analyse complex systems across different domains (i.e. society, environment, economy) and across different scales—local to global—(Wiek et al. 2011). A student referring to an ecological walk in the School Forest identifies the cultural services it provides and reflects systems thinking whilst connecting different systems domains (environment-society) and different scales (School Forest-Eastern Hills)

> I told a friend to go and see, she came with her cousin, and it is also a way to exercise, and there is also a forest with waterfalls in "Rosales" [another forest in the Eastern Hills], walks help a lot, because the place is magical, there is a kind of peace, helps to create awareness so people realise that "Bogotá" has a forest, you think about Bogota only as a city, but it really has very beautiful places

Students are often unaware of the importance of urban ecosystems in which they live (Barnett 2011), lack the skills to understand how their actions affect local urban ecosystems, and how they can improve and change their city's ecosystems (Manzanal 1999). Contact with the natural world is a key to developing environmental literacy and a stewardship ethic, providing this experience in urban environments where many people believe nature only occurs "outside" the city can be challenging, but is nonetheless important (Johnson and Catley 2009). Once students

observe and learn about the plants and animals in their immediate environment, they will better understand and value biodiversity to make more ecologically informed decisions in the future (Johnson and Catley 2009).

4.2 The EP's Perceived Impact Regarding the Adoption of Lifestyles or Actions that Contribute to SD

- Impact at school

Focus groups perceive that the EP has had an impact in student's family life as well as in their engagement with peers. The impact is perceived by students at many different levels such as contact with nature, waste management, water saving, urban agriculture. Parents perceive these attitudes in their children but they find, it might be also a generational attribute.

Teachers believe students engage with the project beyond the classroom. One teacher said

> You hear discussion on the topic in the halls, between friends.

Teachers who have been working at the school for a longer time remark that the project's impact has increased in terms of the girls' actions and environmental stewardship. Students perceive this too, emphasising that now they have a closer and more active approach to the project and a sense of appropriation of it

> When I was in primary school, there were things about recycling, but it wasn't so focused, I knew we had a forest, but I didn't know about it and never understood, I mean they told me to take care of it but in a superficial way… They didn't tell me why they started to remove trees, about the species…they took me to the forest but to pick up little plants, but never to really do something for my forest

On the same subject, another teacher said

> It is a topic that has generated big changes in terms of awareness and it is determining the school's identity, is like a stamp of the school

It is worth noting that the last quote suggests that the project also has been influential in terms of shaping the school's identity.

The project is perceived by teachers as a tool to witness how knowledge arises when students can interact with the forest and can see its changes. As teachers said, the presence of animal species in the forest that sometimes are seen from the classrooms has had a positive impact on the pedagogic processes.

> We also have spaces for pedagogic activities like the garden, the waste management room; all this evidences a huge possibility to let the girls see what they learn in practice. For example when they see birds or squirrels arriving, that allows a real and tangible learning experience

When pedagogic practices consider natural and human interactions in the local context they can make learning more relevant to students by getting them involved

in their own communities, promoting the participation of adults and organisations that care about identifying and solving real problems (Martusewicz et al. 2015).

One student evidenced her attachment to the project

> […] and you see the girls much more interested, all of them say: my school has a forest, you can't imagine all the animals that you can see and there are very beautiful plants and we go to plant trees and we name them and one gets enthusiastic

The previous quote may also evidence that experiences of planting trees may have increased their interest in nature. Children who have had outdoor learning experiences have demonstrated higher levels of motivation and interest in learning about the environment (Drissner et al. 2010). Additionally, direct interaction with nature might influence a child regarding the development of positive attitudes concerning environmental issues that probably will last into adulthood (Ballantyne and Packer 2002).

- Impact beyond the school

Teachers and parents perceive students promote environmental actions and behaviours more than ideas or explanations. They do it with their friends at the school and beyond; this may reinforce teacher's perception of student's engagement with the project beyond the classroom.

One mother perceived a shift in how students create community and communicate in social networks about environmental stewardship

> …For example, the use of the straw, which you mentioned: I have high school girls in Facebook and they all share to avoid using straws, all of them use social network for positive things. No disposables, in the lunchbox they don't let me send disposable forks

A new topic within the themes that appears in terms of promoting environmental stewardship is mothers promoting environmental stewardship to a third party, this is a new level of impact of the project. Before they were the children-school or children-family, but now children-mother-third party (i.e. dairy products corporation).

> Last week I was in a meeting in a large corporation of dairy products, they want a yogurt for kids with straw, previously I bought for her that yogurt and after hers change, I didn't buy it again. And during that meeting I mentioned the situation and the girls from marketing chose another. Incredible, because corporations like that one must be prepared, they are not going to use straw, you have to start looking at other solutions for the products, otherwise sales will decrease

The school forest also has a positive impact outside the school, it is recognised as a positive feature of the school, mothers are proud of it, they say it is not only recognised by the school community, but also in external communities. Schools are an important actor among the institutions that should play a governance role in cities, if we define *governance* as the way to govern in which conditions of collective actions, decisions taken by people and power are shared and provided by institutions of social coordination (Folke 2015).

4.3 EP's Perceived Strengths and Challenges

- The project's approach

Some focus groups discussed positive aspects of the project by valuing good communication of the project, and its enjoyment and impact.

Students perceived the approach of the project to be engaging and appropriate. They enjoyed the activities and their own sense of environmental stewardship had developed accordingly

> when you are forced a lot to do something, it seems you stop liking it, if they tried too hard to force you into taking care of the forest I wouldn't internalise it, but they never put it that explicit like that you have to take care of the forest, or that if you drop a paper you will die. It is really nice that through activities it all gets into you, but through nice things, they never force you […] it is much nicer

> They talk to you about nature and one learns to have affection, […], then it does create a consciousness, and at least in my case I think I worry for nature and I have to be there, because I help the forest, I have to try to take care of it. And for example with the animals, like Mari was mentioning that many native animals came back, that fulfils you, that really excites you and that creates interest

The focus group of parents find the school's actions coherent with the SD discourse promoting lifestyles more aligned with SD in the community whilst avoiding a catastrophic view that frightens the children without being constructive. Parents perceive in their children feelings of grief and concern about the future, which is a difficult topic, psychologically and in practical terms

> For that fear, I try not to open beyond, yes we must save water but it is not going to be over, to finish, not that string, because also hope, like then, What should I do? Why am I going to have kids? if there is not going to be water?

Young people seem to have a genuine concern for environmental issues and often they do things individually to minimise their ecological impact, nonetheless their general feeling is pessimistic and they feel powerlessness when it comes to dealing with these issues (Threadgold 2012).

There also seems to be a sense of community and democracy in relationship to the project

> The projects are everyone's, everybody can participate in the projects, when they organize walks, it is not that only the EC leaders can go, everybody can go. When we go to plant tree, all the class goes

Focus groups suggest that the aims of the educational approaches that the EP combines might have been achieved to some extent. First, the development of critical thinking skills to become autonomous agents or learners that can engage with environmental issues was evidenced in some students (i.e. growing food or implementing waste management systems at home). Strategies to enhance student's innovation and technology skills might be effective to continue developing student's abilities to become and/or improve as autonomous SD agents. Second, the

EP has been effective whilst contributing to the involvement of students in the promotion of specific actions for the solution of previously identified environmental issues. Nonetheless this might not be the case of all the school students, but might be a consequence of their different interests and concerns.

- Perceived barriers

Some focus groups suggested challenges that could allow the project coordinator to design strategies to improve the EP.

For example, students and teachers agree that not all teachers engage at the same level with the project. For some teachers, the project is perceived to be linked with the curriculum more easily for those who have taught science. Therefore, it is important to provide teachers with support through resources or workshops to make links to other areas other than science.

One teacher noted

> In English there is an easy relationship, it has been made for example with projects like the signs of the forest

However, another participant suggested that it is

> … easier for those who have taught science

Another teacher reflected that there was a need for staff development

> …to learn about the project's topics and to have the skills to link the project with our lessons

Students and teachers both emphasise that time constraints are barriers for engagement with the project.

> In English they have let us time to work that, there are teachers that worry more about losing time, then for example when we go planting tree you notice that they are not happy about the activity and I understand obviously (student)

> It is difficult to integrate the whole community because of time constraints (teacher)

The previous quote suggests that time constraints link to the rigidity of the system that forces teachers to approach specific content in specific ways. Besides teachers might have fear of outdoor learning experiences. Educators face several challenges to encourage students to approach nature: first, there are several obstacles to incorporate ESD in the classroom due to the educational system (Johnson and Catley 2009), second, sometimes teachers experience fears of losing control by taking students outside (Bunting 2006).

Many authors (Sterling 2012; Lozano 2010; Lidgren et al. 2006) have identified barriers to the integration of ESD in higher education including no motivation, no understanding of ESD, uncertainty of what is required, or ESD as a threat to their own credibility. These barriers seem to be very similar in primary and high school education, and teacher's perceptions evidence this partially, nonetheless further research in this area is required. Individual enthusiastic ESD educators are relatively

isolated, which results in difficulties sharing experiences and good practices that might support teachers who wish to strengthen ESD in their work but lack the skills and knowledge to do so (Roberts and Roberts 2008). Empowering practitioners of ESD to promote their sharing of successful pedagogic strategies involving the school EP might help to enhance staff development through participative and collaborative work.

5 Conclusion

Students understand the relevance of the project for the city and are able to identify the urban ecosystem services this natural ecosystem provides. The project enhances the development of ESD competencies in the students and their engagement in the promotion of sustainable lifestyles inside and outside the school. Barriers for teachers in terms of integrating ESD into the curriculum include lack of time, lack of understanding and lack of motivation. These are the same as the ones found in the literature. Action research is recommended as a method to study the impact of similar pedagogic initiatives aiming to contribute to the enhancement of ESD.

Proposed developments include first, further in-depth analysis of students' and teachers' different levels of engagement in SD initiatives and to the design of strategies to counteract barriers and strengthen the embedding of ESD into the curriculum; second, evaluation of the EP's ecological impact on the conservation of biodiversity and the associated provision of urban ecosystem services; third, the consolidation of The Hills of Bogota School Network to promote schools EP's aiming to strengthen the functionality and conservation of Bogota's natural ecosystems and the promotion of similar initiatives in other schools in urban and rural settings worldwide.

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Teaching Food Security to Low-Income Rural Families in the United States

Taylor Hinton, Kerstin Martin and Eric Pallant

Abstract

In order to achieve the goals of ending poverty and hunger, as stated under the 2030 United Nations Agenda for Sustainable Development, there needs to be a focus on low-income families who are most affected by these issues. Two ways to support low-income families in improving food security include providing access to affordable, fresh foods and education about food systems. Twenty-six percent of residents in Meadville, Pennsylvania live below the poverty line and 50% of students in the school district receive subsidized lunch. In 2014, the Community Wellness Initiative of Allegheny College established an affordable community and school garden in Meadville, Pennsylvania. There are monthly cooking and gardening workshops for community members. The garden-based curriculum is being integrated into middle- and high-school classes to teach students to think critically about the food system while learning basic growing and cooking skills. Students then bring lessons home to their families furthering the education of families in Meadville. This paper will describe how the garden is used to teach families and students of Meadville to grow, prepare, and purchase high-quality food in order to improve food security.

Keywords

Food security · Community gardens · Food education

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1 Introduction

When the United Nations established its 2030 Agenda for Sustainable Development its top three goals were targeted at ending poverty, achieving food security, and ensuring health and wellness (Transforming our world 2016a, b; Patel and Agnetta 2016). Underpinning the UN 2030 Agenda for Sustainable Development is the definition of sustainable development as the type of development that meets the needs of the present without compromising the ability of future generations to meet their needs (WCED 1987). Sustainable development is therefore a process that envisions a desirable environment in which living conditions and resource-use continue to meet human needs without undermining the existence of natural biotic systems (Mutangadura 2015; Sterling 2003).

One reason for establishing the 2030 Agenda for Sustainable Development is that much of the current world's population is not living under conditions that are safe and sustainable. According to the UN Food and Agriculture Organization, for example, one in nine people in the world are chronically undernourished and one in eight people in developing countries are hungry (World hunger and poverty facts and statistics 2015). In 2013, the global poverty rate, defined as less than $1.90 per day has fallen to 10.7%, but both hunger and poverty vary widely by country and within countries (The World Bank poverty overview 2016).

The United States is generally perceived as a country where food is abundant and obesity is the major food issue; however, in 2004, approximately 11.9% of Americans did not have sufficient food at least once during the year (Nord et al. 2005). In 2014, the number of Americans that did not have enough food for their families to sustain active, healthy lifestyles climbed to 14%. The number suffering from food insecurity in the severe range as defined by the U.S. Department of Agriculture was 5.6% (Coleman-Jensen et al. 2015).

Food insecurity, the inability to gain access to nutritious, necessary food at all times, has been linked to detrimental health outcomes in growth, chronic health, asthma, cognitive development and behavior among children and depressive symptoms in mothers (Cook and Frank 2008; Heflin et al. 2005; Kirkpatrick et al. 2010). Hunger has pronounced negative psychological impacts on food-insecure children, who manifest symptoms such as mood disorders, mental illnesses, and poor interactions with others. (Slopen et al. 2010). Similarly, adolescents experiencing food insecurity were more likely to experience mood disorders, anxiety, or substance abuse (McLaughlin et al. 2012).

Even in affluent nations like the U.S., families and individuals in lower socioeconomic strata are much more likely to consume foods with lower nutritional value than families with higher incomes (Davey Smith and Brunner 1997; Dubois and Girard 2001; James et al. 1997). Moreover, impoverished populations that are food insecure are more susceptible to the combined impacts of climate change such as those created by heat stress and air pollution (Balbus and Malina 2009).

To combat the impact that consuming low quality or insufficient food has on the physical and psychological status of families, some studies indicate that involving youth and adolescents in food purchasing and preparation results in improved nutritional quality of the foods they consume (Larson et al. 2006a, b). Children who assist in preparing meals also consume healthier meals and exhibit an increase in positive emotions (van der Horst et al. 2014). School gardens and gardens grown in conjunction with cooking classes can also effectively increase the consumption of fruits and vegetables among low-income youth, increase physical activity, sometimes reduce BMI (and sometimes increase BMI), improve mental health, and reduce consumption of convenience foods (Gatto et al. 2012; Hartmann et al. 2013; Utter et al. 2016a, b; Wells et al. 2014).

For adults, community gardens combat food insecurity and increase consumption of healthful fruits and vegetables, though successful gardens require both directors and grassroots support (Alaimo et al. 2008; Corrigan 2011). Gardens increase physical, social, and emotional well-being for individuals as well as improve social cohesion and support among participants (Armstrong 2000; Comstock et al. 2010; Tieg et al. 2014).

Rural, northwestern Pennsylvania has higher levels of food insecurity and poverty compared to statewide and national averages. According to the U.S. Census Bureau, the percentage of people living in poverty in Meadville, Pennsylvania is roughly double the statewide average: 26.1% in Meadville versus 13.6% for the state of Pennsylvania and 15.6% for the United States (United States Census Bureau 2016). Median household income in Meadville, Pennsylvania over the same time period (2010–2014) was $32,219 while the statewide average was $53,115 (United States Census Bureau 2016). In 2013, one-fourth of the children in Meadville lived below the poverty line as defined by the U.S. government (City-Data.Com).

Poor children in Meadville receive state government-subsidized meals while they are in school. Nearly one-half of children in middle school and high school receive free or reduced-price lunches: 46% in the middle school (grades 7–8), and 44% in the senior high school (grades 9–12) (High Schools.com). Percentages of subsidized lunches in the elementary schools vary by neighborhood, but in some elementary schools a large majority of students receive free lunches (Public School Review 2016).

The Community Wellness Initiative began at Allegheny College in Meadville, Pennsylvania in 2014 to address poverty, food access, and awareness of food production. Gardens were installed near schools and for families in the community. Lesson plans were prepared for school students and guidance in gardening and food preparation was offered to community members. By providing these opportunities —gardens in which families and students can grow food and educational programs on how to best grow and cook produce—the Community Wellness Initiative is supporting low-income families to be more food secure. Families and students participating in these programs gain knowledge to grow their own food so that they have access to healthy, fresh produce. Through cooking workshops and lessons in the classroom, they also learn how to prepare the same fruits or vegetables they are

growing. This empowers families and students to incorporate fresh produce into their daily meals and to be less reliant on heavily processed foods from the grocery store. Therefore, families can better meet their daily needs while utilizing produce that was grown using sustainable practices.

1.1 Community Wellness Initiative Overview

In Meadville, improving fresh food access and education inspired a unique partnership among the community recreation facility, public middle school (ages 11–13), vocational school (ages 15–18), regional hospital, Meadville city government, and Allegheny College beginning in 2014. The support of countless volunteers and businesses has been critical to the success of the multi-project and multi-year Community Wellness Initiative, which is funded by a private foundation based in Pennsylvania.

The work primarily takes place on the property of the Meadville Area Recreation Complex (MARC), which is directly adjacent to the Meadville Area Middle School and the Crawford County Career and Technical Center, a vocational school that teaches occupational and technical training to secondary school students and adults. Both facilities are approximately one mile from downtown Meadville. Projects of the Community Wellness Initiative include: the construction of an interactive "edible trail" that connects the middle school and the recreation facility; the support of a new community kitchen for cooking classes; and the development of the MARC Community Garden, which serves as both a community garden and a school garden by allocating specific areas within the garden to each user group.

The community and school garden have been the primary focus of the initiative. Because both adult community gardeners and students use the garden, the garden serves a range of people and needs. The community section of the MARC Garden involves over 40 residents who maintain and harvest food from both individual garden plots and shared gardens. These garden participants vary in age and income. Within a plastic-covered hoop house, five raised beds (measuring four by 30 ft) serve as the primary garden for the middle school. The majority of the students' academic year (September–May) does not align with the region's short outdoor growing season; therefore, the hoop house extends the growing season through the school year so that students can grow food as part of their classes.

In addition to building the community garden for the purpose of growing food, an accompanying food education program has been developed for both adults and students who use the garden. Evening workshops on gardening and cooking are provided for adult community gardeners, while students learn similar topics during their core classes of the school day and through a summer program. With 26.1% of Meadville residents living at or below the poverty level, the educational component of the garden is important: workshops and classes provide skills that participants can use during their time in the garden and in their homes to grow and prepare fresh food.

Allegheny College supports the garden with grant administration, staff, and college student involvement. Two employees direct the garden's activities: the garden manager coordinates the garden spaces and community participants, while the program coordinator directs the educational programming. Allegheny College students have also been involved at all stages of planning and implementing the programs. An internship program gives Allegheny students the opportunity to develop and implement garden-based curriculum for the Community Wellness Initiative. Other students work as gardeners building and maintaining the garden. Several courses in the majors of Community and Justice Studies, Global Health Studies, Environmental Science, and Political Science have worked on designing aspects of the garden and assessing food accessibility in Meadville. Allegheny students increase the capacity of the Community Wellness Initiative, while themselves learning how to improve food security in low-income areas through food access and education programs.

1.2 Methodology

The purpose of this work is to evaluate whether food insecurity can be alleviated through community-based projects such as a community and school garden with accompanying educational programming. The Community Wellness Initiative has implemented such a model that combines food education with food access. The effectiveness that the Community Wellness Initiative has had on making progress toward the goals of the 2030 Agenda for Sustainable Development was analyzed through informal conversations, surveys, and personal observations. This data about participants' knowledge, experiences, and outcomes was collected by the garden staff. The full results of this program are discussed in this paper for both adult participants and student participants, focusing on how this program addresses food education and food access for each participant group.

2 Increasing Food Security for Community Residents

2.1 Education for Community Members

Throughout the growing season, the Community Wellness Initiative provides adult participants with educational opportunities to learn how to successfully grow produce and how to prepare fresh foods in ways that they will enjoy eating. Food security is increased when participants can grow produce affordably and use that produce to meet their dietary needs.

Before the growing season officially starts in mid-May, the garden manager meets with gardeners to provide information about how the garden works and resources on how to grow crops, and to answer questions. Resource and discussion topics include acquiring seeds and seedlings, determining when various crops should be planted during the season, and planning for multiple crops through the season. Other resources include information on pest management and water conservation. Information is provided early in the year to prepare gardeners for the season and to encourage them to grow spring crops, increasing the volume of produce they can bring home; similarly, gardeners are reminded to plant fall crops to extend the end of the season. Pre-season meetings also encourage participants to develop social connections and feel comfortable in the garden. By fostering these connections and building a sense of community early on, some gardeners are more likely to spend time at the garden and utilize their plot to its fullest growing potential, increasing the likelihood that they will grow and consume more fresh food.

During the growing season both formal and informal garden sessions are scheduled. Formal opportunities include one cooking workshop and one gardening workshop each month. Sometimes more experienced participants of the garden lead these sessions, while other times presenters are recruited from the community. Workshop topics have included: organic gardening basics, which is especially important for first-time gardeners to gain an understanding of how to grow vegetables without adding synthetic products; pest management, which helps gardeners to prevent and manage pests that may impact their yield; making compost with food scraps and other plant materials to create nutrient-rich soil for future crops; how to rotate crops to ensure vegetables will have adequate nutrients to grow; and seed saving, enabling gardeners to grow food the next season without paying for seeds or seedlings. Cooking workshops have covered topics such as utilizing early-spring produce and cooking recipes that are quick, simple, and mostly plant-based. These regular workshops are intended to build gardeners' knowledge and interest so that they can grow significant yields of high quality vegetables to supplement their diets.

Informal educational opportunities are equally important in building gardeners' knowledge, interest, and skills in gardening and cooking. During weekly "shared work" sessions, gardeners work together to maintain shared spaces of the garden: staff plan the crops for these garden beds and assign gardeners with tasks to plant and maintain them. Gardeners have said they benefit from helping to care for these shared spaces because they actively participate in unfamiliar growing methods or in growing different crops than they themselves would have chosen. Gardeners also use the shared work time to inspect others individual plots and exchange information about particular vegetable varieties and growing techniques they are using. Additionally, monthly potluck dinners held at the garden provide opportunities for participants to share favorite recipes and to sample new ones. The communal nature of the garden provides informal support for gardeners to learn from each other.

The weekly sessions that have been described are scheduled each month as follows:

	Monday	Thursday
Week 1	5:00–7:00 pm: Shared work (working together on shared spaces and projects)	9:00–11:00 am: Shared work
Week 2	5:00–6:00 pm: Shared work 6:00–7:00 pm: Garden workshop	9:00–11:00 am: Shared work
Week 3	5:00–6:00 pm: Shared work 6:00–7:00 pm: Potluck dinner	9:00–11:00 am: Shared work
Week 4	5:00–6:00 pm: Shared work 6:00–7:00 pm: Cooking workshop	9:00–11:00 am: Shared work

These formal and informal learning opportunities support gardeners throughout the season. Workshops and shared work times encourage gardeners to utilize their plot throughout the season, even if it is not always successful. Many participants are first time gardeners who benefit from a supportive learning environment; this learning support makes them more likely to have a successful garden and more likely to have food to take home. Food security is increased when the gardeners know how to affordably and successfully grow food that they can also confidently prepare to eat.

2.2 Access for Community Members

The MARC garden provides physical resources to a variety of residents who may not otherwise grow food: some residents lack space or adequate sunlight for vegetable gardens at home, some are not permitted to garden outside rental units, and others may be more successful growing food as part of a community rather than alone. Each gardener is allotted a wooden raised bed measuring four by eight feet. These beds are rented on a sliding scale basis, which accepts monetary payment, volunteer hours, or a combination of both. Thus, income is not a barrier to accessing the community garden. Gardeners choose the types of vegetables they would like to grow in their own plot and they harvest that food for themselves. Food security is increased when gardeners are familiar with produce they bring home, have recipes with which to cook the produce, and enjoy preparing and eating those recipes.

In addition to harvesting food from their own plots, gardeners have access to produce from the "shared spaces" in the garden. Staff encourage gardeners to harvest mature crops through weekly emails, a list written on a whiteboard at the garden, and color-coded flags in the garden beds that signal when crops are ready to harvest. Produce that gardeners can take home from shared spaces has included onions, garlic, carrots, peas, tomatoes, kale, lettuce, zucchini, beets, strawberries, swiss chard, and herbs. Access to produce from the shared space is especially important for gardeners who may not get a high yield of produce from their own

plot. Some gardeners are first-time growers who may not have high yields, and even experienced gardeners may have crops in their individual plots fail due to pest damage, weather, or inconsistent maintenance due to gardeners' time restraints. Shared spaces in the garden ensure that gardeners are able to take home produce no matter their own personal success and therefore this space provides a second layer of food security.

The MARC Garden serves as a community garden for Meadville area residents to grow their own food, increasing the volume of fresh produce available for consumption and thereby increasing food security. Individual plots provide autonomy in choosing produce, while shared spaces provide a guaranteed harvest and increased variety. The twofold approach of individual plots and shared spaces ensures that participants have access to affordable and fresh foods throughout the growing season. In this way, the community garden increases food security for adult participants and their families.

3 Increasing Food Security for Students Through Food Access and Education

3.1 Academic Year (August–June)

The MARC Garden additionally provides school students with a space to learn about gardening and cooking that also increases their access to fresh produce. During the school year, students learn about food and agriculture in their existing classes at the public middle school. Students consume garden produce in these classes and during their lunch periods through Community Wellness Initiative programs.

To reach a wide audience of school students, the wellness program coordinator works with middle school teachers to develop curricula and to ensure that lessons meet state learning requirements. Each seventh-grade student (ages 11–12) participates in multiple food and garden-based lessons within two of their core subjects, including science, family consumer science (formerly home economics), and geography. Content is not added to lessons, but instead modified to focus on sustainable agriculture and foods that promote a healthy lifestyle.

For example, in seventh-grade science class, students learn about plant cell structures by looking at kale cells under a microscope. In the same lesson, they prepare a kale salad to eat. This lesson not only teaches students how to use a microscope (a concept from their seventh-grade science curriculum), but students are also introduced to kale and learn how to prepare it. The majority of students have never eaten kale, yet nearly all of them try and enjoy the kale salad prepared in class. By introducing students to vegetables at school, students are more likely to request those vegetables at home. Kale is a nutritious food that is both affordable and easy to grow in northwestern Pennsylvania, making it more accessible to families in Meadville.

Beyond just learning about food, students consume produce from the garden during most of the food and agriculture-based lessons. The program coordinator works with middle school teachers to plant the school section of the garden. Once vegetables are ready for harvest, teachers utilize the garden produce in their classes. Lessons sometimes focus on the garden produce specifically (such as a class about herbs and spices from the garden), while other lessons are supplemented by the garden produce (such as a lesson on using good bacteria in fermentation that ends with making pickles from cucumbers from the garden).

In addition to the science, family consumer science, and geography classes that use the garden, two special needs classes (for students with autism and learning disabilities) also cook and garden regularly. Special needs classes are specifically intended to teach students everyday skills. Practicing growing and preparing food is particularly important in reducing food insecurity for this potentially vulnerable population.

Prior to the involvement of the Community Wellness Initiative, middle school students only learned about food preparation, budgeting, and nutrition in the family consumer science class. Through the Wellness Initiative, teachers of other subjects are now incorporating food-based lessons in their curricula. Students are therefore learning about how to grow and prepare food through multiple subjects and perspectives. By integrating this learning into the classroom, students are better able to prepare food for themselves or their families, increasing their food security at home.

The Community Wellness Initiative also promotes food and agriculture-based education in the school cafeteria. A 2014 survey of seventh-grade students at the Meadville middle school found that they had a weak understanding of seasonality and what can be grown in northwestern Pennsylvania. Starting in 2015, a "Harvest of the Month" program was implemented to encourage students to recognize which foods are available locally at different times of the year. This type of program has been offered at schools throughout the United States, but had not been offered in Meadville before. Once per month during lunch hours in the middle school cafeteria, students are encouraged to sample a dish prepared with in-season fruits or vegetables. For example, the Harvest of the Month in March 2016 was lettuce, prepared with a homemade honey-mustard dressing. Of students who tried the salad, more students recorded that they liked it than did not. Samples are prepared by students during morning classes, easily integrating with existing learning outcomes of the family consumer science class. Because they are actively involved in the food preparation, students are eager to try the dishes and encourage their friends to do so as well. The produce used in the taste test is either sourced from the MARC Garden or local farmers, supporting the local food economy and utilizing fresh food from the garden.

In addition to the educational benefits of the Harvest of the Month described above, students are provided with a small quantity of fresh produce during the taste tests. The school is now considering adding a salad bar to their lunch menu because the Harvest of the Month salad was well received, which would increase the availability of fresh produce to students. If other local foods are added to the school

cafeteria in the future, students may be more likely to recognize and choose those dishes and request them at home.

The Community Wellness Initiative reaches every seventh-grade student at the Meadville Area Middle School, which includes many students from low-income, food-insecure households. The opportunities offered by the Community Wellness initiative to participate in cooking, gardening, and other forms of learning about food and agriculture increase students' capacity to improve their own food security, both as youth and later on as adults.

3.2 Summer (June–July)

When school is not in session in June and July, the school section of the garden continues to provide youth with learning opportunities and access to fresh produce. The Community Wellness Initiative, in partnership with a local non-profit focused on youth development, offers a free summer program at the garden. Lunch and transportation are provided to all participants, ensuring accessibility to the low-income population living in and around the Meadville area. The program targets students entering eighth, ninth, and tenth grade (ages 13–15) and has three main goals: (1) to learn the basics of growing and cooking food; (2) to understand how the food system operates, both locally and globally; and (3) to learn how youth can have a voice in local organizational and governmental decisions about food. Students are recruited locally using social media and in-person interactions.

Three-week sessions are offered twice per summer during which youth meet on Tuesdays, Wednesdays, and Thursdays from 9:00 am to 1:00 pm. Students begin each day with an hour of garden work, then transition to a class period where they learn about the food system. Students then make their lunch together using food they harvested from the garden. After lunch, there is either a team building activity or a community-centered activity where youth discuss where they live and what change they want to see in their community.

The students in the summer program experience a more focused study of food, nutrition, and agriculture than during the school year due to the additional time available. They are in the garden every day of the program learning how to grow, maintain, and harvest vegetables. This allows them to see the entire growing process, from seed to harvest. Students prepare and eat lunch each day of the program, giving them new recipes as well as access to fresh foods. Students also have the opportunity to take home additional vegetables from the garden that they learned to prepare earlier that day. This availability of produce combined with learning opportunities for cooking makes them more likely to prepare the foods at home. For example, in 2016, one student especially liked a kale salad prepared during lunch. She was then able to harvest kale every day to bring home to her family along with the knowledge of how to prepare the salad. Other studies have found that involving youth in food preparation improves the nutritional quality of the foods they consume (Larson et al. 2006a, b). Similarly to the adult community gardeners,

food security for youth improves when they gain the knowledge, skills, and interest in growing and eating affordable, fresh produce.

4 Other Wellness Benefits of the Garden

In addition to the opportunities for food education and access that the garden provides to both adults and students, there are also social and emotional benefits for those involved in the garden. There is frequent multi-generational interaction in the garden: school students between ages 12 and 18, college students, and the wide range of community members (ages range from infants to those in their mid-80s) all have the opportunity to meet and interact. Many gardeners have developed new connections because of their involvement at the garden. Gardeners frequently comment that they feel more relaxed after they have spent time in the garden, that they feel safe there, and that they take pride in the food they grow.

5 Next Steps

5.1 For Community Gardeners

Based on the success of the garden's initial two seasons, the Community Wellness Initiative plans to expand the gardens' capacity to include more residents in garden education and access to fresh produce. In addition to increasing garden membership through the rentable garden plots, an alternative option to participate as a "friend of the garden" will be offered. This second option will offer participants less commitment than what is required to maintain a plot for an entire season, but will provide structure for volunteers who choose to attend workshops and shared work sessions. In addition to receiving weekly updates about upcoming workshops and events, these volunteers will receive a share of produce from the garden to take home. By offering another way to be involved, more residents will benefit from educational components of the garden and have the opportunity to bring home and prepare fresh produce, improving food security.

5.2 For Students

The Community Wellness Initiative plans to incorporate the garden into other aspects of the school community so that more students learn how to grow food and have access to fresh foods. The garden is currently used in science, family consumer science, geography, and special education classes; moving forward, lessons will be developed for other subject areas. Incorporating the garden into many different subject areas will provide students with a broader knowledge of food and

agriculture. It will also increase students' exposure to new fruits and vegetables, thereby increasing the chances they are introduced to foods and recipes they like and want to make at home with their families.

Additionally, produce from the garden and local farms will continue to be served in the school cafeteria so that students have access to fresh, local foods during their lunch. The Harvest of the Month program demonstrated that students were enthusiastic about eating salad; the programs coordinator will work with stakeholders at the school to develop and implement a plan for a salad bar in the cafeteria. The produce for this salad bar will be sourced locally when possible so that students make connections between what they are learning in the classroom and what they eat in the cafeteria.

5.3 For the Community Wellness Initiative

One of the limitations of this study is that assessment is based mostly on staff observations, informal conversations, and surveys from the first year (2015) of programs. These methods may not fully capture the impact of the garden on those involved. In 2016, structured interviews of community gardeners and surveys of students who participated in garden-based programs are being conducted to collect further data.

6 Conclusion

The Community Wellness Initiative is enhancing food security in Meadville for both low-income adults and school students by providing better access to and education about growing and preparing fresh foods. The result of this program is that a growing number of residents in a low-income community are consuming fresh, local food with little to no added financial cost. They are also gaining skills around food preparation that they can continue to use throughout their lives.

The CWI model of community and school gardens, which emphasize access and education, can easily be scaled to fit a variety of other communities, although paid staff is important to the success of the program. Even small areas of land can be used to support this kind of garden, so space should not be a constraint. By bringing together multiple segments of the population (schools and various community members), more people benefit from the garden and become invested in the programs so that they can be sustained over the long term. In addition, school gardens and accompanying education programs are a resource that a growing number of schools are utilizing. These schools may benefit from adopting the Community Wellness Initiative's model in which community gardeners are also a part of the school garden. Conversely, community gardens might consider the benefits of integrating local schools into their structure, especially for maintenance and usage during the fall and spring.

The program demonstrates one method of alleviating food insecurity. By providing food and gardening education and access to low-income families, it may be possible to address poverty and hunger, as set in the goals of the 2030 United Nations Agenda for Sustainable Development.

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A Holistic Approach to Embedding Social Responsibility and Sustainability in a University—Fostering Collaboration Between Researchers, Students and Operations

Liz Cooper and Dave Gorman

Abstract

Universities have the potential, and a responsibility, to contribute to sustainable development through their own business operations, through research and through providing learning opportunities for students. The University of Edinburgh is committed to social responsibility and sustainability, and a department of the same name works on seven key areas: climate change and energy; resource efficiency and circular economy; supply chains and fair trade; responsible investment; learning, teaching and research; community and public engagement; and sustainability reporting. There are clear links between these areas of work and the Sustainable Development Goals, both in terms of environmental protection, and in reducing poverty and increasing well-being locally and globally. One approach to these themes is to view the university as a Living Lab—where research is carried out on the institution's own operations, both by academics and by students. This paper shares experience from implementing the Living Lab approach at Edinburgh, which has provided useful learning on how to facilitate collaboration between different stakeholders within a university (academics, operations and students), and how to foster a sense of being a united learning community with sustainability aims. The paper highlights issues and learning around developing networks, data governance and initiating action research as practitioners.

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Living Lab · University · Sustainability · Social responsibility · Collaboration · Multi-stakeholder · Research · Partnerships · Students

1 Introduction

Universities, with their dual roles of furthering scientific knowledge, and providing high-quality education to students, are well placed to contribute to sustainable development. They are often significant organisations in their own right, providing further opportunities to influence policy, corporate behaviour and market development through the way they operate their estate, buy goods and services and make investments. Universities across the world are now engaging in discussions about the new Sustainable Development Goals. While some are debating the quality of the 17 goals and 169 targets themselves, others are making plans to mirror their framing in institutional strategy regarding research, curricula and business operations. This paper does not attempt to map how the different goals are reflected in university practices and plans. Instead, it provides an account of attempts to embed a holistic and interdisciplinary approach to social responsibility and sustainability at the University of Edinburgh, recognising that the goals reflect the University's own aspirations regarding making 'a significant, sustainable and socially responsible contribution to Scotland, the UK and the world, promoting health, economic growth and cultural wellbeing' (University of Edinburgh 2012).

The University of Edinburgh has a long track record of delivering social responsibility objectives since its establishment as the 'Tounis College' (Town's College) in 1583 (Grier and Bownes 2014). Building on decades of active work on energy management, sustainability and local city projects, the University took the decision in 2012 to establish a Department for Social Responsibility and Sustainability (SRS), which was formally launched in 2014.[1]

Figure 1 presents a representation of the 'logic model' behind the creation of the Department for SRS. The drivers of a University response to SRS issues are many and varied but typically include the need to respond to staff and student expectations, to manage legal compliance and risk and reputational issues, to deliver on a range of societal and environmental benefits, to meet wide ranging stakeholder expectations and to allow for opportunities for the University to grasp new research, learning or service innovations and programmes. An empirical, experience-based analysis of these drivers and how they take shape led to the decision in 2012 to establish the SRS department, and Fig. 1 summarises this analysis. Often the concepts being proposed are new and relatively untested in a University context, therefore requiring debate and awareness raising. The combination of ethical, legal and self-imposed objectives points to a need for a focal point to work through these issues. The very wide range of issues identified as SRS issues means that often

[1]See http://www.ed.ac.uk/about/sustainability/about.

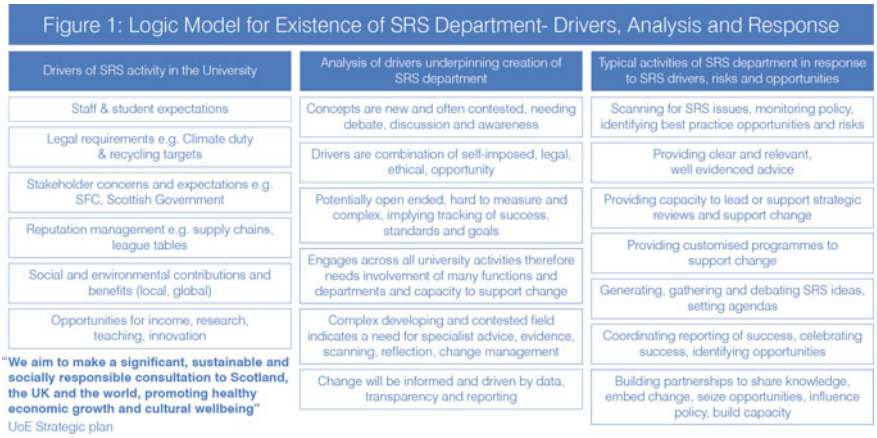

Fig. 1 Rationale for department for SRS

many functions across the University require to be involved, and a central capacity to support change and maintain a 'corporate memory' is needed. Often the complexity and contested nature of some of the issues means there is a need for specialist advice, proactive evidence gathering and marshalling, and a requirement for transparent reporting and institutional reflection.

Finally, once the principle of establishing an SRS department was agreed, the shape and form of the activities of the department need to embrace both the drivers for change and the University's analysis of the problem. Again, Fig. 1 summarises activities from proactive horizon scanning and active risk management activities, to providing capacity to convene interested parties to shape agendas, to specific programmes to deliver that change, and the ability to reflect, report and learn as part of the improvement cycle.

Whilst the creation of the Department for SRS is an important development underpinning the University's ambitions, the department of course cannot 'do' sustainability and social responsibility for the University and it is crucial that work in this area remains owned by the University community at large. With a community of 50,000 staff and students, more than 200,000 alumni, a turnover now approaching £1 billion, and the third largest University endowment in the UK, Edinburgh is a large, high performing and globally connected institution, with vast potential to made a real difference through its operations, research, teaching, procurement and investments—and even more so if those elements can be joined up and directed towards common goals and stretch objectives.

This paper is written by two staff members from the Department for SRS at the University of Edinburgh, motivated by a desire to draw out and share practitioner knowledge and reflections that could be useful for other organisations, and to encourage a research-oriented culture within our own work (Coghlan and Brannick 2010; Cooper 2015). The paper first describes the vision of a university as a Living Lab—where academics, operational and administrative staff, students and where

relevant the wider community are working together to tackle sustainable development problems. Theory and experience of organisational change through bringing different types of knowledge, and of the importance of intermediaries is then discussed. Key learning points from our experience of developing a Living Lab approach are then shared, namely that a long-term strategy is required to break down barriers between functions, and that the roles of intermediaries can become more important over time. Future plans regarding developing Living Labs further at Edinburgh are then shared. The paper concludes that the Living Lab approach is a key way for universities to contribute to meeting the SDGs, with benefits for all actors involved.

2 Vision of a Living Lab

The concept of the University as a Living Lab has become popular among those working on sustainability in higher education in recent years. For example, in the UK, the University of Cambridge operates a Living Lab for Sustainability programme run by a dedicated Living Lab Coordinator, which has benefited from funding from Santander[2], and the University of Manchester runs an extensive University Living Lab initiative funded by University of Manchester Research Institute and the Higher Education Innovation Fund[3]. In North America, Harvard University has recently relaunched its Living Lab initiative to include a new course and a fund[4]. Penn State University aims to involve all of its estate in its Living Lab approach to implementing its Sustainability Strategic Plan[5]. The University of British Colombia operates a flagship Living Lab programme with a focus on sustainable buildings, which operates as a test bed for regenerative sustainability[6] ideas (Robinson et al. 2013). Robinson et al. (2013), who has written and spoken extensively on the approach, argued that universities are uniquely placed to be able to solve sustainability problems, as they can make their own decisions, for example about estates development, are public bodies and so can allow longer pay-back periods, and of course universities carry out both education and research. The concept of integrating research, teaching and facilities to develop sustainable solutions is at the heart of the International Sustainable Campus Network (ISCN) Charter, of which the University of Edinburgh is a signatory.

There are different definitions of Living Lab, but there is broad consensus that it is an environment in which new solutions are developed, tested and validated through stakeholder collaboration (Graczyck 2015). At the University of Edinburgh, treating the University as a Living Lab means *using our own academic and*

[2]http://www.environment.admin.cam.ac.uk/living-lab.
[3]http://universitylivinglab.org/.
[4]https://green.harvard.edu/climate-solutions-living-lab-course-and-research-project.
[5]http://sustainability.psu.edu/sustainability-strategic-plan/our-approach-living-lab.
[6]Regenerative sustainability is described as the capacity for human activity to actually improve both environmental conditions and human quality of life.

student research capabilities to solve social responsibility and sustainability issues relating to our infrastructure and practices. Collaborative Living Lab projects can provide answers and guidance for operations and professional services staff; real-life learning opportunities for students; and opportunities for research impact for academics (University of Edinburgh 2015). The following criteria that a Living Lab project should attempt to fulfil have been devised between academics and the Department for SRS:

- Solve a real-life problem by developing an understanding of the context and developing practical solutions through research.
- Develop collaboration with and buy-in from key stakeholders, providing an opportunity for recommendations for change to be taken up and tested.
- Use existing and newly generated quantitative and qualitative data, embracing digital technologies where possible.
- Trial and test ideas in real-life settings—to further refine solutions proposed
- Share data and analysis generated openly, for the Living Lab to continue

The potential for innovation through collaboration among cutting edge researchers, bright young minds and skilled practitioners working in universities can bring about the transformative change needed for sustainable development, first on campus and then in the wider community once solutions are developed (König and Evans 2013).

The Living Lab impact goes further than the solutions developed through projects, and can have lasting impact on students' approaches to their future careers, through providing them with opportunities to solve real-world sustainability problems collaboratively while at University. Indeed, Mcmillin and Dyball (2009; p. 58) describe the campus as 'the most readily available laboratory for hands-on projects, and acts as a shadow curriculum for the students to apply to the campus what they learn in the classroom'. Moore et al. (2005) found that students are also more likely to buy into university sustainability policies if they have been involved in their development. Students themselves are increasingly asking for these opportunities to work on real-life problems to gain experiential learning, and a large number are asking for sustainability to be the focus (Graczyck 2015; Higgins et al. 2013; Drayson 2015). More broadly, a recent National Union of Students survey found that 75% of higher education students surveyed (n = 5521) expect universities to develop students' sustainability skills as part of courses (Drayson 2016).

While Edinburgh has not yet benefitted from any external funding to develop the Living Lab approach, a range of types of projects contribute to solving sustainability problems and developing new approaches to our own practices (as illustrated in Fig. 2), although it must be noted that there is often overlap between these different types.

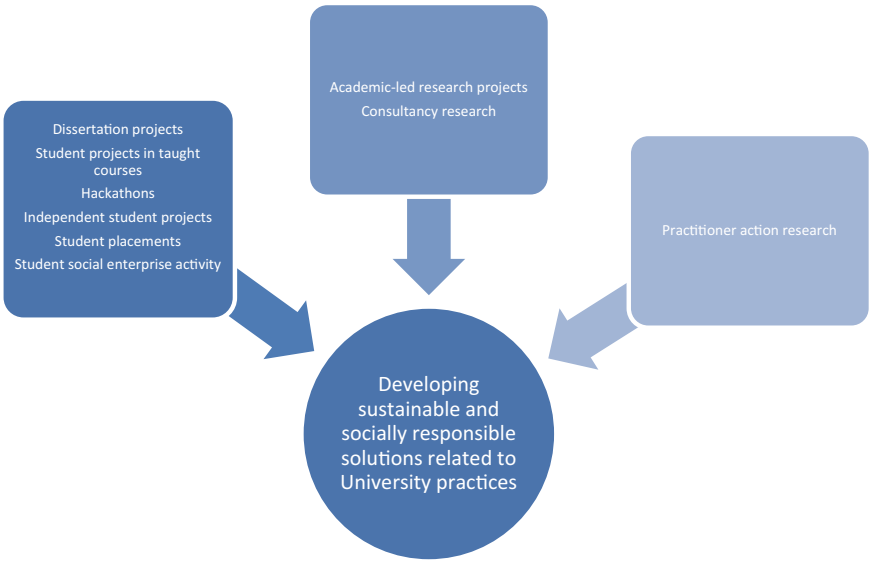

Fig. 2 Types of projects that can contribute to a Living Lab

Examples of projects at the University of Edinburgh include the following:

SRS programme/thematic area	Past/current projects
Energy	• Impact of 'Switch off' campaigns in labs • Energy data visualisation to engage building users • Project on improving energy coordinators network and effectiveness • Hugh Robson Building photovoltaics study • Main Library alternative energy case study • Solar glare reduction • Undergraduate behaviour change in energy saving at home
Resource efficiency and circular economy	• Circular economy at the University • Contamination in waste streams • Developing waste champions
Fairness in trade and sustainable procurement	• Conflict minerals in construction industry • Palm oil sustainability • Garment supply chains social responsibility • Tackling modern slavery in supply chains
Sustainable labs	• Measuring impact of 'switch off' materials • Freezer studies re temperature increase and energy saving
Sustainable travel	• Project on increasing cycling • Review of other universities' business travel policies

(continued)

(continued)

SRS programme/thematic area	Past/current projects
Responsible investment	• Developing social finance and social enterprise
General SRS approach	• Engaging Ph.D.s in the SRS Academic Network • Research on integrated reporting

Plans are in place for future projects in all of the above areas, and also in relation to additional themes of welfare and well-being, biodiversity and community engagement.

Looking to the future, a fully developed Living Lab university would be a learning organisation, where different types of expertise were naturally brought together to collaborate on projects, where interdisciplinary working would be the norm, where the roles of different types of staff and students would be flexible, and where all learning was documented, reflected on and shared. The concept of the University as a Living Lab could be embedded in staff inductions, welcome weeks for students and job descriptions. There would be a commitment to open data relating to university operations and practices, and a platform for sharing learning from academic and practitioner research relating to the organisation's own sustainable development progress.

However, we are currently some way from achieving this vision. The observation made by Rynes et al. (2001) that management does not seek out academic research to inform strategy, and that academics do not consult practitioners when defining research objectives, still holds true in many cases. While more and more academics are developing collaborations with external practitioners in business, policymaking or the third sector, there remains a void on the whole between research and practice within the university itself. A tendency for 'them and us' attitude in universities, dividing academics and operations or professional services staff, is widely recognised (Shiel and Williams 2014; Whitchurch 2013). There can be a lack of understanding within regarding what the other group's roles require of them, which can lead to a culture of criticism for different working styles. It may be perceived that academics focus on theory without enough focus on applicability, and that operations staff focus on practical approaches that may not be sufficiently informed by theory (Moore et al. 2005; Cooper 2015). Of course, the business-focused wing of a university cannot easily find time to incorporate experimentation into its day-to-day activities.

For those who are beginning to look to develop such collaborations, there are a number of barriers in the structure and working practices of a university today, beyond the abovementioned perception-related barriers. The rigid distinction between academic staff and others is augmented by having with two different human resources pathways. There are some who move from a role in one side, to one in the other, but this does not necessarily mean they will work to bridge the two sides, as people often perform based on the expectations of their role—for example, Rynes et al. (2001) found that people with an academic background stop reading academic journals when they take on a practitioner role. These different roles have

different priorities, time restrictions and ways of working; academics may be focused on publications and long-term research projects, and teaching requirements, while practitioner staff are often required to focus on Key Performance Indicators and shorter term objectives, with little flexibility to develop new initiatives beyond the activities in their job description (Shiel and Williams 2014). Operations staff are often concerned about data confidentiality and hesitant to share data with researchers without fully understanding and agreeing on how it may be used. Evidently, if there is no funding available to cover people's time needed to develop and implement Living Lab projects, it can be hard to engage academics in particular, despite increasing interest in getting involved. Students have further timescale restrictions, in terms of the academic year structure and the relatively short time they spend at the institution. There is also typically a physical separation between these groups, and between disciplines, with academic and non-academic staff offices often in different buildings, and students working in their own designated spaces. Finally, a university tends to be a very hierarchical, devolved, large organisation, where it is difficult to embed a new approach across the board.

3 Organisational Change Through Combining Different Types of Knowledge

There is extensive theory around why bringing together different stakeholders and different forms of knowledge is key to solving complex problems, such as those inherent in the challenge of sustainable development. Changing institutional practices to more sustainable and socially responsible ones requires the appropriate knowledge about what changes are best. When tackling a sustainability problem such as how to reduce energy use in a building, for example, a project can draw on building user knowledge and experiences, researcher knowledge from architecture, engineering, sociology, etc., practitioner knowledge from energy managers and other facilities and services staff. However, these types of knowledge are drawn out and presented in different ways, and may be viewed differently in terms of their legitimacy. For example, Polk et al. (2013) contrast high-quality academic work with practical results, implying that useful learning for practitioners may not be taken seriously by publishers of academic knowledge.

Sterling (2003, in Sterling 2013, p. 32) describes 'levels of knowing' in relation to bringing about change in an organisation, which include actions, ideas/theories, norms/assumptions and paradigm/worldview. The idea is that taking action can in turn lead to new ideas, norms and then worldviews, but also that the adoption of a new worldview in an organisation can trickle down and eventually change actions on the ground. A Living Lab project could lead to a shift in worldview in an organisation, and influence its strategic planning, through taking action early on, rather than carrying out a lengthy piece of research with recommendations at the end. At the same time, Living Lab project stakeholder meetings to assess a particular issue such as waste reduction could lead to a change in worldview among

operations staff towards adopting the concept of a circular economy, which could in turn shape their actions. Similarly, Rynes et al. (2001) describe the concepts of externalisation of knowledge—making tacit knowledge more explicit through developing tangible models that can influence action, and internalisation of knowledge—making explicit knowledge tacit through learning by doing. Again, an iterative process that goes between reflecting and theorising together, to taking action, and back again, is said to be effective for bringing about change in an organisation. However, given the variety of stakeholders in a university, it is not always possible to reconcile views and achieve a consistent change in worldview and in turn strategy. As recognised by Meehan (2013, p. 109), 'organisations, regardless of size, comprise a complex mix of personalities, priorities and policies'. Even if consensus is reached, there is a risk of groupthink, with individuals within a group taking positions they would not on their own. An organisation's knowledge, learning and memory are different from those of an individual (Spender 1996)—which could be positive or negative for sustainable development, depending on how particular groups think.

Action research has a longstanding tradition of drawing on different types of knowledge (experiential, presentational and propositional) among stakeholders, in order to co-create 'practical knowledge', said to be the most useful for solving a problem (Coghlan and Brannick 2010). The Living Lab approach draws heavily on the action research tradition, with projects undergoing cycles of collaborative problem forming, data collection, analysis, action and reflection (Polk et al. 2013). However, in Living Lab collaborations between academics and practitioners, it is found that the academics do most of the analysis (Polk et al. 2013) and likely also the presentation of new learning in papers and reports. While operations staff are continually learning new approaches to their work through doing it, there is often not a culture of reflecting on and recording this learning. In order for new approaches and ideas to be adopted by a university, learning needs to reflect a joint analysis between researchers and practitioners as best it can and be presented in a way that resonates with these different actors, as well as with senior decision-makers, which is clearly a challenge.

Stage	Activities
Problem identification and formation	Stakeholder workshops; briefing papers on background of issue; research on global best practice and 'gap analyses'
Data sharing and generation	Operations staff share quantitative data, automated data accessed, staff and students are interviewed/take part in focus groups, observations, reflective journaling, project meetings to reflect and analyse
Reporting and sharing findings and recommendations	Written report circulated; additional stakeholder workshops to move from questions to answers
Implementation of changes	As appropriate/feasible
Monitoring, modifying, reflecting	Embedding an action research approach
Sharing research	Research publications, conference presentations

Fig. 3 Stages of an SRS living lab project at the University of Edinburgh

At the University of Edinburgh, the approach outlined in Fig. 3 has been developed for Living Lab projects by the Department for Social Responsibility and Sustainability:

While the above approach facilitates collaborative project planning and evaluation, there remain limitations in terms of which actors carry out which roles, as discussed above, and in terms of how to balance practitioner knowledge and analysis with academic research and analysis. Often, what is 'good enough' to satisfy immediate operational challenges and drivers may not be sufficiently rigorous to satisfy academic needs; conversely the deployment of full academic procedures may be disproportionate to the size of the problem being considered by the organisation, or may be too lengthy to remain relevant to the necessary timescales, or may simply be directed at a 'level of knowing' higher than that required by the operational practitioners at that moment. It is also possible that recommendations from such collaborative projects are not followed by the relevant managerial staff, and that business as usual continues after a project. This may be due to a failure to fully understand each actor's limitations on their ability to change practices, or may be due to lack of buy-in from individuals. It is also worth noting that new knowledge tends to be adopted slowly in most contexts (Rynes et al. 2001), so a long-term approach is needed ensuring follow up after a particular project has been completed.

4 The Roles of Intermediaries

There is much literature on why intermediaries are helpful to link researchers to practitioners. Howells (2006) highlights a range of reasons why intermediaries are important in innovation, looking at literature on technology transfer and innovation management. These include the roles intermediaries play in identifying and linking partners in the first place, packaging technological innovations appropriately, supporting deal-making processes, helping formalise informal collaborations and helping transform ideas. Bansal et al. (2012), when looking at how to bridge the gap between researchers and management practitioners, highlighted the need for intermediaries to help frame problems in ways that are specific and clear enough to be investigated by researchers, while at the same time reflect the 'messy reality of the problems of practice' (p. 84). There is also often a need for an appropriate third party to translate knowledge into a form that is accessible to practitioners (Bansal et al. 2012)—which has given rise to a growing body of research brokers and knowledge brokers (Sin 2008).

Literature on intermediaries in Living Lab projects specifically includes a whole range of terms for those who help connect stakeholders, including coordinator, messenger, facilitator, contributor, co-creator, etc. (Nyström et al. 2014). These roles may be fulfilled by researchers, practitioners or by those whose day job is managerial or administrative. It is broadly recognised that particular actors can occupy several of these roles, and that their roles are fluid. At the same time, recent

literature on the rise of intermediary roles in universities has emerged, notably in Whitchurch's (2013) work on 'third space' professionals who link research and practice in difference ways, including institutional research, community projects, university strategies and research impact partnerships. These roles are filled typically either by people with an academic background who have moved over to more practical, project-based roles or by practitioners who have academic qualifications and interest (Whitchurch 2013). Indeed, in universities there is a growing sector of knowledge exchange professionals and commercialisation experts, requiring knowledge of working styles in both research and industry.

The University of Edinburgh's Department for Social Responsibility and Sustainability acts in many ways as an intermediary between academics and operations in Living Lab projects, and can be said to be staffed by several 'third space' professionals. The types of roles it is taking on have been rapidly changing in recent years. Evolving from a Sustainability Office in the Estates Department, and then being established as a Department within Corporate Services Group, it has traditionally been closer to operational colleagues than to academics. This means it was well placed to be aware of operational sustainability challenges, with operations staff in some cases requesting that the department collates their ideas for projects and connects them to researchers, but only able to develop links with academics on an ad hoc basis, through personal links or individual direct contact. The reaction to the department among academics when reaching out to discuss potential Living Lab projects has been mixed, with concerns that the corporate side of the university might be attempting to tell academics what to research (Meehan 2013), or concerns that a corporate services department would not have the necessary academic skills or outlook to collaborate on research. A further risk may arise from the denuding of academic skills and experience in the department if there is an over focus on operational issues, or conversely a risk of separation from operational needs if too much time and attention are devoted to academic interests and needs.

In the last couple of years, the Department has worked to establish itself as a cross-university function that interacts with operations, teaching, research and high-level strategy. In 2014 the SRS Academic Network was established, at the request of a close academic collaborator, and through consultation with key stakeholders, to act as a non-discipline-specific place for sharing between academics across the university on social responsibility and sustainability themes. The network has now attracted over 170 members on its email list and has begun to have face-to-face meetings, at the request of members, to discuss collaboration on specific projects and themes. This network has proven useful for recruiting new collaborators on Living Lab projects related to various aspects of university practice. A number of network members have now asked the Department for SRS to devise research objectives for Living Lab projects related to different priority themes, and present to the network how these objectives could be fulfilled by both large academic research projects, and small student projects that could be run in courses. The Department for SRS is being increasingly asked by academics to collaborate on research funding bids, teaching projects and knowledge exchange events. This change has been rapid; in 2015 a piece of research on Living Labs at

the University of Edinburgh (Graczyck 2015) found that there was a lack of understanding of the concept of the Living Lab among staff, including academics, but in the past year there have been more and more staff integrating the approach into their work and proposing collaborations on campus sustainability projects, and the term Living Lab is now in the University's new Strategic Plan (2016).

Figure 4 represents the increase in types roles experienced by the Department for SRS with regards to Living Lab projects, noting that all four types of roles continue to be appropriate depending on the context.

5 Key Learning

To summarise, in developing a Living Lab approach at the University of Edinburgh over the last few years, the following learning points have become apparent. First, breaking down barriers between functions and introducing new approaches takes time, but progress can be made through a two-pronged approach. Developing a number of small-scale Living Lab projects with willing partners can gradually begin to shift the worldview of the wider university community, while integrating a Living Lab commitment into high-level strategy can gradually influence individuals and departments to develop such collaborative projects. Next, intermediaries (that sit neatly neither with operations or academic functions) are key to achieving multiple and continuous links. Intermediaries may begin as facilitators, encouraging other parties to set direction of projects, but can increasingly build up reputation and trust, and in time become initiators and partners in projects. Establishing an SRS

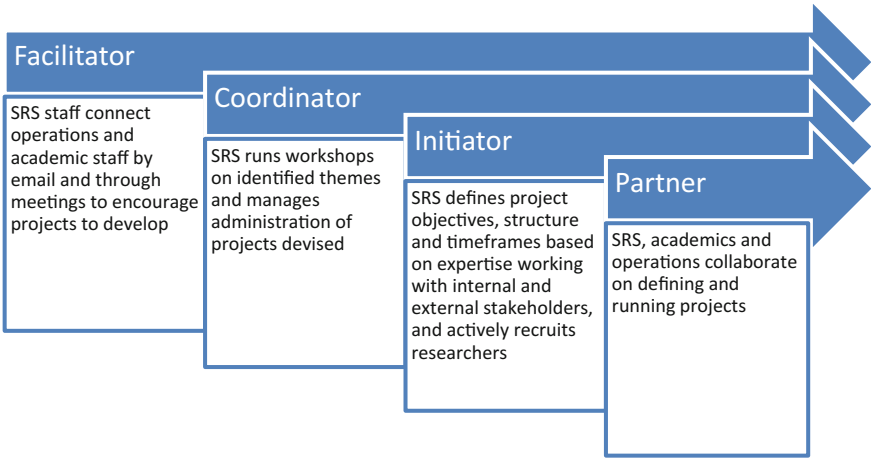

Fig. 4 Evolution of SRS department roles in Living Lab projects

Academic Network has been extremely useful in terms of building up contacts in different disciplines, and bringing people together around particular sustainability themes. In order to continually improve the approach, action research principles can help encourage cycles of action and reflection, learning and recording learning as practitioners. On a practical level, data access for Living Lab projects can be problematic, so a clear data governance policy is required, developed jointly by all stakeholders. Finally, while Living Lab projects can help meet Sustainable Development Goals, the opportunity they also provide of experiential learning, contributing to student satisfaction, can be a key motivator for university leaders.

6 Future Plans

In the 2016/17 academic year, plans are in place for a number of projects where the Department for SRS will act as initiator and partner. Once research objectives are drafted within the Department for SRS in consultation with operations colleagues, interdisciplinary collaborations will be sought through SRS Academic Network meetings. However, it is recognised that there is still plenty to learn about how to best develop collaborative Living Lab projects at the University that meet the requirements and expectations of all parties, and how to best communicate and work together, recognising the different objectives and working styles as discussed above. Given the ever present limit on resources, it is not feasible to try to expand current structures to overcome any issues around the balance between practical and academic skills within the Department for SRS department. However, modern management offers a range of alternatives—embedded action researchers, short-term secondments, virtual task groups, shadowing, intensive innovation 'sandpits' and so on that can help in ensuring that the necessary skills are available at the right time. The likelihood of participation in these activities is enhanced when they are nested within the raft of other linkages and loops of engagement.

In addition to playing a range of intermediary roles in specific Living Lab projects, the Department for SRS is increasingly working to increase the visibility and understanding of the Living Lab approach, currently working with academic colleagues to develop a web space to share tools, case studies, project ideas and to act as a central communication point. SRS is working closely with Edinburgh Living Lab, an initiative developed by a group of academics from the Schools of Art, Social and Political Science and Informatics.

In the medium term, SRS plans to contribute to Edinburgh Living Lab's efforts to develop an open data approach within University operations, including the introduction of a technology-led big data approach, using smart data, apps to collect individual data and principles of the internet of things. The University is collaborating with the Higher and Further Education sector sustainability organisation Environmental Association of Universities and Colleges (EAUC) on a project to research Living Lab best practice globally, and develop guidance.

In order to make real progress in social responsibility and sustainability, a long-term approach is needed, and the Department for SRS will continue to scan the horizon as well as highlight current challenges, maintain continuity between projects (recognising that academic staff and students may be more likely to change the focus of their research or move on from the University) and ensure research feeds into long-term strategy.

7 Conclusion

This paper has argued that a Living Lab approach to solving sustainability problems is a key way a university can contribute to sustainable development, by drawing on its own researchers, including students, and combining academic knowledge with practitioner knowledge to develop new solutions. These solutions can be tested within a university campus environment, and can inform practice in the wider world. Using the case of the University of Edinburgh and its Department for SRS, this paper has demonstrated the value of intermediaries, in bringing together academics and operations within universities. Such intermediaries can ensure longevity of initiatives in cases where academic staff and students are more transient, can help interpret different challenges and ways of working between functions, and can help bring in more collaborators through their university-wide networks. This case study has described how such intermediaries can begin as facilitators, and can gradually begin to take on roles of initiators and partners in Living Lab projects, as their value in linking projects to high-level university strategy and to relevant external partners, and their sustainability knowledge as practitioners in their own right are recognised.

Many challenges remain including how to involve more than the motivated few in Living Lab projects, how to collect, generate and manage data related to operational sustainability, and how to co-devise projects that meet operational needs and sustainability goals, and provide opportunities for contributing to academic knowledge.

In future, greater impact in terms of tackling sustainable development can be achieved by universities if the Living Lab approach is further developed and embedded in universities worldwide; sector organisations such as the EAUC and the ISCN have key roles to play in achieving this goal.

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Multi-stakeholder Partnerships (SDG #17) as a Means of Achieving Sustainable Communities and Cities (SDG #11)

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Abstract

As social and ecological problems escalate, involving stakeholder groups in helping solve these issues becomes critical for reaching solutions. The UN Sustainable Development Goal #17 recognizes the importance of partnerships and collaborative governance. However, organizing large multi-stakeholder groups (or partnerships) requires sophisticated implementation structures for ensuring collaborative action. Understanding the relationship between implementation structures and the outcomes is central to designing successful partnerships for sustainability. In the context of sustainable community plan implementation, the larger research project of which the results presented in this book chapter are one

For more information about the project see https://uwaterloo.ca/implementing-sustainable-community-plans/.

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part of, examines how stakeholders configure to achieve results. To date, we have the data from a survey completed by 111 local governments around the world. The survey was offered in English, French, Spanish, and Korean. Seventeen integrated environmental, social, and economic topics are considered, including climate change, waste, ecological diversity, and local economy. Despite the prevalence of sustainable community plan implementation in local authorities around the world, there is scant empirical data on the topics covered in these plans internationally, the partners involved in implementation, and the costs and savings to the local governments that implement in partnership with their communities. The results presented in this book chapter show that sustainable community plans continue to be created and implemented in a diversity of communities around the world, are integrated in the sustainability topics that they cover, involve local organizations as partners in implementation, act as motivators of resource investment by the local government in community sustainability, and result in savings for the local government.

Keywords
Sustainable community plans · Local Agenda 21 · Multi-stakeholder partnerships · Implementation structure · Outcomes

1 Introduction

Our Common Future, also known as the Brundtland Report, is responsible for the promulgation of the term sustainable development (Dresner 2008). The report defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987, p. 43). *Our Common Future* was written following the United Nations Conference on the Human Environment held in Stockholm, Sweden in 1972 (Mebratu 1998). The ideas underpinning sustainable development from the Stockholm conference and *Our Common Future* heavily influenced the agenda for the 1992 United Nations Conference on Environment and Development (Earth Summit) (Mebratu 1998). It was at this conference in Rio de Janeiro that the influential Agenda 21 outcome document was created (United Nations 1992). Agenda 21 opens, in Chap. 1, 1.1 with the following quote:

> Humanity stands at a defining moment in history. We are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the ecosystems on which we depend for our well-being. However, integration of environment and development concerns and greater attention to them will lead to the fulfillment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future. No nation can achieve this on its own; but together we can - in a global partnership for sustainable development (United Nations 1992, p. 1).

This quote embodies the global sustainable development challenges as they are now and as they were in 1992. It highlights the urgency of global environmental and social disparities that underpin the world's environmental and development challenges. It also charts a path forward, identifying partnerships as a way to sustainable development. In 2015, 43 years after the Stockholm conference, 28 years after *Our Common Future*, 23 years after Agenda 21, and 3 years after *The Future We Want*, seventeen Sustainable Development Goals have been adopted (United Nations 2015a). These goals are meant to address the seventeen most pressing global sustainable development challenges faced by our world today. Among them are SDG #1 to end poverty in all its forms everywhere; SDG #13 to take urgent action to combat climate change and its impacts; SDG #11 to make cities and human settlements inclusive, safe, resilient, and sustainable; and SDG #17 to strengthen the means of implementation and revitalize the global partnership for sustainable development (United Nations 2015a). The global problems that stand between where humanity is today and the future we want are the key macro drivers behind the sustainable development goals of countries around the world (United Nations 2015b).

Agenda 21 was the primary outcome document of Earth Summit; it is called on the world's nations to partner in a global pursuit for sustainable development (United Nations 1992). Agenda 21 outlines a plan of action for sustainable development at the global, national, and local levels (United Nations 1992). 178 governments that attended the Earth Summit adopted Agenda 21 (United Nations 1992). The problems addressed in Agenda 21 span the globe, and so the recommended policies and plans are broad in scope. To make Agenda 21 relevant at a community scale, a local approach called Local Agenda 21 (LA21) that addresses the specific needs of individual local governments was recommended (Bond et al. 1998). Participatory processes that involve stakeholders as partners throughout the development, implementation, and oversight of LA21 plans were encouraged by the United Nations and ICLEI (ICLEI 2002). By 2012, there were over 10,000 Local Agenda 21s (or equivalent) initiatives around the world (ICLEI 2012). In coherence with SDG #17, multi-stakeholder partnerships continue to be part of the solution, and are mentioned throughout the New Urban Agenda (Habitat III 2016).

The Local Agenda 21 process, and the sustainable community plans (SCPs) that commonly result from this process, is a growing global phenomenon (ICLEI 2012). The results presented in this book chapter provide further evidence that SCPs show recent growth as over 60% of the SCPs represented in our sample are under 5 years. However, little is known about SCPs implemented through multi-stakeholder partnerships, particularly from an international perspective. The aim of this research is to address this gap by providing empirical data from around the world on SCPs implemented through multi-stakeholder partnerships. Based on our data, the results presented in this book chapter identify common sustainability topic areas covered in SCPs. These findings indicate that globally communities are prioritizing waste, energy, and water issues. The results also signify that many local governments are working in partnership with organizations in their communities to implement their SCPs, according to our data 56.7% of the local governments surveyed have over

11 partners. This indicates that internationally local governments see value in partnerships and stakeholder engagement for both the formation and implementation of their SCP. To this point, the results of our study may also partially explain the value that local governments derive from implementing with partners. For example, our findings signify that local governments can acquire resources from partnership implementation. Our purpose in researching and presenting data on resources is to improve understanding not only about the resources required, but also about the resources leveraged through working with partners during implementation, including financial costs and savings, employee time, and volunteer time. In presenting this data, we hope to help local governments make informed decisions about how to implement SCPs.

This chapter provides background on SCPs and collaborative strategic management; introduces multi-stakeholder partnerships as a means of enabling community-wide actions; and discusses both partner and plan outcomes. This chapter provides an overview of the research done on structure and outcomes as part of a larger project on implementing SCPs (University of Waterloo 2016) to set the context, and then it introduces original research based on an international survey of 111 local governments. This chapter concludes by discussing how this data ties to the implementation of the global Sustainable Development Goals and the New Urban Agenda.

2 Literature Review

2.1 Sustainable Community Plans (SCPs)

Local governments are well acquainted with the complexity of addressing community-wide sustainability challenges (Roseland and Spiliotopoulou 2016). As mentioned there are about 10,000 LA21 initiatives worldwide addressing social, ecological, and economic issues through SCP implementation (ICLEI 2012). SCPs can include a wide range of topics, depending on what the community stakeholders (i.e., partners) decide to prioritize. A study that reviewed SCPs in Canada found that there are 17 dominant topic areas (Taylor 2012). Such topic areas include energy, land use, transportation, waste, air, water, education, health, safety, employment, and local economy (Taylor 2012). SCPs are created through a public consultation process whereby stakeholders determine the sustainability vision and goals for their community, and then implement the plan in partnership with local organizations (Clarke 2012).

2.2 Collaborative Strategic Management

The process of collaborative strategic management in the context of community sustainability involves five stages. The first stage involves understanding the

stakeholder relationships with the community by assessing contextual considerations and forming the partnership (Clarke and Fuller 2010). During the second stage the collaborative strategic plan, in this case the SCP, is formulated by the partners. Plan formulation requires partners to work together in establishing their shared sustainability vision and goals for their community that will be reflected in the plan (Clarke and Fuller 2010). Implementation of the plan happens during the third and fourth stage of the process. Implementation of the plan is conducted at two levels, internally by partner organizations focusing on their individual sustainability actions, as well as collectively among partners focusing on community-wide sustainability actions (Clarke and Fuller 2010). In the final stage, outcomes of the SCP are realized by the partnership as a whole and by individual partners (Clarke and Fuller 2010). A collaborative strategic process such as the one defined here is iterative in nature. The process is continually evolving and changing with external and internal influences (Clarke and Fuller 2010).

2.3 Multi-stakeholder Partnerships

As mentioned SCPs are implemented in partnership with local organizations. These partnerships, called multi-stakeholder partnerships, typically involve two or more organizations from each of the private, public, and civil society sectors (MacDonald 2016). Multi-stakeholder partnerships are part of a broad class of partnerships called cross-sector social partnerships, whereby two or more organizations from all three sectors join to realize a mutual goal or to tackle a common problem (Parmigiani and Rivera-Santos 2011). For the multi-stakeholder partnerships discussed in this chapter, local organizations join to tackle the community sustainable development challenges outlined in their SCP (Freeman et al. 1996). Typical partners that participate in this type of partnership from the civil society sector include not-for profit organizations, local environmental groups, and neighborhood associations (Freeman et al. 1996). Organizations such as the chamber of commerce, local businesses, and industry associations often represent the private sector (Freeman et al. 1996). Finally, from the public sector are organizations such as local governments, schools/colleges/universities, development agencies, and energy utilities (Freeman et al. 1996). This way of implementing the SCP is recommended by the United Nations (ICLEI 2002) and coincides with SDG #17 (United Nations 2015a).

2.4 Implementation Structure

Previous research has identified two levels of implementation in multi-stakeholder partnerships: the partner level (Huxham 1993) and the partnership level (Brinkerhoff 1999). Implementation happens at both these levels simultaneously (Huxham 1993), though there is variance in how the partnership strategy is implemented at each level (Clarke 2014). At the partner level, efforts toward implementation are not

interorganizational (Hardy et al. 2003). Partners leverage their capabilities to help implement the strategic plan, often requiring partners to reallocate resources and/or change their policies (Waddell and Brown 1997). At this level, individual partners may develop internal structures for implementing the goals outlined in the strategic plan (Clarke 2011). For instance, a partner might commit to reducing greenhouse gases by adapting its internal processes, thus contributing to the overall goals of a climate action plan, or hire a sustainability coordinator to help the organization meet the internal sustainability goals it committed to the partnership (Clarke 2011).

The partnership level is the interorganizational framework that sustains partner engagement and, ultimately, ongoing implementation of the plan through the partnership (Albers et al. 2013; Hood et al. 1993). The partnership level includes mechanisms for governance and processes of implementation (Clarke 2010). Past research on the Canadian experience uncovers five key components at the partnership level that are required for the implementation of SCPs (Clarke 2012): (1) Oversight, plan implementation requires an oversight body such as a secretariat or a decision-making body; (2) Partner engagement, there should be mechanisms in place to engage key stakeholders; (3) Community-wide action, partners need to adopt their own sustainability initiatives to extend implementation beyond the local governments jurisdiction; (4) Communications, plan implementation should include mechanisms that connect partners and provide them with opportunities to learn; and (5) Monitoring and Measurement, it is imperative that the progress of the plan is monitored so that adjustments can be made in a timely manner (Clarke 2012).

2.5 Plan Outcomes

Plan outcomes represent progress made by the partnership and the partners on the goals outlined in the strategic plan (i.e., the SCP) and relate to specific topic areas like the ones discussed in Sect. 2.1 (Clarke and Fuller 2010). For example, the main goal of the climate action plans would be emissions reductions at the community level. When assessing the community's plan outcomes, the trend within each region itself is most important (Clarke 2011).

2.6 Partner Outcomes

Partner organizations involved in implementing an SCP collaboratively are important contributors, but they also benefit from engaging in the partnership. In a recent study on partner perceptions in the Canadian communities Hamilton, Montreal, Vancouver, and Whistler, partners attributed a number of gains in organizational resources to their involvement in the SCP partnership (Clarke and MacDonald 2016). Some of the resources identified by partners as outcomes of their involvement include networking opportunities, increased social capital with other partners and the community at large, gained knowledge in the area of sustainability, and improved reputation (Clarke and MacDonald 2016).

3 Methodology

In 2014, we conducted a survey of local governments around the world asking them to share information regarding their SCPs. The survey was distributed by ICLEI Local Governments for Sustainability (ICLEI), and was offered in English, French, Spanish, and Korean. An advantage to working with ICLEI is that they have direct access to a large sample of local governments that fit this study's criteria for participants. Study participants needed to be local governments that are implementing SCPs/initiatives through multi-stakeholder partnerships. 111 communities responded from six continents including Africa, Asia, Australia, Europe, North America, and South America. Table 1 outlines the percentage of respondents by continent.

The communities ranged in population from under 50,000 to over 5,000,001; with the largest percentage of respondents in the under 50,000 range. Table 2 shows the percentage of respondents representing different-sized communities/cities.

Survey respondents were asked to share information regarding their SCPs. In particular, they were asked several questions about the implementation structure of their partnership and about outcomes at different levels. Survey respondents were also asked to share general information about their SCPs, such as the age of the plan, the time horizon of the plan, and the topic areas included in the plan. Figure 1 summarizes the variables and relationships between variables that were studied in this research project.

Table 1 Respondents per continent

Continent	Valid percent
Africa	2.7
Asia	15.3
Australia	10.8
Europe	6.3
North America	61.3
South America	3.6
Total	100.0

Table 2 Percentage of respondents by population size

Population	Valid percent
Under 50,000	31.8
50,001–100,000	18.2
100,001–500,000	21.8
500,001–1,000,000	7.3
1,000,001–5,000,000	19.1
5,000,001+	1.8
Total	100.0

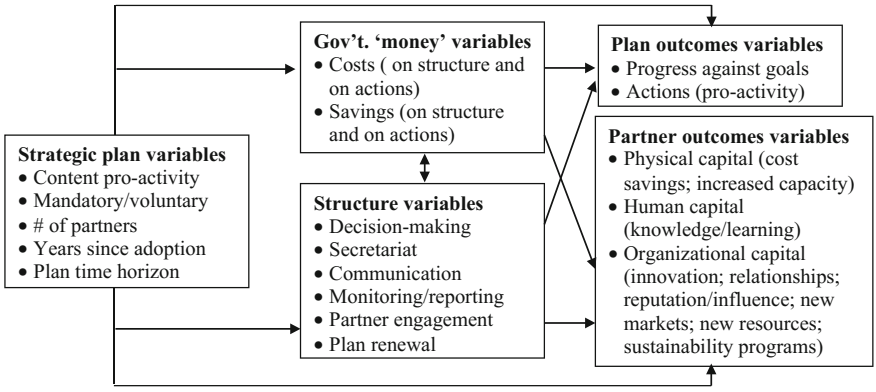

Fig. 1 Variables and relationships being studied in the research project

In the dataset, we have detailed information about the most common structural elements within the partnerships in relation to communication systems, decision-making processes, role of the oversight entity, monitoring and reporting systems, partner engagement mechanisms, and the role of the secretariat. Due to space restrictions, they are not included in this chapter. The results represented in this chapter summarize our findings for the strategic plan variables and government money variables.

3.1 Limitations

Steps were taken to minimize the limitations of this study; however, there are some nuances of context, feasibility, and the phenomenon that the reader should consider when interpreting the results.

First, the partnerships studied in this research project are in the context of implementing SCPs. Across the partnerships studied, the partners share a geographic location, implement plans that include comparable topics, and implement with processes recommended by international agencies such as the United Nations. The main benefit of studying partnerships with comparable attributes is the ability to control for aspects that could otherwise influence the results; however, the drawback is that the generalizability of these results is perhaps limited to partnerships that implement SCPs.

The second challenge of this research is attributable to budget constraints. Our preference would have been to distribute the survey in additional languages, but we were limited financially to four translations. We consulted with ICLEI to determine which languages would reach the largest number of their members and determined that French, English, Korean, and Spanish would be the best choices. This decision allowed us to reach the largest number of ICLEI members, but limited us to survey participants who can fill out a survey in one of those four languages. Moreover,

the majority of cities participating in our research have been based on developed countries. While the results are likely generalizable to most developed countries, further study would be needed to see the generalizability to emerging economies and developing country contexts.

Finally, SCP multi-stakeholder partnerships are constantly adapting to their changing contexts (Kolk et al. 2008). For instance, many of these partnerships are closely tied to the local authorities as so they can be susceptible changes in political leadership. New partners joining or partners leaving the partnership can also have important implications for these partnerships, especially if the partner is significantly affected by or affects the ability of the partnership to meet its local sustainability objectives (Freeman et al. 2007). Thus the results of this study represent a cross-sectional analysis of one time frame, rather than a long-term narrative of SCP partnerships.

4 Results and Analysis

As represented in Fig. 1 we surveyed local governments to learn more about their SCPs. We asked participants about the maturity of the plan, the topics covered in the plan, and the number of partners involved in implementing the plan. The findings in our sample show that the majority of plans were under 8 years old. These findings indicate that SCPs are an emerging trend. Table 3 summarizes these findings.

Table 4 summarizes the 16 topics which were included in the SCPs. This information demonstrates that none of the topics were included in every plan; however, some were more common than others. It can also be noted that there is a distribution between environmentally, socially, and economically based topics, though commonality decreases, respectively. Regardless of this distribution, these findings show that the majority of the SCPs are highly complex and require efforts beyond the local government's role.

Table 5 indicates that in our sample almost all of the local governments are engaging with partners during plan implementation, though there is variance in the number of partners involved. This project is currently doing an in-depth study of

Table 3 Maturity of the sustainable community plan

Years of implementation	Valid percent
0–2 years	32.4
3–5 years	27.9
6–8 years	19.8
9–11 years	5.4
12–14 years	6.3
15+ years	7.2
Not sure	0.9
Total	100.0

Table 4 Percentage of SCPs that included a topic

Topic	Valid percent
Waste	84.7
Energy	82.9
Water	82.9
Climate change	78.4
Land use	72.1
Transportation	71.2
Air	57.7
Ecological diversity	56.8
Civic engagement	49.5
Employment	49.5
Housing	45.9
Social infrastructure	42.3
Safety (crime)	27.9
Food security	27.0
Poverty alleviation	25.2
Noise pollution	15.3

Table 5 Number of partners in the partnership

Number of partners	Valid percent
0	9.3
1–5	25.9
6–10	8.3
11–20	9.3
21–50	13.0
51–99	5.6
100+	13.0
Not sure	15.7
Total	100.0

four partnerships with more than 100 partners to learn more about partner outcomes and ideal structural design.

This study also asked questions about the financial resources available and resources used by the local governments to create and implement the SCPs. When asked if the local government had a department/unit dedicated to sustainability initiatives, approximately 70% responded 'yes'; and of particular relevance is that, of those, approximately 60% did not have that department/unit before creating the SCP. This finding indicates that these plans create accountability and act as motivators for progress on sustainability from the local government.

With regards to the number of full-time employees, Table 6 shows that the majority of respondents recorded 1–5 employees. When counting volunteers, as noted in Table 7, the majority of respondents recorded 1–20. This is in part due to the size of the communities, with almost half having a population of 100,000 or less

Table 6 Number of local government employees supporting the SCP implementation

Number of full-time employees	Valid percent
<1	13.3
1–5	65.6
6–10	7.8
11–20	5.6
21–30	0.0
31–40	0.0
41–49	1.1
50–100	3.3
101–200	3.3
Total	100.0

Table 7 Number of volunteers supporting the SCP implementation

Number of volunteers	Valid percent
0	21.8
1–20	43.5
21–40	10.2
41–60	7.7
61–80	0.0
81–100	3.8
100+	13.0
Total	100.0

Table 8 Money questions

SCP outcomes	*N*	Minimum	Maximum	Mean	SD
Money saved from implementing internal sustainability initiatives	88	1	5	3.17	1.09
Additional funding attracted for community-wide sustainability initiatives from others	89	1	5	3.22	1.26
Financial or other resources contributed to the internal sustainability initiatives	91	1	5	3.10	1.08
Financial support contributed to the governance and/or administrative activities	92	1	5	3.08	1.12

(and therefore a small staff team for the entire local government). It is notable that almost all the communities surveyed had at least one full-time staff position dedicated to SCP implementation.

Table 8 shows the results of the 'money questions'. On a Likert scale from 1 to 5 (1 being 'None at all' and 5 being 'A significant amount'), respondents were asked about funding. Results show that while funds are being invested into the SCP, there are also funds invested by others, as well as savings.

Probably most importantly, the survey asked questions about the actions taken on the 16 topics, and the results achieved. Again due to room constraints this information is not included here. The project's next steps are to look at correlations between the variables to determine if certain structural features of the partnership design are critical for achieving sustainability progress. Preliminary analysis shows that proactive actions, monitoring and reporting, communications, partners helping implement, higher number of partners, and plan renewal are critical for sustainability progress (when considering all topics).

5 Policy Relevance

The information from this survey puts forth valuable insights into on-the-ground progress toward the 2015 Sustainable Development Goals; particularly number 11: Make cities and human settlements inclusive, safe, resilient, and sustainable (United Nations 2015a). To achieve the specific actions within this goal by 2030, communities must be incorporating the relevant topics into the goals of their SCPs at present time, as many included time horizons of over 15 years. In addition, the information in this chapter can be considered for the implementation of the New Urban Agenda that was finalized at the third UN HABITAT conference. We provide a window into the current international situation on community sustainability planning. Further, the survey included a section regarding the integration of climate change mitigation into the respondent's SCPs which can feed into the climate change conversations as it relates to low-carbon urban development.

5.1 Implications

- There was a great uptake of Local Agenda 21s (and equivalent) post-1992. While LA21s are rarely discussed anymore, ICLEI's report prepared for Rio + 20 indicates that there are over 10,000 LA21 initiatives around the world (ICLEI 2012). The recent trend is toward silos again (climate change plans, energy plans, transportation plans, affordable housing plans, etc.) with discourse still paying reverence to holistic and integrated approaches. SCPs exist and are an excellent mechanism to further community-wide implementation of SDGs at the local level. They provide an umbrella strategy that goes beyond land use planning, and consider community-wide goals including, but also beyond, the local government's jurisdiction. That said, they require ongoing support to succeed.
- Given the silo approach, policy coherence between levels of government is more important than ever before. As national governments create climate strategies and invest in the transition to a low-carbon economy, investments should support lasting local sustainability progress. Likewise, local climate mitigation

and adaptation action plans should be action plans to implement sustainable community plans (and not instead of SCPs).

- SCP content could be reconsidered in light of the SDGs. There is considerable overlap, but not all plans address all topics, though most of the SDGs have local implications that could be included in a sustainable community plan.
- In terms of implementing SCPs, engaging partners is critical for making local sustainability progress. This has been statistically proven through an earlier study in this project. While this was found for all topics in one partnership, it was also found that certain structural features are more important when considering topics alone (for example, progress, on local economy goals).
- Also, the structure of the partnership is important. Engaging a large number of organizational partners from different sectors requires a sophisticated design with particular attention to serving the partners' needs as well as ensuring progress on sustainability goals. This research project provides concrete evidence of the importance of structure and offers best practices.

6 Conclusion

The complexity of the issues facing communities and cities today requires the involvement of government, as well as local businesses, non-governmental organizations, and citizens. In practice, the challenges for these collaborative initiatives are found in the structures of implementation. A wide variety of structures have manifested in an effort to best coordinate the collaborative nature required to implement a comprehensive plan, but until now little research has been done regarding the success of these structures.

The results from the larger study show that the design of the partnership is key to ensuring progress on community sustainability goals and to maintaining partner engagement. Design of the structural features (e.g., decision-making processes; role of the oversight entity, monitoring and reporting systems, communication systems, partner engagement mechanisms, and the role of partners) is critical for achieving desired outcomes. The results presented in this book chapter, which are a subset of results from a larger study, provide several insights about SCPs around the world. First, the findings signal that new SCPs are being created and implemented around the world and that many SCPs are prioritizing overlapping issues, such as waste, energy, and water. The topic area results also indicate that the issues covered in SCPs often integrate all three dimensions of sustainability. This type of overarching and holistic plan that considers the implications of local action from an integrated social, environmental, and economic perspective may be better positioned to achieve community-wide commitment and results. The wide spread uptake of SCPs and the integrated nature of the topics covered position these plans as a potential avenue for addressing the SDGs internationally at a local level. The finding that SCPs are being implemented by local level multi-stakeholder partnerships indicates

that local governments believe that stakeholder engagement through a partnership is an effective SCP implementation strategy. It supports the well-established notion that sustainability challenges reach beyond the capacity and jurisdiction of local governments alone (ICLEI 2012; Mercer and Jotkowitz 2000; Selsky and Parker 2005). The results that summarize resources invested versus resources gained indicate that while local governments are investing resources into SCP implementation they are also gaining resources through attracting investment and cost savings. In addition, the discovery that of the 70% of local governments that reported having a department/unit dedicated to sustainability initiatives, 60% formed the department/unit after developing their SCP. The implication of this finding is that the plans may create accountability and impetus for progress on sustainability from the local government. Moreover, SCPs may act as motivators of resource investment, as indicated by the findings about new units/departments, new sustainability job positions created, volunteers involved, and additional funding attracted from others.

Building on the findings in this study, there are several potential avenues for future research. First, researchers who are interested in the numeric costs and savings experienced by local governments that implement their SCP through partnerships might pursue research that uncovers financial costs compared to savings and investments attracted, to determine the costs and savings/investments balance. Other researchers interested in partners aside from the local government might study the financial cost savings versus investments experienced by different types of partners, including partners from both the private and civil society sectors. The results of such a study may uncover financial benefits to partners involved in implementing an SCP thereby making a stronger business case for engagement from a partner perspective. Finally, researchers interested in the sustainability outcomes and impacts of SCPs might assess whether financial resources invested and saved are related to progress on plan outcomes.

The research project highlighted in this book chapter continues to expand and is currently studying four large sustainability partnerships: Gwangju Council for Sustainable Development in Gwangju, Korea; Montreal Community Sustainable Development Plan in Montreal, Canada; The Bristol Green Capital Partnership in Bristol, UK; and Barcelona + Sostenible in Barcelona, Spain. Each of these partnerships has over 100 organizational partners. With this data we will be able to consider the relationships between the partnership level governance structure, the partner involvement (motivation, ongoing engagement, actions taken), and the resulting partner and plan outcomes. We are also studying the relevance of the results to local climate partnerships, and are continuing our analysis of the international surveys responses. The project has another 2 years of funding. We welcome new funding and research partners as we consider our future direction.

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Pioneering in Sustainability Reporting in Higher Education: Experiences of a Belgian Business Faculty

K. Ceulemans, T. Stough and W. Lambrechts

Abstract

Sustainability reporting is increasingly perceived as a valuable tool for organizations to communicate and engage with stakeholders on their sustainability activities and performance. While sustainability reporting is mainly a corporate activity, over the last 10 years some pioneering higher education institutions have started engaging in this process. Yet, until today, the higher education sector is still lacking in-depth guidance on how to organize the sustainability reporting process in complex organizations such as higher education institutions. This paper addresses this gap by describing and analyzing the sustainability reporting process in the preparation of four consecutive sustainability reports (2010–2014) for a Belgian university, led by the business faculty's sustainability office. The study is aimed at broadening the knowledge on the topic of sustainability reporting in higher education institutions, by unfolding elements of the process and some of its main challenges and opportunities through the use of action research. The paper describes (1) how the Global Reporting Initiative's Sustainability Guidelines were used; (2) how the

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data collection and analysis were organized; (3) which types of stakeholder engagement took place within the sustainability reporting process; and (4) how students were involved in the reporting process. Afterward, these different elements are reflected upon and the main challenges of the process are identified, such as the organizational structure of higher education institutions linked to the data collection process and the absence of suitable indicators to report on higher education's core impacts on society. Moreover, the paper specifically highlights the opportunities for higher education institutions and business faculties to engage in this process, including the use of sustainability reporting as an educational tool and the link with accreditation activities.

Keywords
Sustainability reporting · Higher education · Global Reporting Initiative · Sustainability assessment · Sustainability indicators

1 Introduction

Supported by global frameworks such as the United Nations' (UN) Decade of Education for Sustainable Development (DESD) (2005–2014) and the Global Action Programme (GAP) on Education for Sustainable Development (post-2014), higher education institutions (HEIs) have been among the actors engaging for sustainable development (SD) within our society. While a number of actions and initiatives have been undertaken by HEIs around the world to integrate sustainability into their systems, significant progress can still be made (Disterheft et al. 2013; Lozano et al. 2015; Wals 2014). For example, the UN DESD final report stressed the need for stronger leadership for SD integration in HEIs, increased inclusion of SD in existing student curricula, further academic staff development on SD, and solid network building to increase capacity and expand influence on SD (Buckler and Creech 2014). The UN GAP has pointed to the need for regular future monitoring and evaluation of the progress made in implementing education for sustainable development (ESD) practices (UNESCO 2014).

The practice of sustainability reporting (SR) has been identified as one of the elements needed to foster progress on SD integration in HEIs (Lozano et al. 2013b). SR helps organizations monitor and assess, as well as communicate and engage, with stakeholders on their sustainability performance and activities (Adams and Frost 2008; Joseph 2012). While sustainability reporting is mainly a corporate activity, over the last 10 years some pioneering higher education institutions have started engaging in this activity (Alonso-Almeida et al. 2015; Ceulemans et al. 2015a). However, there is a lack of exchange of information on the topic in the higher education sector and a lack of in-depth guidance on how to organize the

sustainability reporting process in organizations as complex and distinctly organized as HEIs (Lozano et al. 2013a). Moreover, the topic of SR in HEIs has, until today, not been researched extensively (Ceulemans et al. 2015b).

This paper addresses this gap by describing and analyzing the sustainability reporting process during the preparation of four consecutive sustainability reports (published in 2011–2014) for a Belgian university, led by the business faculty's sustainability office. The study is aimed at broadening the knowledge on the topic of SR in HEIs, by unfolding elements of the process and some of its main challenges and opportunities. It offers analytical insights valuable for researchers and practitioners in the field, through the use of action research drawn from an analysis of the experiences of the leading authors and developers of these four sustainability reports.

The paper continues as follows: first, a short overview of the recent literature on the topic of SR in HEIs will be given. Second, the methods will be described, including a presentation of the university and faculty under study. Afterward, the findings section will provide a detailed description of the SR process in the university, followed by a discussion of the main opportunities and challenges of the sustainability reporting process for universities and business faculties in particular. Finally, some concluding comments and insights on the SR process will be offered for researchers and practitioners in the ESD field.

2 Sustainability Reporting in Higher Education

SR is a voluntary activity practiced by all types of organizations, aimed at communication of, and accountability on, SD impacts toward stakeholders and at the assessment and improvement of the organizations' SD performance (Adams and Frost 2008; Daub 2007; Joseph 2012). More specifically, for HEIs, a recent study on the early adopters of SR in the higher education sector found that HEIs mainly engaged in SR for reasons of increasing transparency, facilitating SD assessment, stakeholder engagement and change for SD, and improving their reputation (Ceulemans et al. 2015a). In this study, the surveyed HEIs identified the following objectives of SR as less important: improving HEIs' ranking positions, facilitating external benchmarking, and providing evidence for accreditation bodies.

A large number of current sustainability reports are compiled through adherence to international reporting guidelines or frameworks, offering in-depth guidance on *how* to report and *which areas* of the organization's activities to focus on. The Global Reporting Initiative's (GRI) Sustainability Guidelines (GRI 2013) is one of these available frameworks. It is a comprehensive, indicator-based framework that is widely used by mainly corporate organizations throughout the world, and it was conceived through broad and ongoing stakeholder processes (Brown et al. 2009; Daub 2007; Lozano 2006). One of the main downsides of this framework for HEIs is that there is no sector-specific guidance available for HEIs that summarizes the

material topics or offers indicators for HEIs to include in such GRI reports (Ceulemans et al. 2015b; Lozano 2006).

From the total of 32,438 sustainability reports available in the GRI Sustainability Disclosure Database in March 2016 (covering publication years from 2000 to early 2016), a total of 234 sustainability reports were published by 99 HEIs (GRI 2016). In the ESD literature, some studies have focused on the state of SR in HEIs and found that there was a low level of SR by HEIs (in terms of quantity and quality of the reports) and a strong focus on the disclosure of environmental impacts of HEIs (Alonso-Almeida et al. 2015; Fonseca et al. 2011; Lozano 2011). Alonso-Almeida et al.'s (2015) study stated that Europe and North America were the leading continents in adopting the GRI Sustainability Reporting Guidelines in HEIs and that HEIs were in the early adopter stage in terms of practicing SR.

A number of HEIs have also been assessing their SD activities through the use of HEI-specific SD assessment tools, such as the Sustainability Tracking, Assessment & Rating System (STARS)[1] (AASHE 2016a), the Campus Sustainability Assessment Framework (CSAF) (Cole 2003), and the Auditing Instrument for Sustainability in Higher Education (AISHE) (Roorda 2002). However, research has shown that it remains difficult to design appropriate instruments for monitoring and analyzing the SD performance of HEIs (Disterheft et al. 2013; Shriberg 2002; Velazquez et al. 2006), due to the lack of reviews of current SD assessment tools (Glover et al. 2011; Lambrechts and Ceulemans 2013) and the failure of certain tools to assess HEIs' core activities or to cover SD integration holistically (Lozano 2006; Yarime and Tanaka 2012; Wals 2014).

The UN's Principles for Responsible Management Education (PRME) offers a framework for business schools and business faculties, comprised of six principles, to help them structure and reflect on the integration of SD and social responsibility into their activities (Lambrechts et al. 2015; PRME 2016a). PRME also invites the signatory business schools and faculties, currently 645 institutions, to biennially report on their SD activities and adherence to the PRME principles through "Sharing Information on Progress" (SIP) reporting (PRME 2016b, d). Yet, in a recent study, Godemann et al. (2014) contested PRME's potential to foster changes for SD, because the principles are mainly used to promote current activities, rather than being a lever for new SD initiatives.

In the ESD literature, some scholars have attempted to standardize SD assessment through the use, or combination, of higher education SD reporting and/or assessment tools. For an overview of such studies, we refer to Ceulemans et al.'s (2015b) systematic literature review on the topic of SR in HEIs (see Ceulemans et al. 2015b, Sect. 3.4.2).

[1]The Association for the Advancement of Sustainability in Higher Education's (AASHE) STARS tool is currently one of the most broadly used HEI-specific SD assessment tools around the world, with a total number of 750 HEIs registered to use the tool, among which mainly North American HEIs (AASHE 2016b; Lidstone et al. 2015).

A topic that has until today not been studied in depth in the literature on SR in HEIs is the process of SR, as compared to a focus on the outputs of SR, e.g., through published sustainability reports (Ceulemans 2015). Ceulemans et al.'s (2015a) recent study on SR in HEIs found that the SR process is not systemized in most HEIs—reporting is mainly done without a clear structure or plan—and that time and resources for SR are very scarce. In this study, it was identified that, in some cases, the SR process helped increase the HEI's operational performance and the level of internal engagement for SD initiatives, and thus contributed to change toward SD in the organization.

In the recent literature, Moudrak and Clarke (2012), Lozano et al. (2013a), and Adams (2013) have identified different parts, features, or steps of the SR process, based on the authors' personal experiences with SR. Moudrak and Clarke (2012) and Lozano et al. (2013a) based their steps of the SR process on their experiences with SR in their own institution. The purpose of both articles was to document the SR process, rather than to attempt generalizing the process for the whole higher education sector. Adams (2013) proposed a more general approach, based on her SR expertise throughout the years and applied to HEIs in a theoretical manner (see Table 1). Table 1 discusses the features of the sustainability process in higher education, according to Adams (2013). The table includes some of the issues previously mentioned in this section, such as the use of international frameworks for SR, or the identification of material impacts.

Stakeholder engagement is an important element of the SR process in HEIs (see Table 1), yet it is often overlooked (Disterheft et al. 2015) or omitted from the SR process (e.g., in the SR activities described in Lozano et al. 2013a). The ESD literature has mentioned the presence of internal (e.g., employees, management, students) and external (e.g., suppliers, governments, accreditation bodies, future student employers) stakeholders in SD integration processes. From a change management perspective, the importance of stakeholder involvement is highlighted in relation to countering resistance against change, improving communication, and raising awareness, empowerment, and involvement on SD issues (Verhulst and Lambrechts 2015). However, the recent literature on SR in the higher education context does not clarify how stakeholders can be involved in the SR process in a meaningful way (Ceulemans et al. 2015b).

The GRI guidelines require that the reporting organization identifies its main stakeholders and responds to their reasonable expectations and interests (GRI 2013). Based on the input of stakeholders, an organization can identify which topics are most important, or "material", and this helps set the boundaries of the sustainability report (as well as shape future policy making, etc.). Stakeholder engagement activities can range from a wide array of activities, such as internet bulletin boards, questionnaire surveys, or open meetings for stakeholders and organizational representatives (Thomson and Bebbington 2005).

Table 1 Features of the sustainability reporting process in higher education (Adapted from Adams 2013)

• Identification of key stakeholders to involve in the various stages of this process
• Development of a shared vision, goals, and principles which incorporate sustainability
• Use of one or more globally recognized reporting frameworks
• Identification of material social and environmental sustainability and community impacts
• A collaborative approach to determining key performance indicators for material impacts
• A collaborative approach to determining quantified targets and actions to achieve them (both of which are included in operational plans and individual performance goals)
• Regular monitoring of performance against actions and targets

3 Methods

This paper provides insights into the challenges and opportunities of the sustainability reporting process in higher education. The study was done through the use of action research, undertaken at the business faculty of the Hogeschool-Universiteit Brussel (HUB) and KU Leuven—University of Leuven, during the preparation of four sustainability reports published in 2011–2014.

3.1 Research Strategy

Action research is a research strategy conducted by and for those actors undertaking the action and aimed at both theorizing about and improving certain practices (Jupp 2012; Saunders et al. 2012; McTaggart 1991). It implies an active and deliberate engagement of the researchers in the study (McKay and Marshall 2001) and usually results in knowledge production (for research and practice) and changes in the undertaken practices (Eden and Huxham 1996; McTaggart 1991).

When researching the topic of sustainability reporting, action research can be a valuable method to use, as it can "*assist organisations in bringing about improvements to their sustainability reporting process, accountability and sustainability performance*," while also offering the ability to theorize on the understanding of the topic (Adams and McNicholas 2007: 399). In the particular case of studying sustainability issues in the higher education context, "*a methodology underpinned by action research is recommended for university transformation, because its focus is on facilitating multi-level, multidimensional learning*" (Wooltorton et al. 2015: 433).

3.2 Data Collection and Analysis

The data collection and analysis of the sustainability reporting process was done through a cyclical process, with overlapping phases of action and reflection, allowing for the researchers to learn from their experiences during the study (Davidson et al. 2004; McTaggart 1991).

The data collection took place between 2011 and 2014 and included participatory observation of the interactions with the actors engaged in the process (e.g., during different types of internal meetings, or the stakeholder dialogue), interviews with internal stakeholders in preparation of the reports, and document analysis (e.g., of the sustainability reports and internal documents of the university).

The authors of this paper were involved in the sustainability reporting process as well as in the development, data collection, and data analysis of this study. The two first authors of the paper were actively involved in the reporting process as the lead authors of the sustainability reports, while the third author was involved as a HUB employee (internal stakeholder).

3.3 Limitations of the Study

One of the limitations of this research could be the active involvement of the researchers in the research context through action research, leading to a lack of distance of the topic under study and possibly resulting in overly positive findings. However, the main aim of this paper is not to convey a success story, but, on the contrary, to share a best practice of SR with practitioners and researchers in the field, and offer insights into the challenges and opportunities of engaging in this process. Moreover, the findings of the study were also triangulated through analysis by a third researcher, who was familiar with the research context as an employee, but not actively involved in shaping the sustainability reporting process.

Studying the sustainability reporting process at one specific HEI is also context-specific. However, as the intention of action research is to produce conclusions or implications beyond those directly related to the project or study (Eden and Huxham 1996), other HEIs operating in similar and different contexts can also learn from the findings of this study. However, this also implies that the challenges and opportunities of the process that are discussed in this study are intended to provide a comprehensive, yet not exhaustive overview of these elements of the sustainability reporting process.

3.4 Presentation of the University (HUB—KU Leuven) Under Study and Its Business Faculty

The Belgian business faculty presented in this paper was formerly situated in the Belgian university-college Hogeschool-Universiteit Brussel (HUB), and known as the Faculty of Economics and Management (FEM). The HUB provided

professional and academic education, and consisted of over 7000 students and more than 900 staff members (HUB 2011).

The FEM took a leadership role in systematically integrating SD into the whole of HUB. In 2011, the HUB was the first Belgian HEI with a sustainability report registered on the Global Reporting Initiative's online database (GRI 2016; Weybrecht 2013). The preparation of HUB's report was led by the FEM and its sustainability office. The decision to engage in the reporting process spurred from feedback generated through an AISHE audit performed in 2009 by the FEM for two of its study programs (see Lambrechts and Ceulemans 2013). Through this process, it was determined that many SD initiatives were simultaneously occurring, but communication about these initiatives needed to be strengthened, after which the decision to start reporting was made. Some of the actions leading to the development of HUB's sustainability reporting activities are outlined in Fig. 1, which was reprinted from HUB's second sustainability report (HUB 2012).

The former institution of HUB has since dissolved, with professional and academic education being decoupled. The FEM, offering academically orientated educational programs, became part of the Faculty of Economics and Business (FEB) of the Belgian university KU Leuven in 2013 (HUB and KU Leuven 2014; Weybrecht 2014). The integrated KU Leuven FEB (including the former FEM) currently has four campuses, approximately 8000 students, and approximately 750 staff (KU Leuven 2016). The university and faculty, referred to throughout this

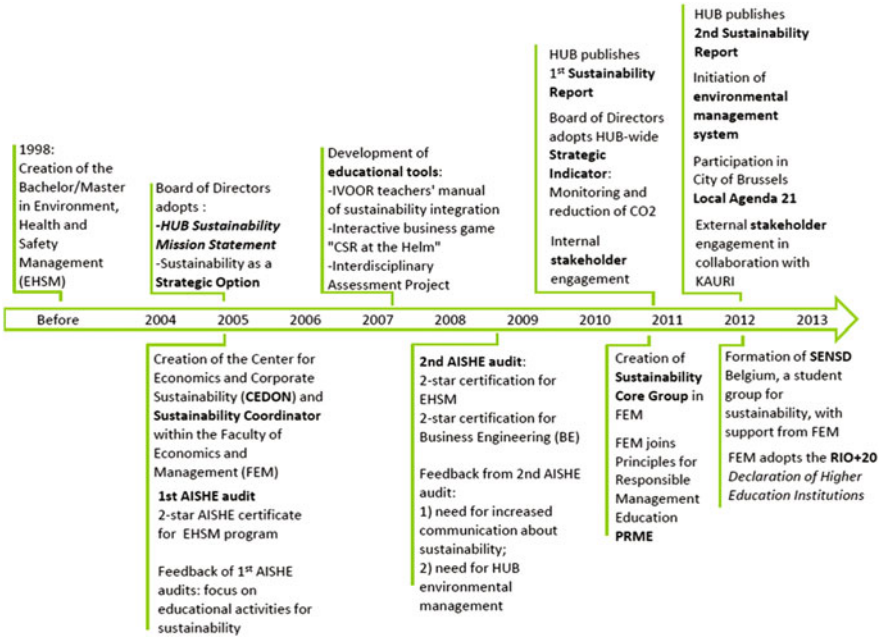

Fig. 1 Timeline of sustainability integration at HUB (HUB 2012)

chapter refers to HUB and HUB's FEM, respectively, prior to the integration in 2013, and KU Leuven and KU Leuven's integrated FEB thereafter.

4 Findings: Description and Analysis of the Sustainability Reporting Process at HUB—KU Leuven

4.1 Adhering to the Global Reporting Initiative's Sustainability Reporting Guidelines

The decision to use the GRI guidelines for the preparation of the faculty's first sustainability report in 2010 was based primarily on the fact that they are the most widely used guidelines, and that the indicators have been developed through GRI's multi-stakeholder processes (Weybrecht 2013). As a business faculty, there was also internal expertise on the process of SR and the use of GRI, as it was a topic covered in research and in curriculum on sustainable management.

In 2010, Belgium was a laggard in sustainability reporting, with only 73 reports registered on the GRI database for the entirety of the county's sectors between 2000 and 2010, and there were no Belgian HEIs present in the database at the time. The university published its first GRI sustainability report in 2011, covering data from the academic year 2010–2011. The university's four consecutive sustainability reports (2011–2014) can be consulted on the GRI Disclosure Database (see http://database.globalreporting.org/companies/view/3659).

The GRI guidelines were used to guide the data collection and analysis process (see below) and to provide indicators to disclose the HEI's main environmental, social, and financial impacts. Because the GRI guidelines are not specifically catered to the needs of HEIs, the framework does not provide SD indicators dealing with education and research activities. In the absence of specific indicators, the faculty chose a narrative approach to presenting information on its SD educational and research initiatives.

4.2 Sustainability Reporting Data Collection and Analysis

Preparing the first sustainability report can be considered the hardest because of the problem of "where to begin." An overview of the data collection process in the preparation of the university's first sustainability report is shown in Fig. 2. The faculty's sustainability office did reconnaissance by meeting with central departments—logistics, human resources, student services, financial, etc.—to discuss the GRI indicators and see which data were already monitored and available. Internal documents relevant to indicators (i.e., HR policies, the annual reports, etc.) were also reviewed. The stakeholder engagement process, which is also covered in Fig. 2, will be discussed in the section below.

Fig. 2 Reporting process in preparation of HUB's 2011 Sustainability Report

With multiple campuses, rented spaces in adjoining buildings, and outsourced catering, scope setting proved to be a challenging task. To ease data collection, the university chose to focus its environmental impacts on the buildings it owned. Within the GRI's social indicators, there is a focus on management's responsibility toward employees (i.e., return to work after giving birth), but since HEIs also have a responsibility toward their student population, the university chose to include student data for some social indicators (i.e., for diversity and discrimination, as well as health and safety). When calculating CO_2, the issue of scope was especially pressing (i.e., whether or not to include airline travel of international students). Scope setting became even more convoluted when taking into account institutional reorganizations (i.e., the decoupling of professional and academic departments).

The GRI guidelines include indicators that require data to be collected from all over the organization. The high level of autonomy of different groups within the organization made this a challenging activity. Taking procurement as an example, KU Leuven has general purchasing policies that impact most purchasing decisions on a general level (i.e., framework agreements with suppliers for certain items, such

as paper), then the central faculty and each research unit within the faculty make their own purchasing decisions (within the constraints of the university policies). Some items (for example, catering) are not overseen by the university's policies, so each entity of the university selects their own caterers for events. Therefore, even within a single faculty purchasing the same item, there would exist various approaches to procurement, which makes data collection and reporting challenges.

As an academic faculty preparing the sustainability report for the entire organization, it was also challenging to cross organizational boundaries to work together with central departments. What became evident while collecting data was that even the central departments were not regularly communicating on certain issues. In some cases (for example, solid waste management of the former HUB), one department maintained the data (i.e., Logistics), while another department was responsible for policies (the Environmental Coordinator), and there was no clear coordination between the two on the topic. For some topics, data simply were not being maintained at all (i.e., CO_2 emissions), being maintained in highly fragmented ways (i.e., environmental investments), or topics were not being considered by the organization (i.e., risks and opportunities related to climate change).

Sometimes, it was challenging to explain to colleagues how sustainability related to their activities. There was a general preconceived idea that "sustainability" was about environmental topics. For example, the GRI includes indicators on marketing practices because of issues related to ethics and responsibility (i.e., marketing to children or portraying gender roles). Even though ethical marketing is not one of the material aspects of the university, the sustainability office met with the marketing department of the former HUB anyway because earlier versions of the GRI guidelines encouraged reporting on as many indicators as possible instead of focusing only on material issues. The marketing department was hard pressed to see the link between what they do and "sustainability".

In some ways, data collection became easier after progressing in SR. For example, having an already-printed report made it easier to communicate with colleagues about how the data will be used and how themes tie into the umbrella term of "sustainability." Subsequent reporting processes were streamlined because it was then known which persons/departments in the organization maintained what data. With the launch of the GRI G4 guidelines in 2013, further focus was set on material aspects for SR. There were some sets of data that remained a challenge to collect year after year—these were mainly data sets unique to the GRI indicators that had to be generated for the sole purpose of SR (i.e., compilation of the workforce organized by category, age, gender, and pay).

4.3 Stakeholder Engagement Processes

Various methods of stakeholder engagement have been used throughout the different reporting cycles. In the preparation of the first report, it was a struggle to engage stakeholders in a systematic and meaningful way, as the faculty was not yet fully aware of what it wished to garner from engagement processes. After

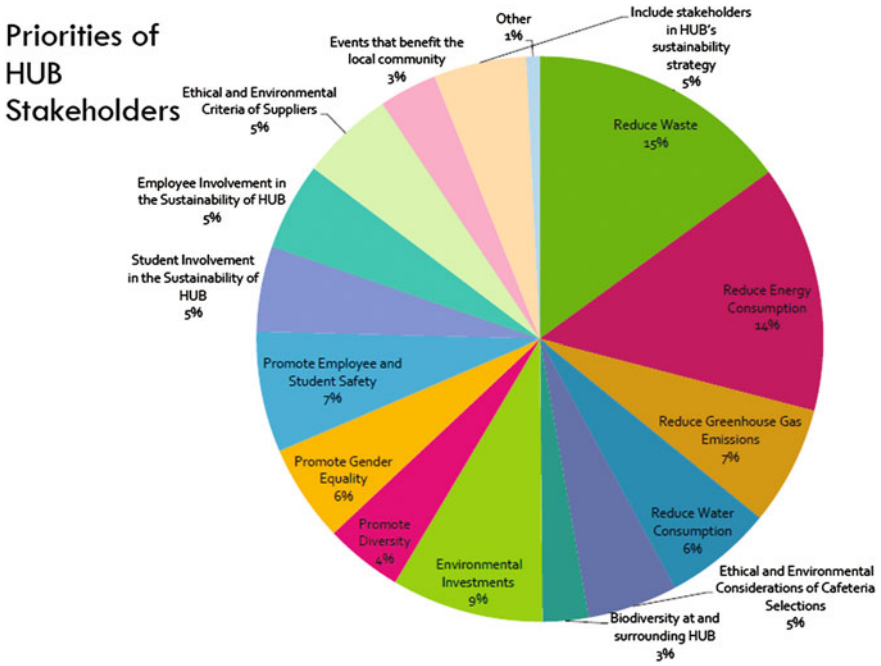

Fig. 3 Priorities of HUB's internal stakeholders in 2013 Sustainability Report (HUB 2013)

progressing in SR, the university became more able to focus on engagement methods that worked best for them.

The faculty utilized an annual online survey that sought to gain insight into the perception of internal stakeholders (students and personnel) on how well the organization was doing in implementing SD into education, research, outreach, and operations. For example, students were asked to what extent they felt SD was represented in their study program. This also gave an indication as to the extent stakeholders were aware of efforts to integrate SD into the organization (i.e., if stakeholders felt there was a low level of integration when many initiatives were in place, it could be an indication that there needed to be increased communication). The survey also asked participants about their priorities, which helped develop materiality matrices (see Weybrecht 2015) and set directives for future initiatives. An example of the priorities of HUB's internal stakeholders, reprinted from HUB's 2013 Sustainability Report, is provided in Fig. 3.

In addition to internal stakeholder engagement, the faculty held an event for external stakeholder engagement in 2012 (HUB 2012). In collaboration with a Belgian stakeholder network KAURI,[2] the faculty organized a "roundtable discussion" that brought together stakeholders relevant to key material aspects (for

[2]KAURI is currently part of "The Shift", a Belgian organization that serves as a meeting point for sustainability. See www.theshift.be.

example, the Belgian FSC branch was present, as paper usage is a material issue for most HEIs). The organization's personnel responsible for the oversight of material issues was present, and KAURI facilitated the discussion. Feedback (see HUB 2012: 14) included how social, environmental, and financial sustainability performance could be improved (i.e., integrate "sustainability" into financial decision-making processes), as well as how the report itself could be improved (i.e., define absolute targets for sustainability goals, such as CO_2 reduction). Feedback from external experts was especially motivating for the organization.

While the external stakeholder event yielded great insights, due to time and resources constraints, the external event was not held every year. Feedback takes time for an organization to integrate and it is a constant struggle to balance between engaging stakeholders and utilizing the collected information in a meaningful way. As students are, arguably, the most important stakeholder group of the university, it was decided to focus on stakeholder engagement activities with students.

4.4 Student Involvement in Sustainability Reporting

Over the course of four years of SR at HUB and KU Leuven, the business faculty's students have been involved in different ways in the SR process. First of all, students have been part of the stakeholder engagement processes for the sustainability reports annually (see above). For example, in the course *Corporate Social Responsibility* (*CSR*)[3] students learn about sustainability reporting and stakeholder engagement. Students first receive a lecture on the sustainability initiatives of the faculty and university as a whole, and then work in small groups, using the GRI indicators as a framework, to rate the materiality of different issues to them as stakeholders (HUB 2012: 26; Weybrecht 2013). Students learn about the GRI reporting tool, which they can apply in their future careers, and this highly detailed form of stakeholder engagement is used by the faculty when compiling its materiality matrix (Weybrecht 2013, 2015).

Second, some student groups have been engaged as coauthors of the sustainability reports (HUB 2013: 28; HUB and KU Leuven 2014: 41). In the faculty's study program Environment, Health, and Safety Management (EHSM), students prepare for a career in environmental management, health and safety, sustainability management, or related fields. Utilizing this group of students' highly developed competencies in SD, they are challenged to help prepare parts of the sustainability reports. This activity is organized as an assignment for their course *Sustainable Management*. Over the course of the three years that this collaboration has been occurring, the approach has evolved based on previous learning. Yet, it has proven to be difficult to balance getting recent enough data with the time it takes operational departments to generate the data and the short timeframe of a semester-long assignment.

[3]The faculty's CSR course is offered as an elective to Master students of the Business Administration, Business Engineering, and Business Economics Programs.

5 Discussion: Opportunities and Challenges of Sustainability Reporting in Higher Education

5.1 Main Challenges of the Sustainability Reporting Process

While SR may offer HEIs certain opportunities to help achieve the integration of SD into their organization (as discussed below), there are still a number of challenges that need to be addressed in order for SR to maximize its impact.

As in any type of organization, the lack of time and resources to engage in the reporting process is a major challenge (Ceulemans et al. 2015a; Lozano et al. 2013a). One of the major challenges for HEIs is that the reporting process is not well documented (Lozano et al. 2013a), nor well adapted to the higher education context (Ceulemans et al. 2015b; Lozano 2006). The GRI framework offers support to all types of organizations; yet because the guidelines are not designed specifically for HEIs, initiating the process of reporting remains difficult for HEIs without the availability of guidance or good practices. While other recognized frameworks may not focus specifically on issues like data analysis or stakeholder engagement protocols, they might offer a set of indicators that address HEIs' material SD impacts. As this is an important aspect of the SR process (Adams 2013), finding synergies between the currently available instruments (e.g., combining GRI and STARS, as discussed by White and Koester 2012) might help increase the use and impact of SR in HEIs.

The process of data collection is a challenge for all organizations, but—as described above—for HEIs there are added complexities. Defining the scope of the report is one of these challenges, especially in the case presented here, where the organizational boundaries were in constant flux over the years. Moreover, students —arguably the most important stakeholder for HEIs—can be perceived as internal *and* external to the organization. Therefore, HEIs need to decide (for certain indicators) whether or not to include student data (e.g., diversity). The collection of financial data has also proven to be complex in the case presented here. In Belgium, public HEIs adhere to a high level of transparency, having to publically disclose the intake and expenditure of financial resources. This makes certain financial data readily available. However, it is arguable that HEIs do not have a culture of transparency, which can prove difficult to overcome during the reporting process for collecting such data.

While stakeholder engagement is required by the GRI guidelines (GRI 2013) and is an important part of SD integration processes (Adams 2013; Disterheft et al. 2015), it can take an organization time to find engagement methods that work for them (especially in regards to time and resource constraints) and that provide meaningful feedback. Mass surveys generate quantifiable input from a large population, which can be good for prioritizing general topics (i.e., rating the importance of GRI aspects), compiling materiality matrices. Engaging with smaller groups can harvest more detailed input about, for example, barriers to change, expectations of students toward the organization, why issues are material to different groups, etc.

Consulting external stakeholders is a great way to expand the organization's thinking on certain issues and compare material issues with other comparable organizations (and maybe even result in collaboration). However, internalizing stakeholder feedback can be a slow process for HEIs.

Engaging students in the reporting process is challenging and time-consuming for the faculty and staff members involved. Including student authors for the report requires the continued coaching from staff, in addition to the usual workload of data collection and analysis. Input from students can vary in terms of quality, and final inputs from students still need to be fact checked and integrated into the overall report. However, the inclusion of students has improved the reporting process, as students can be idealistic in thinking, and they challenge the organization in the sense of why are we not doing better?

5.2 Main Opportunities of the Sustainability Reporting Process

Through unfolding the SR process undertaken at the Belgian business faculty, some potential opportunities of SR for HEIs have been identified. Producing sustainability reports and engaging in the reporting process may increase the communication and collaboration on SD initiatives, in addition to leading to potential increases in SD performance (see Ceulemans et al. 2015a). Moreover, for business faculties or schools, SR can be used as a learning tool and synergies can be found with business-oriented accreditation standards that have begun to further value SD issues.

Publishing sustainability reports helped the university showcase its SD activities, both to its internal and external stakeholders. In some cases, this helped stakeholders increase their understanding of the SD integration process and their willingness to engage in it. For example, throughout repeated reporting cycles it became easier for the faculty to collect information from other academic departments in the data collection process, as they became more aware of the advantages of showcasing their SD initiatives. The published reports also offered the university a platform to highlight its initiatives to the outside world—to governmental bodies, accreditation bodies, business partners, and other academic institutions. For example, the sustainability reports were used to communicate with PRME on the faculty's adherence to the PRME principles, and served as its SIP reports. Reports published on the GRI disclosure database offer HEIs an opportunity to share best practices and learn from each other.

In the case presented here, the reporting process has been a lever for sustainability integration at the university level. While the business faculty was managing and leading the reporting process, the effects of the process were visible in different parts of the organization. This was because many of the topics and the indicators addressed in the reporting process exceed the level of the individual department and thus required collaboration between internal actors. For example, this pushed HUB to design an environmental management system, thereby leading to improved

management and a potential for increased operational performance. The former institution of HUB did not have a formalized environmental management system in place at the time of the preparation of the first sustainability report in 2010. The reporting process brought together academic personnel, with expertise in environmental management systems and with operational personnel responsible for the environmental oversight of the campus. Through this relationship, HUB developed a formalized environmental management system and this also helped to create a platform for different actors from the central services to come together and discuss —leading to better management of topics (see PRME 2016c).

The reporting process at the university has also encouraged other universities in Belgium to start publishing sustainability reports, and thus has helped shaping SR in the Belgian higher education landscape. The faculty was pleased to hear of the University of Ghent's preparation of their first sustainability report, and during the preparation of their report, the sustainability office met with a student contributor to share its experiences in reporting.

One of the major opportunities of sustainability reporting in a HEI, and in a business faculty specifically, is the ability to use the reporting process as a learning tool. Using the university as a "living laboratory" means that students are involved in the sustainability process of HEIs, while simultaneously gaining hands-on knowledge that can be applied later in their careers. In a business faculty, aspects of sustainable management and CSR are integrated into the curricula. Using the sustainability reports as a learning tool in courses has offered the faculty a chance for two-way dialogue between the organization and its students.

In the business faculty, the experience with preparing and publishing sustainability reports has also helped in achieving a business school accreditation. The faculty decided to pursue the EQUIS accreditation (see EFMD 2016) in 2013. EQUIS requires the presence of ethics, responsibility, and sustainability (ERS) in all aspects of the business faculty or school, such as its governance, strategy, programs, or research activities. As the SD activities of the faculty were already recorded in a comprehensive way in the sustainability reports, this facilitated the EQUIS self-assessment reporting on ERS matters (see Weybrecht 2014). Moreover, as (other) accreditation organizations might further prioritize issues of sustainability, the organizations already reporting on such issues will have an advantage.

6 Conclusion

Sustainability reporting is increasingly perceived as a valuable tool to support the integration of sustainability into HEIs. Since only a limited number of HEIs are currently preparing and publishing sustainability reports, the availability of best practices and guidance on the topic is limited. Until today, the majority of research in the field of Education for Sustainable Development has also not focused specifically on studying the practice of sustainability reporting.

This chapter offers insights into a best practice from the perspective of one of the early adopters of sustainability reporting, an HEI pioneering in practicing and continuously improving the sustainability reporting process. The paper identifies a number of challenges (e.g., including material impacts, defining the report scope, engaging stakeholders) and advantages (e.g., showcasing sustainability activities, engaging internal actors in the sustainability integration process, using sustainability reporting as a learning tool for students) of the sustainability reporting process. The complex (and often decentralized) nature of universities can present specific challenges for sustainability reporting in HEIs. When this is coupled with the time and resource constraints identified in the case, one can begin to understand why there are less than 100 reporting HEIs worldwide. Nevertheless, there are major advantages to sustainability reporting for HEIs that can make the process worthwhile. The potential of sustainability reporting to evoke change and better management of sustainability-related topics (hence the old adage "what gets measured, gets managed") cannot be overstressed. As HEIs in their very nature (education, research, outreach) contribute to society, the sustainability reporting process can serve as a framework in which internal, as well as external, exchanges, learning, and communication can emerge. For business faculties in specific, engaging in the sustainability reporting process is especially meaningful as it can serve as a tool for the university's sustainability management to become a "living laboratory" where students can learn first-hand this essential practice.

As the GRI Sustainability Guidelines continue to evolve, the development of sector supplements for higher education needs to be prioritized (perhaps creating synergies with HEI-specific assessment tools such as AASHE's STARS). Accreditation bodies also need to continue to place higher value on issues related to sustainability, thus making evident the links between sustainability integration and quality of higher education. In doing so, sustainability reporting may become more essential and less of a "nice to do" for HEIs and business schools. As is also the case with non-HEI reporting organizations, attention needs to be paid to comparability of HEIs' reports to help HEIs benchmark their sustainability performance compared to comparable organizations.

The university presented in this chapter humbly acknowledges that the process has been, and still is, that of constant learning. As the pioneering HEIs evolve in their sustainability reporting (and exchange information), they will become more able to reflect on the reporting process and think critically about: how the report boundaries can be adapted in order to increase the impact of sustainability reporting, what they wish to garner from stakeholder engagement, and how published reports can be utilized (i.e., in education-accreditation processes, program visitations, environmental certifications, PRME reports, etc.). When more HEIs choose to report, the breadth of knowledge on reporting processes expands and the ability to learn from each other deepens. HEIs should take an active role in sharing their experiences with their peers, so that in the future, sustainability reporting can become a way for HEIs to help achieve their sustainability goals, in addition to communicating on past sustainability achievements.

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The Challenges of Implementing Sustainable Development Goals in Brazil: An Analysis Based on the Outcomes of the Brazilian Millennium Development Goals

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Abstract

This article discusses the importance and influence of the Millennium Development Goals (MDGs) within the Sustainable Development Goals (SDGs) in the Brazilian context, and makes a comparison of the converging aspects between them. The Brazilian performance regarding the MDGs is fundamental for identifying the challenges of the SDGs implementation in this country. The data presented is based on the Fifth National Monitoring Report of the Millennium Development Goals launched in 2014. These results show that Brazil has succeeded in some aspects. However, it has not reached some of MDGs' targets that had a fixed due date for 2015, such as achieving a universal primary education; promoting gender equality and empowering women; improving maternal health; combating HIV/AIDS, malaria, and other diseases;

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and ensuring environmental sustainability. Therefore, these goals are present in SDGs' targets, and are characterized as strategic challenges for Brazil in order to achieve the SDGs by 2030.

Keywords
Sustainable development goals · Millennium development goals · Sustainability · Brazil

1 Introduction

The concept of development has recently received a new multidisciplinary perception, encompassing a holistic view of the subject, based on different factors, those being economic, social, and political (Abreu 2008; Gadotti 2005; Mendes 2009). Within this discussion, the Millennium Development Goals (MDGs) arose in 2000, presenting 8 topics and 60 goals to be achieved in 15 years by the countries involved (UNDP 2014).

Brazil presented good results in most of the MDGs targets; however, the country still lacks in some mainly because these challenges have been restated in the framing of the new agenda for development proposed by the United Nations post Rio + 20. This agenda presents 17 goals and 169 targets, launched in early 2016 that have 15 years to be achieved (UN 2012).

This new UN agenda that gives continuity to the work on development and quality of life is based on the sustainability tripod (environmental, social and economic) (Foladori 2002; Kates et al. 2000). The environmental preservation still stands as a prerequisite for the proper functioning of the economy and for the promotion of social justice. Thus, it is necessary to maintain the three pillars of sustainability in harmony, both in national and international aspects (Finkbeiner et al. 2010).

The SDGs have as its conceptual basis the Brundtland report of the World Commission on Environment and Development. The report affirms that "Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future" (UN 1987 p. 39).

In this perspective, it is understood that there is intergenerational equity through the prism of sustainability, meaning that each generation should have the same well-being, or equal opportunities as the other (Diniz and Bermann 2012), and so, it was established that the purpose of the SDGs is to ensure this.

Due to the importance of meeting these new goals, this study aims to find the challenges Brazil faced whilst attempting to the 2015 agenda, compares their targets and indicators with the new UN agenda, and outlines the major challenges that Brazil will face for the Sustainable Development Goals implementation in the future.

1.1 Millennium Development Goals

In 1990, the UN created the Millennium Declaration (Körbes 2011), a document for the 'new' century that was divided into 8 goals and was implemented in 2000 (UN 2000a).

The first goal intended to eradicate extreme poverty and hunger. As Koffi Annan said (2000, p. 19), "Extreme poverty is an affront to humanity. It also makes many other problems worse." as hunger and malnutrition seriously undermine the dignity of humankind and the human capacity (Sen 2000).

The purpose of the second MDG was to achieve a universal primary education whilst analyzing the challenges for the future. The goal is to ensure basic quality education for all, thus safeguarding that all children regardless of color, gender, and social class can finish elementary school.

The third goal seeks to guarantee rights and equality between genders. The Millennium Declaration promises "to promote gender equality and the empowerment of women as effective ways to combat poverty, hunger, and disease and to stimulate development that is truly sustainable" (UN 2000b).

The aim to reduce infant mortality is in the fourth MDG. Care for maternal health is one of the mechanisms found to reduce infant mortality rates; consequently, the fifth MDG is to improve maternal health.

Santa (2013) informative report entitled "Eight ways to change the world"[1]states that AIDS, malaria, leprosy, tuberculosis, and other diseases are considered to be neglected diseases in many countries, regarding financial investments, the development of prevention, and control strategies. Therefore, the United Nations placed these central diseases as its sixth goal.

The seventh goal aims to put an end to unsustainable exploitation of resources by increasing cooperation and reducing the number of man-made natural disasters (UN 2000a). The eighth and last MDG establishes the idea of creating a global partnership for development. It aims to promote the benefits of new technologies, especially information and communication technologies, in cooperation with the private sector (UN 2000a).

1.2 Sustainable Development Goals

The Sustainable Development Goals were developed based on the Millennium Development Goals proposal and on the recurrent need for sustainability (Yumkella and Yillia 2015), and thus the States established an agenda to be held from 2015 to 2030. For this reason, 169 new targets have been incorporated in 17 goals (UN 2015), which include the economic, social, environmental, and governance sectors (Waage et al. 2015; UNSDSN 2013).

The first goal "End poverty in all its forms everywhere" (UN 2015) brings forth targets for the making of public policies, ensuring that the poorest people are less

[1]Translated by the authors.

vulnerable to climate impacts (Osborn et al. 2015), as rural smallholder farmers, who are exposed to external shocks and scarcity of resources (Bohle et al. 1994).

"End hunger, achieve food security and improved nutrition and promote sustainable agriculture" is the second goal, which underscores the need to encourage small farmers, especially women (UNDESA 2016a).

The third goal aims to "ensure a healthy life and promote well-being for all and at all ages" (UN 2015), this links directly to the MDGs focused on health and updates its goals to the need of combating the Non-Communicable Diseases (Brende and Høie 2015).

The concept of education developed from the need to achieve primary education in the existing MDGs (Sachs and McArthur 2005), to the need to achieve education for life. Hence, settling the fourth goal "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UN 2015).

The fifth goal aims to "achieve gender equality and empower all women and girls" (UN 2015), with targets that not only involve the social aspect but also raises concerns about economic and leadership issues.

The next goal "Ensure availability and sustainable management of water and sanitation for all" relies on the integration of developed and developing countries, which is the best way to ensure efficient water distribution according to UNDESA (2016b).

The seventh goal is to "Ensure access to affordable, reliable, sustainable and modern energy for all" and its targets revolve around increasing energy production from renewable sources (UN 2015).

Some economic aspects are found in the eighth, ninth, and twelfth goals. The first mentioned aims to "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all," with targets aimed at the reduction of unemployment rates. The ninth "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" is focused on small businesses. The twelfth, "Ensure sustainable consumption and production patterns," encourages producers to keep their productions (environmentally) clean and waste-free (UN 2015).

The tenth goal "reduce inequality within and among countries" (UN 2015) deals with migration concerns, aiming to make the process safe and regular (UNDESA 2016c). The eleventh goal aims to "make cities and human settlements inclusive, safe, resilient and sustainable."

The SDGs highlight the importance of the United Nations Framework Convention on Climate Change in its thirteenth goal, stating that there must be taken urgent actions to combat climate change and its impacts.

The environment is also emphasized in the fourteenth and fifteenth goals. The first being to "conserve and sustainably use the oceans, seas and marine resources for sustainable development" and the second to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss," which aim to prevent desertification and conserve ecosystems (UN 2015).

The sixteenth goal is "promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels" (UN 2015), aiming to build States where violence and corruption are reduced.

In addition, in order for all these goals to be achieved, the proposals in which the SDGs are based on are pointed out in its seventeenth goal, which is the need to "strengthen the means of implementation and revitalize a global partnership for sustainable development" (UN 2015).

2 The Major Brazilian Challenges in the Achievement of the Millennium Development Goals

This topic analyzes the major Brazilian challenges on the execution of the Millennium Development Goals presented on the Fifth National Monitoring Report of the Millennium Development Goals (IPEA 2014), evaluating the country's achievements and deficiencies according to the MDGs targets and indicators.

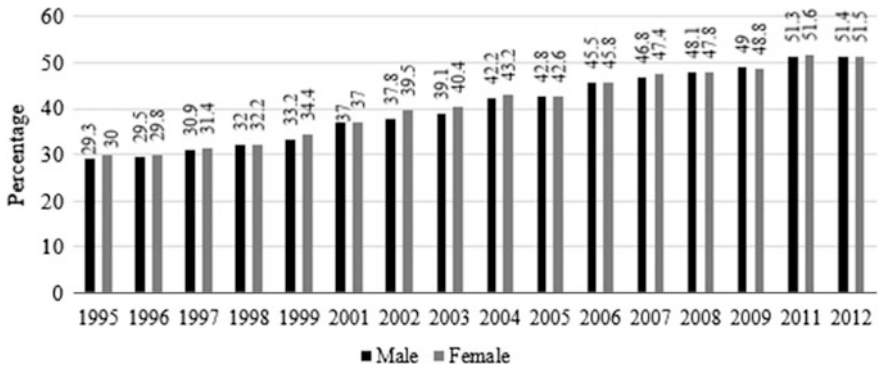
2.1 Brazilian Challenges in the Second MDG

According to the National Monitoring Report on the MDGs (IPEA 2014), the United Nations considers that Brazil has not reached the second MDG, which has only one target (target A): "ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling." Even though there were changes throughout the years, they were not enough to put the country on the proposed position.

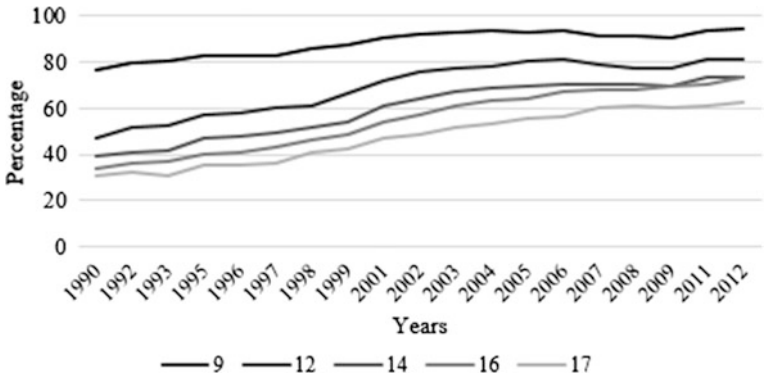
As shown in Graph 1, there was an increase of about 20% in the number of 0–6-year-old children that were properly enrolled in educational institutions in Brazil. However, the result is not satisfactory since the total number of people enrolled reached only 51.4%, what was expected to be higher in Brazil.

The second indicator of the target A of MDG 2, selected to be presented, since Brazil did not reach it entirely, informs the adequacy ratio of children in the proper or correct school grade, meaning that the child is studying according to his age group. In 1990, only half of the students between the ages of 9 and 17 were attending the appropriate grades in schools. In 2012, this number reached four-fifths (IPEA 2014). In Graph 2, it can be seen that, as students get older, the less they are able to keep up with their proper grades. This demonstrates failure concerning quality and a huge rate of truancy.

The UNDP (2016a) suggests that policies to minimize racial differences in education, such as quota systems, resulted in the growth of university vacancies for black people from 30,000 to 60,000. According to Graph 3, the number of black people in higher education institutions was 10.1 in 2012.



Graph 1 Enrollment rate of the population 0–6 years, comparing male and female (in %) *Source* Elaborated by the authors, based on the Institute of Applied Economic Research (IPEA) (2014) (The years of 2000 and 2010 have no data to present)

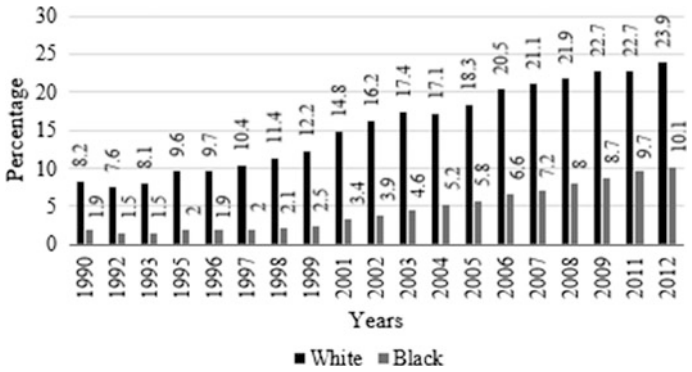


Graph 2 Age adequacy rate for frequented grades of students 9–17 years (in %) *Source* Elaborated by the authors, based on the Institute of Applied Economic Research (IPEA) (2014) (The years of 1991, 1994, 2000, and 2010 have no data to present)

Despite the increase in the number of black people studying, it is still insufficient since it is noted that the racial disparity grew from 6.3 in 1990 to 13.8% points in 2012. Brazil's ineffectiveness in achieving these indicators portrays the difficulties the government has when applying policies that indeed work, while trying to improve the current condition of education.

2.2 Brazilian Challenges in the Third MDG

The third goal aims to promote gender equality and empower women: it has only one target and three indicators (IPEA 2014). Although Brazil has a balanced participation of both genders in education, the participation of women in the



Graph 3 Net Enrollment rate in higher education of the population from 18 to 24 years among black and white (in %) *Source* Elaborated by the authors, based on the Institute of Applied Economic Research (IPEA) (2014) (The years of 1991, 1994, 2000, and 2010 have no data to present)

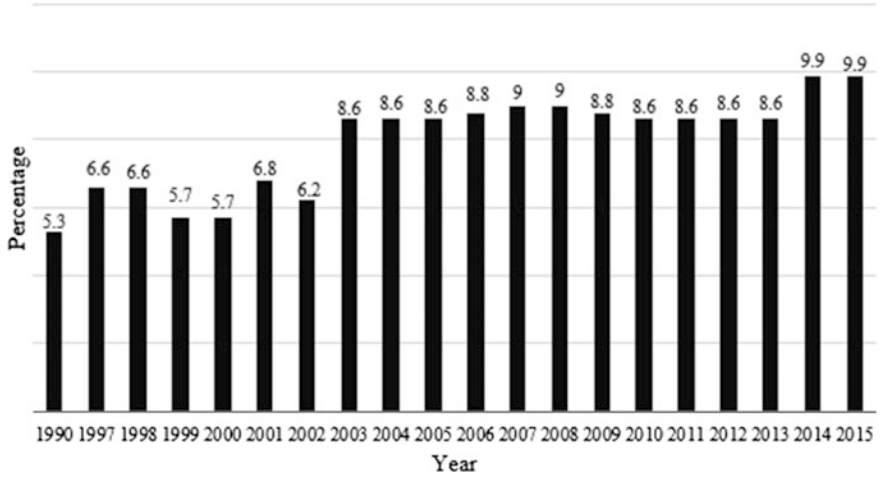
decision-making sphere remains small. The global average is around 20% and, although Brazil has increased the number of federal deputies and senators elected since 1994, the percentage of women in the House and Senate remains below the global average. In the House of Representatives, women's participation does not exceed 9%, and in the Senate the situation is quite similar: since the 2002 elections, women account for 14.8% of the elected senators (UN 2013).

The presented data in Graph 4 considers the number of women elected to the House of Representatives and Senate. Over a term, this indicator can change both the output of women elected as the replacement of male parliamentarians by alternate females (IPEA 2014).

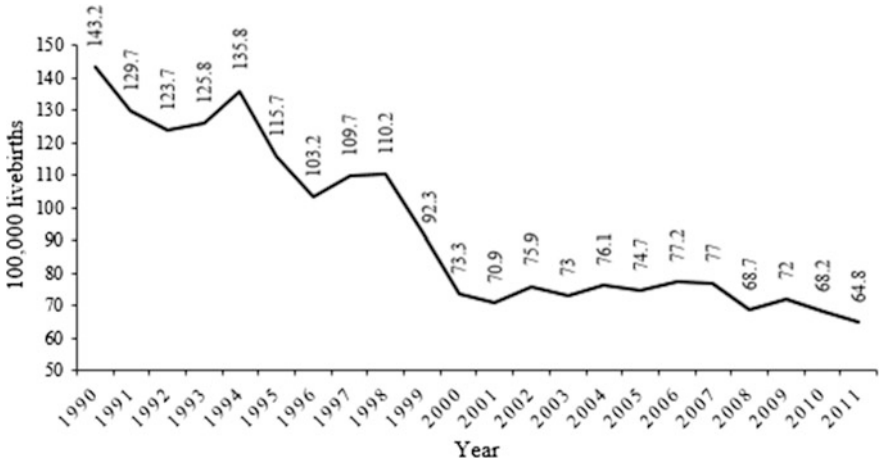
2.3 Brazilian Challenges in the Fifth MDG

The fifth Millennium Development Goal has two universal targets and a third one directed at Brazil (IPEA 2014). The target to reduce maternal mortality by three-quarters of the levels seen in the 1990s having two indicators: the main one is the maternal mortality rate. Despite it being reduced from 143 deaths to 64.8 for every 100,000 births between the years 1990 and 2011, it has not reached the target set, which is 35 deaths per 100,000 births, as demonstrated in Graph 5. The high number of C-sections is one of the factors that make it difficult to reduce maternal mortality rates in the country (IPEA 2014).

Target C aimed at reverse the growth trend in mortality from breast cancer and cervical cancer index. Cervical cancer mortality index remained almost the same



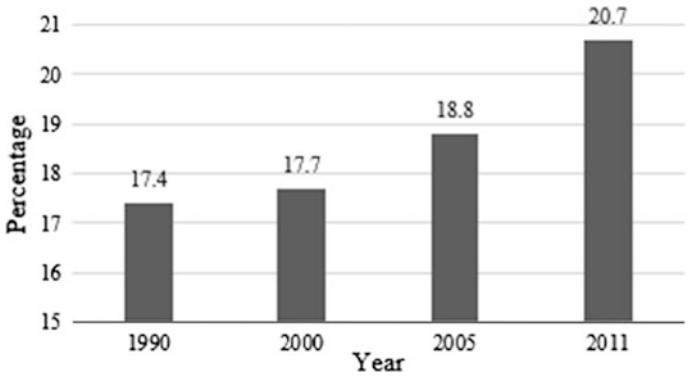
Graph 4 Proportion of seats held by women in national parliament *Source* Elaborated by the authors, based on the World Bank online database (2016) (The years of 1991, 1994, 2000, and 2010 have no data to present)



Graph 5 Maternal Mortality Rate (per 100,000 live births) *Source* Elaborated by the authors, based on MSB (2012a, b)

throughout the years, while the mortality rate from breast increased, where results can be seen in Graph 6 (IPEA 2014).

The data presented demonstrates that, although Brazil advanced or even made progress in almost all of the goals indexes, it was not able to reach them entirely.



Graph 6 Mortality from breast cancer (in %) *Source* Elaborated by the authors, based on the Institute of Applied Economic Research (IPEA) (2014)

2.4 Brazilian Challenges in the Sixth MDG

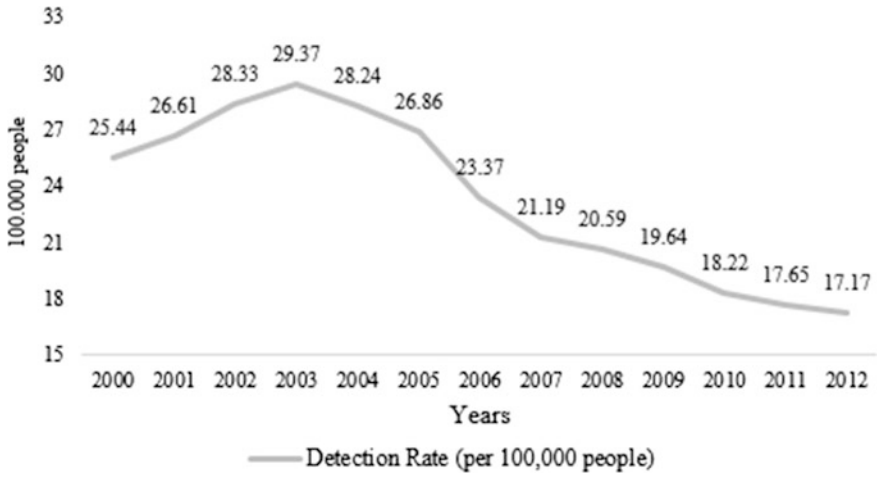
As for Goal 6, in reference to target C, Brazil has failed to achieve the target of eliminating leprosy as a public health problem, a target set by the country, which implies less than one case per 10,000 inhabitants. The cure percentage in leprosy cohorts presented in Graph 7 demonstrates the capacity to treat and cure diagnosed cases (IPEA 2014).

The Dengue fever is progressively gaining attention from the Brazilian government, due to its increasing incidences over the years (Brazil 2016). In 2014, 589,107 cases of dengue fever were confirmed (MSB 2016f), of which 475 were considered serious cases that resulted in deaths (MSB 2016g), and in addition to the dengue fever, the mosquito *Aedes aegypti* that transmits the chikungunya and Zika virus has also been in the spotlight (Luz et al. 2015).

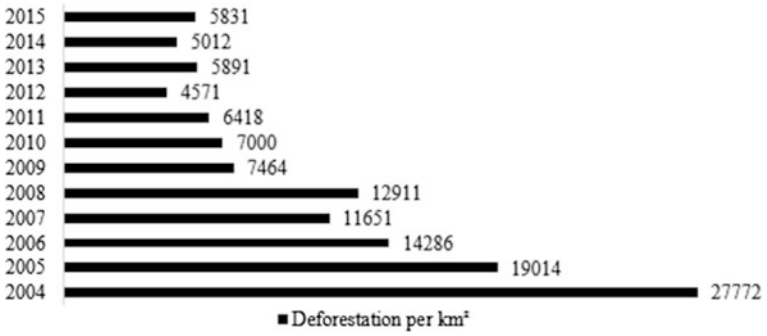
2.5 Brazilian Challenges in the Seventh MDG

The aim of the seventh goal is to ensure sustainability. Updated data from the Brazilian Amazon rain forest was taken by PRODES (Satellite Monitoring of the Brazilian Amazonian forest) (Brazil 2014) showing that, although the number has greatly improved since 2004, there has been an increase in the deforestation rates in recent years, as described in Graph 8. It demonstrates the need to resume the care of this goal, mainly in targets A and B, which were intended to reduce the loss of environmental resources.

The second indicator of the targets A and B of Goal 7 aimed to reduce the emission of gases that are harmful to the environment. Although Brazil has reduced its level as a whole, the energy and agriculture sectors had an increase in their levels of greenhouse gas emissions as shown in the comparison between Graphs 9 and 10.



Graph 7 Leprosy in Brazil *Source* Elaborated by the authors, based on the Institute of Applied Economic Research (IPEA) (2014)

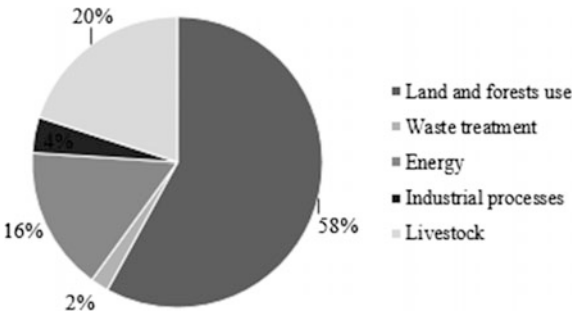


Graph 8 Deforestation per km^2 in Amazônia Legal from 2004 to 2015 *Source* Elaborated by the authors, based on Brazil (2014)

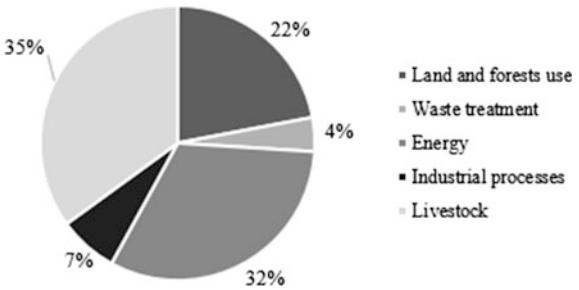
In the energy sector, it was mainly due to the use of fossil fuels and the reduced use of renewable sources (IPEA 2014).

Target C aimed to halve the population without access to clean water and sanitation, which was achieved by the Brazilian Government. However, by separating the values between the rich and the poor, the rural and the urban, a big difference can be seen in the distribution of those who have and those who do not have gained access to clean water and sanitation, as shown in Graph 11.

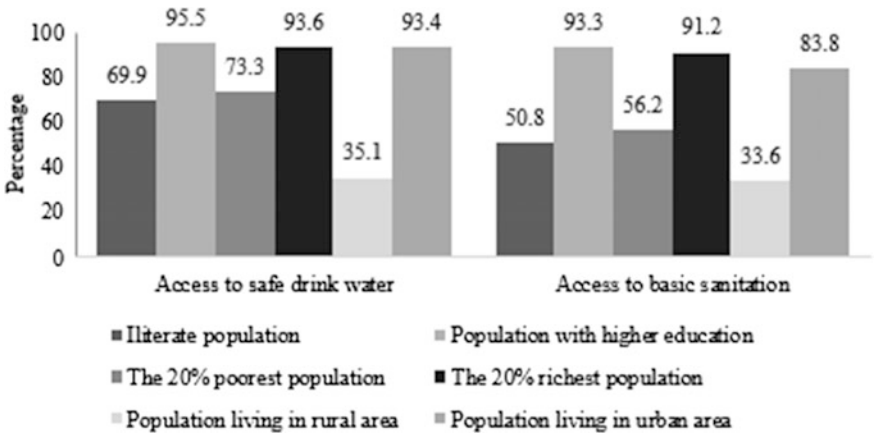
The last target of this goal is, for the country, to present a significant improvement in the lives of at least 100 million slum dwellers. Such conditions have been reduced by almost 17% in Brazil, in the last 20 years, but the population



Graph 9 Greenhouse gas emitters contribution in 2005 (in %) *Source* Elaborated by the authors, based on the Institute of Applied Economic Research (IPEA) (2014)



Graph 10 Greenhouse gas emitters contribution in 2010 (in %) *Source* Elaborated by the authors, based on the Institute of Applied Economic Research (IPEA) (2014)



Graph 11 Access to safe drinking water and basic sanitation in 2012 divided by population group (in %) *Source* Elaborated by the authors, based on the Institute of Applied Economic Research (IPEA) (2014)

distribution with inadequate conditions remains uneven, whom mostly live in the North and Central West regions of the country (IPEA 2014).

3 Brazilian Challenges in the Sustainable Development Goals

This topic compares the Millennium Development Goals targets and indicators with the new UN agenda, and outlines the major challenges that Brazil will face implementing the Sustainable Development Goals.

3.1 Challenges in Achieving Universal Education in the SDGs Context

MDG 2, which, according to IPEA (2014), ensures that children finish primary education, and is also found in the new agenda through SDGs: 4.1: "ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes"; 4.2 "ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education", and 4.7: "ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development" that expands the scope from basic education to other areas of education (UN 2012).

Some areas that received little attention in the former agenda were reinterpreted. Under the sustainability scope proposed by the UN (2012), the school environment and the teachers are valued and understood as dissemination tools of global sustainability.

According to IPEA (2014), the disparity between men and women who manage to complete their studies in the correct year, or, the adequacy rate, tends to get worse as students get older, due to recurrent episodes of absences and those who are held back grades. The failure of the MDGs continues with the percentage of young people who failed to complete primary education, which fell from 41.1 to 16%. It represents two-fifths of the figure shown in the 1990s (IPEA 2014). Moreover, it is safe to say that the country needs to raise its public education level.

Although being successful in some indicators, the failures in this MDG determine the challenges for the implementation of the agenda post-2015 and can be used as a strong incentive to achieve full success in the SDG 4 enforcement, concerning the quality of education in Brazil.

3.2 Challenges in Achieving Gender Equality in the SDGs Context

The third MDG has only one target: to combat gender and education inequality. In this way, it reverberates in seven SDGs targets. As can be seen in Fig. 1, those targets are 4.5, 5.1, 5.5, 5.c, 8.5, 10.2, and 10.4.

Although the proportion of Brazilian women with academic degrees in higher education is greater than those of men, the percentage of the adult female population with diplomas is 12%, in comparison to 10% of men. This statistic suffers a reversal role in the labor market. When analyzing people who work in higher level positions, 91% are men and 81% are women (OECD 2012).

Regarding the female participation in the political sphere, one of the government's actions to reverse this inequality was to launch the campaign "Equality in Politics" (Igualdade na Política) aiming to encourage the increase of female participation in the national parliament, which was released on March 31, 2016 (TSE 2016). With this, it shows that Brazil has challenged or attempted to change the scenario of gender inequality.

3.3 Challenges in Achieving Maternal Health in the SDGs Context

The fifth MDG is connected to the third SDG by the target 3.1 that brings forth concerns about reducing global maternal mortality, and in target 3.7, the access to sexual and reproductive health services (UN 2015). In addition, the fifth SDG, target 5.6, corresponds to gender equality, which also states the need for universal access to sexual health (UN 2015).

There is also the need for better income distribution and extended education optimization in all regions. There is a clear rate of maternal deaths in Brazil occurring within the black population, women with low income, young women,

Target 3.A: Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015	4.5 By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities,
	5.1 End all forms of discrimination against all women and girls everywhere;
	5.5 Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life;
	5.c Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels;
	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal
	10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status;
	10.4 Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality.

Fig. 1 *Source* Elaborated by the authors, based on the United Nations (2012)

domestic workers, residents of northeastern Brazil, and with incomplete elementary schooling (Oliveira and Ribeiro 2015; Martins 2006).

Another challenge facing pregnant women in Brazil as a whole is the relation between the Zika virus, microcephaly and malformation of babies, confirmed by the MSB (Brazilian Ministry of Health) (2015), which can be transmitted sexually (MSB 2016a).

From October 2015 to May 2016, there were 1326 confirmed cases of microcephaly, suggestive of congenital infection; according to the MSB (2016b), 1190 of these cases were confirmed in the Brazilian northeast region, mainly affecting poor women (Diniz 2016).

Some policies have been implemented to meet these challenges like the deployment of a high-risk maternity in Recife (MSB 2016c), free distribution of vaccines to all pregnant women (MSB 2016d), and the creation of the Integral Health Assistance Program for Women, based on Brazil's Unified Health System (MSB 2004), the State Committees and Maternal Mortality, and the National Council of Women's Rights (Reis et al. 2011).

3.4 Challenges in Combating Diseases in the SDGs Context

MDG 6 is associated with the SDG 3, in the targets 3.3 "end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases," and 3.8 "achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all" (UN 2015). With Brazil's poor performance in the MDG 6, target C, which deals with communicable diseases, these new UN agenda goals demonstrate the continuing challenges faced by the Brazilian government to improve health care as a whole.

Despite reaching the proposed targets related to AIDS, it is necessary to take action on issues such as disparities in the incidence in men and women, reduction trend detection rate by region, and mortality in the country (IPEA 2014).

The target concerning the elimination of leprosy as a public health problem was the farthest from being achieved; it implies having less than one case per 10,000 inhabitants, and the current number is 1717 (IPEA 2014). A letter addressed to the Journal "Atención Primaria", from Spain, shows a case where a patient acquired leprosy in Brazil and the disease was manifested only years later when she was in Spain (Muruzábal et al. 2016). This reinforces the need to end the disease because it demonstrates the ease in which it can move from one country to another.

Currently, the Zika virus is a health concern in Brazil, not only for microcephaly cases, but also because the spread represents

> … an additional challenge for public health systems, particularly because of the risk for concurrent transmission of DENV and CHIKV by the same vectors, Ae. aegypti and Ae. albopictus mosquitoes, which are abundant throughout tropical and subtropical regions (Cardoso et al. 2015, p. 2276).

According to the MSB (2016e) from January 4 to April 25, there had been recorded 1054,127 probable dengue fever cases, being 262,148 of which discarded, totalizing 791,979 probable cases, with 3966 confirmed cases. There were 64,349 possible cases of chikungunya fever, while 11,182 were confirmed and 120,161 probable cases of fever by the Zika virus, of which 39,993 were confirmed. These figures demonstrate the urgency of taking measures for the treatment and prevention of these diseases.

3.5 Challenges in Achieving Sustainability in the SDGs Context

It is possible to outline some points of the seventh MDG in some of the SDGs, for instance, the sixth and the fifteenth, which seek to ensure access to water and sanitation for all and protect terrestrial ecosystems (UN 2015).

Future scenarios of deforestation rates for 2030 show the country's possibilities of failure in achieving some targets of the fifteenth goal, which distinguish the importance of combating desertification, forest conservation, and detention of deforestation (UNDP 2016b).

Given that statistics foresee that by 2030, 33% of the Amazon rain forest will be deforested, in an optimistic scenario, assuming that levels could reach up to 22% of deforested area (Costa and Pires 2010). Moreover, Brazil will still have to face more extensive challenges with fragmented forest areas and changes that will affect the Brazilian Amazon caused by Brazilian development plans and future land-use trends (Laurance et al. 2001).

Brazil must be especially cautious with the preservation of mature forest and combating degradation by pasture planting, since this scenario will affect rivers negatively due to the forested area reductions (Ferraz et al. 2005), impacting the water quality (Allan et al. 1997).

Within the MDGs, access to water and sanitation is concentrated on the richest and most educated portion of the population in the country (IPEA 2014). This fact cannot reverberate on the SDGs, which aims in the sixth goal to ensure availability and sustainable management of water and sanitation for all (UNDP 2016b).

4 Conclusion

Despite the positive results in the MDGs implementation, the failures that Brazil presents become clear when analyzing the results of each goal individually. Education, gender equality, health, and the environmental areas have not achieved the expected results. Therefore, demonstrating that these matters need greater government attention, mainly in the distribution of resources and vulnerabilities among Brazilian regions, as shown in the paper, there are still many inequalities in achieving the goals in different regions of the country. It is expected that this study

will contribute to drawing the attention of policymakers on these subjects, considering that it brought to light a deeper analysis of the not succeeded goals, explaining in depth which policies and practices were failures and which need reinforcement.

The SDGs represent a new opportunity for the country to develop more, particularly in sectors that were overlooked in the previous agenda. The challenges for the implementation of SDGs go beyond those presented in this article, especially regarding sustainability that is the focus of the 2030 agenda. Nevertheless, Brazil has gained experience with the failures noted in this paper and so, this presents an opportunity for a better performance in implementing the new agenda. In summary, this article objective and discussed the importance and influence of the MDGs within the Sustainable Development Goals in the Brazilian context and concluded that the score of those targets represents a challenge for the country.

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Corporate Policies on Rights and Engagement of Communities: Alternatives and Advances

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Abstract

The commitment to implement the goals for sustainable development places the Sustainable Development Goals implementation challenges at the center of debate since 2015. In this context, companies need to maintain and/or expand their operations in the market seeking to adapt their management practices to meet the new emerging realities. Sustainability is a recent theme in global debates, leading new definitions and redefinitions of corporate policies. Corporate policies gain particular importance in promoting the relationship engaging communities that may be affected in some way by its daily activities. This notion of inclusion deals with the need of rethinking the production's systems operation that requires reducing environmental exploitation and friendly relationship with communities, as well as keep it as operation economically sustainable. Through exploratory research, it sought to make a conceptual study of the advances and alternatives of the relationship between corporate policies

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and engagement of communities in decision-making processes, with aim of stimulating society's debate and interest by this theme that begins to gain visibility within construction's prospects of the understanding about sustainability. The terms of Free, Prior, and Informed Consent represented a tool that closes an advanced stage of community relations to the extent that human rights are fully respected, considering the minimization of conflict and environmental disasters.

Keywords
Corporate policies · Engagement · Sustainability · FPIC

1 Introduction

In the corporate world, the necessity of debates over themes that become relevant to the continuation of life on our planet becomes crucial in promoting the collaborative understanding through the search for alternatives that encourage sustainability, for future generations and also for the current one.

The profile of the consumer market has been changing due to the aggravation of the scarcity of resources and the need for the preservation of all types of life, so society itself may continue to exist. In this context, companies need to keep and/or expand their presence in the market and, thus, try to adapt their management practices to overcome the challenges of new emergent realities.

Sustainability is a recent issue in national and international debates, what is present in the reflections on the definitions and redefinitions of postures and policies of the organizations, many of them being transnational ones, as well. The relationship between sustainability and what is proposed by the Universal Declaration of Human Rights (UN 1947) might be the representation of a natural evolution for deepening this debate.

Advancing toward the fulfillment of the Sustainable Development Goals (SDGs), which represents the sequence to the actions initiated through the launch, follow up, and evaluation of the Millennium Development Goals (MDGs), proposes opting for actions that involve actions related to the sustainability approach to different areas of knowledge. Therefore, the organizations have been trying more and more to adequate and acquire tools that support their activities according to the scope of what is understood as sustainable development, by practicing social responsibility in consonance with what is proposed by diverse universal declarations, among them the Universal Declaration of Human Rights.

Then corporate policies gain space and particular importance in the promotion and encouragement of the relationship with the engagement of communities that, somehow, may be affected by their everyday routine.

In search of reaching the concepts of sustainability in the most overarching way possible, companies find themselves facing this challenge of sharing, communicating, and interacting when making decisions on their performances that, to respond to the current aspirations of society, must try to be the most sustainable decisions within their prospective activities.

Free, Prior, and Informed Consent (FPIC) appears as an alternative tool to effect the interaction and integration between corporate policies and the engagement of communities in the decision-making process.

Construction of knowledge about sustainability presupposes incentives to issues debate that appear and this study seeks understanding of relationship between corporate policies and community engagement as alternative to advances in the application of sustainable principles in the practices and relations of organizations with their environment.

2 Corporate Policies on Rights

The organizations, while trying to act in a way that responds to the desires and needs of their internal constitution and pleases their clients (external consumers), must try to structure themselves based on the guiding principles that will establish the profile of this organization and the way it will answer to the milieu or interested parties (stakeholders).

This structure is established through the definition of the policies that will be adopted by all the organization. According to Umeda and Trindade (2004) *the policy is created through three fields of influence: the external environment, the evaluation of the current operations, and management values*.

Corporate policies show the environment and/or society how the organization intends to act in the market and how it handles the main questions related to its actions. These are ground rules that direct the work and relationship of the company with its interested parties; they are guidelines for the orientation of the organization.

Defining the policy is making explicit a set of rules or regulations of a certain organization, which commits itself to guiding the decisions and actions through these rules (Bethlem 1981; Spies and Paula 2015).

The policy is situated between the objectives of the organization—which are at the top of the hierarchical pyramid of concepts—and the operational procedures and practices—which compose the basis of this design of the structure of the organizations (Umeda and Trindade 2004).

Modernity brings in its essence new norms of capitalism in its intensive global form, which generates a greater extent of responsibility in the actions performed by the companies in relation to their enclosing environment, associated to the need to frequently respect and practice international norms as the United Nations Universal Declaration of Human Rights, considering the higher transnationality index of the corporations and the particularities of each region of the world.

The challenge is to operationalize the relationship between Corporate Social Responsibility (CSR) and human rights (Mathis and Mathis 2012), because the international standards for the promotion and guarantee of human rights in the current organizational practices cannot be disconsidered.

The aims of the organizations that corroborate the CSR practices are presented through the sustainability reports in which the projects and social programs are recorded, besides other documents that confirm the involvement of the company with projects, programs, the public power, or non-governmental organizations (NGOs) (Mathis and Mathis 2012).

According to the authors, these practices represent a:

> Process of capital restructuring defined by the introduction of new technologies, new market demands, changes in the consumption habits, new ways of work recruitment and workforce management that extrapolate the production sphere per se and expand into all social relations (Mathis and Mathis 2012).

The debate on the relationship between CSR and the need to consider the human rights in the activities of the organizations has been increasing more and more and brings reflection on the effective participation of the State as defender of the rights that are universal and of the role of the companies in considering these rights when implementing their activities.

Promoting sustainability involves the development of the dialogue between government, companies, and societies (Spies and Paula 2015; Umeda and Trindade 2004) in search of relationship-building and the empowerment of communities in the decision-making process, considering the impacts of the implementation of organizations on the direct exploitation of the land and on the extraction of natural resources.

3 Sustainability

The organizations, entities that mainly fulfill the demands imposed by their target market, most of the time show little concern for their production practices that may cause impacts beyond their own organization. Those practices that directly impact the image of the company before legislation or market agents are examples of elements that permeate such concerns (Pacheco Júnior et al. 2011; Veiga 2005).

The questions about sustainability that propagate from the concept of sustainable development, first coined in the Brundtland Report (Veiga 2005), become evident from the questioning about the ways the organizations act, beyond their technical and economic capacities, in the middle of the twentieth century.

According to Veiga (2005), the concepts unfold into wider adjectives:

> Sustainability in the time of human civilizations will depend on its capacity to submit to the precepts for ecological prudence to make good use of nature. That is why we talk about sustainable development. Strictly speaking, the adjectivization should be unfolded in

> socially inclusive, environmentally sustainable and economically sustained in time (Veiga 2005).

This inclusive, sustainable, and sustained conception deals with the need to rethink the operation of the productive systems that may impose less degeneration on the environment and the populations, even considering the sustainable economic strategies that these systems have as business operation policy.

It is expected a new model from the companies that try to develop capacities, abilities, and resources to work in a more dynamic and complex approach, centered on the person and on the detriment of the still valid, mechanical, simple, and linear approach (Araújo et al. 2012; Rodrigues and Costa 2012).

According to Pacheco Júnior et al. (2011), the performance of the organization transcends the architecture of the productive system articulated with the marketing strategies, going beyond the transference of responsibilities in search of reaching the effectiveness of the company.

From these reflections, it is possible to identify the organizations as participants in the debates over the dilemma between environmental conservation and economic growth and their relationships with social development.

It is still difficult to foresee how the sustainability issues will be solved, because the contradiction between the imperative of economic growth and the finitude of the planet's resources is associated with connections between human phenomena and ecological phenomena. And in this relationship the systems adapt themselves and are complex, because they are alive (Rodrigues and Costa 2012; Veiga 2005), which does not make the design and composition of the scenarios that point to possible alternatives for solutions something unfeasible.

The restructuring in ways to identify, follow, and evaluate the impacts that the economic development of the companies generates, such as *aggravations of physical, physiological, emotional, psychic, and economic nature toward workers*, as estates Pacheco Júnior et al. (2011), needs to experience a change of paradigm, which involves the understanding of the concept of sustainability in all levels, be it be local or global.

Some authors (Araújo et al. 2012; Rodrigues and Costa 2012; Veiga 2005) understand the search for solutions cannot stop, the alternatives have infinite possibilities. The creation of indicators to measure the characteristics of the system may be an alternative to dazzle perspectives on performance from the ample concept of sustainability.

The organizations are a constituent and important part of these discussions; however,

> In relation to the organizations, the discussion cannot be only limited to the dimensions efficiency, efficacy and effectiveness, on the verge of incurring all types of frustrations. It may happen because there is the elementary need to understand the conditions that create the indicators (Pacheco Júnior et al. 2011).

The role of the organization as a global being with influence and participation in the productive systems is essential in the debate over sustainability, mainly when we plunge into the questions related to socially inclusive issues, considering the ample scope of the understanding of the theme.

At this point, the communities begin to stand out and the integration work comes from the perception of the organizations that there is the need to build collaborative policies which promote the engagement of these communities in the decision-making processes that may impact the environs of their operations, short and medium distance.

4 Engagement of Communities

Developing relationships among/with interested parties, with the intention of gaining competitive advantages, may be understood as engagement of the stakeholders.

> The statement of purpose or the strategy to gain competitive advantages through the development of intrinsic relationships with a great diversity of internal and external participants, or interested parties, is commonly called engagement of stakeholders (interested parties) (Boszczowski 2010).

Engagement is also understood as all the activities the organization develops aiming to establish and potentiate the relationships with the interested parties, trying to involve them in their activities and decisions.

The concern about the engagement of the interested parties is translated into the establishment of collaborative relationships from initiatives of the company, which develops strategic competence to execute its sustainable strategies (Boszczowski 2010; Crisóstomo 2006).

The development that is performed from this concept establishes that competence is related to elements such as the protection of the environment and the people, organizational learning and social legitimacy; it means, the company develops the coordination of assets like knowledge, interaction, and action as a source of competitive advantage.

The conception and execution of strategies to achieve resources, sources of competitive advantages, is a basic premise of the need to coordinate this engagement process.

The process has its degree of complexity and permeates through the public sphere as a fomenter of new practices and conduct of the company, mainly in the issues that involve land and the extraction of natural resources.

Considering the interested parties in the project minimizes risks and conflicts that the implementation of the activities of the company in a determined place may generate.

Establishing relationships based on dialogue and understanding corroborates the principles of sustainable development, besides promoting the empowerment of community in the decision-making process.

The great challenge is to identify, during the establishment of corporate policies, the concern about the preservation of rights and the public statements of community engagement, which work as elements of the promotion of corporate responsibility.

5 Free, Prior, and Informed Consent (FPIC): An Alternative

Being founded by the constantly growing demand, the extractive industry has been advancing more and more toward the most remote areas of the planet. This advance causes negative impacts on the environment and, consequently, on the local communities.

This way, Free, Prior, and Informed Consent (FPIC) becomes an important tool to preserve the rights of these communities. The principle of this tool is to inform the indigenous peoples far in advance and assure their right to decide on the projects that may affect their lands. The basic premise of FPIC is that the agreement may be reached without any kind of coercion or manipulation of the involved communities. This process must be continuous.

It represents a process that prioritizes the good actions associated with sustainable development, which implies that the interested parties will be heard, envisioning, with such actions, the minimization of conflicts, and the legitimation of projects (Report 2015).

There are, however, innumerable barriers, whether they be political, ideological, or even economic, that stem the achievement of a more transparent process. The benefits for both involved parties are huge. By adopting FPIC the companies respect the rights of the communities and somehow, diminish their costs when they minimize the risk of conflicts. It is a two-way street in the legitimation process.

During the last years, the extractive companies have been losing large amounts of money due to the social conflicts generated by the advance of their projects, without mentioning reputation and image damage.

Diverse documents, such as the International Labour Organization (ILO) Convention 169, the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), the International Covenant on Civil and Political Rights, the International Covenant on Economic, Social and Cultural Rights, the International Convention on the Elimination of All Forms of Racial Discrimination, among others, have been adopted as a demand for FPIC.

Unfortunately, this practice is not incorporated in the legislation of the majority of the countries and the companies still see it as an additional cost.

However, there have been advancements. The Philippines and the Northern Territory of Australia have legislations that provide protection for their traditional communities, demanding that the projects have the approval of these communities. In the Indigenous Peoples' Rights Act of 1997 in the Philippines, and in Australia,

the Aboriginal Land Rights (Northern Territory) Act of 1976, their implementation is a challenge, though.

Another exception is Latin America, where the majority of the countries have ratified the ILO Convention 169.[1] The acquisition of FPIC is a good business option for the companies that have the chance to minimize the risk of human rights violations.

6 Methodology

The methodological process aims to provide robustness for a scientific research and, in order for it to happen, it is convenient that the process that supports and structures the research on the issue that is supposed to be observable be chosen carefully.

Thus, the present study conducted exploratory research, which, according to Oliveira (2005), is a type of research that *conducts studies that offer a global vision of the fact or phenomenon to be studied*. The study aimed to use bibliographic and documental research to collect data, considering it to be an adequate method to make the observations that are pertinent to this research, which is inserted into the universe of the qualitative methodology of scientific research.

This study is characterized as a theoretical and conceptual work on a specific theme (Zago and Retour 2013; Oliveira 2005), that presents a systematization of bibliographic research through critical analysis.

The collection of data related to the investigation was conducted based on the bibliographic survey and on the analysis of the document 207 Oxfam Briefing Paper, July 23, 2005 that *examines publicly available policies regarding community rights and community engagement of 38 oil, gas, and mining companies* (Report 2015).

The Briefing Paper brings data collection related to the year 2015 of the *oil*, *gas*, *and mining company public positions on Free*, *Prior*, *and Informed Consent* (*FPIC*) (Report 2015), presented through the 2015 Community Consent Index (CCI —2015).

7 Results and Analysis

The study aimed to conduct a content analysis of 207 Oxfam Briefing Paper, July 23, 2005, which brings data collection through the 2015 Community Consent Index of the positioning of oil, gas, and mining companies related to FPIC. The purpose was to consider corporate policies and their relationship with the involvement

[1]The International Labour Organization (ILO) Convention 169 deals with the basic rights of the indigenous and tribal peoples.

and/or engagement of the community in the understanding and acceptance of such policies outlines through the use of tools like FPIC.

Extractive sector are exploited by corporations, because is necessary high investments, the ability to promote debates that effectively preserve the environment gains expressiveness on the world. Data presented by the Oxfam report will contribute to this debate.

The impact data that the activity of these companies may cause on the environs of local communities are collected, observed, and identified, and these communities, through FPIC, are heard in the coexistence period of the companies in that local, which represents effective progress toward the guarantee of rights and the engagement of these communities with the commitments and policies assumed by the companies.

There are three words that aggregate fundamental concepts, which permeate through the debate that 207 Oxfam Briefing Paper brings out publicization, commitment, and the empowerment of women.

Publicization refers to the transparency in the publication and availability of data and information to society in general. Commitment refers to the effectuation of what was announced with FPIC and the empowerment of women deals with their participation in the decision-making process.

Aiming at emphasizing evolving trends in the companies of the studied areas and applying an updated version of the CCI—2015, Oxfam has conducted a study with 38 companies.

The majority of the companies have not made commitments with the affected non-indigenous communities, besides the fact that there is confusion about concepts, such as ample support from society and social license to operate. This confusion makes the influence, participation, and negotiation with the companies difficult by part of the community.

This may generate *the risk of conflict among and within communities is increased and corporate accountability is weakened* (Report 2015).

Oxfam has developed a community engagement spectrum that evolves, culminating in the public commitment, according to Fig. 1.

The stages constitute the evolution in the implementation of alternatives for community engagement and the guarantee of rights in which the companies can be based on to public make commitments like this one.

Fig. 1 Community engagement spectrum. *Source*: Adapted from 207 Oxam Briefing Paper (2015)

These commitments must be attuned to the corporate policies, which need to be developed and elaborated considering such perspectives on the operation of the company.

Free, Prior, and Informed Consent (FPIC) is defined by Oxfam as:

> The principle that indigenous peoples and local communities must be adequately informed about projects that affect their lands in a timely manner, free of coercion and manipulation, and should be given the opportunity to approve or reject a project prior to the commencement of all activities (Report 2015)

It is a continuous process, granted to the indigenous people as a right connected to international laws, but which has been increasing as positive practices for sustainable development.

For Oxfam:

> The communities' consent should be obtained by governments when land-use decisions are being made, including before the assignment of concessions and blocks, which occurs prior to a specific project being approved (Report 2015).

In practice there are two significant cases, which are The Indigenous Peoples' Rights Act of the Philippines, sanctioned in 1997 and which demands FPIC, and the Australian case, with the Aboriginal Land Rights (Northern Territory) Act of 1976, in which protection to the aboriginal peoples is established.

Those are two examples of actions developed by governments that act as promoting agents for the engagement of communities and are responsible for ensuring the guarantee of rights.

This brings us to the challenge of implementing the stages of community engagement, because the articulations between society, government, and companies need to be in a dialogue level convergent with the ideals of sustainable development. Considering that the State must ensure the protection of human rights and repress violations and the companies have the responsibility related to human rights, access to land, and natural resources.

Furthermore, the empowerment provided for women in the decision-making process that is offered by the implementation of the FPIC stage is an advance in a social construction of the differentiated and connected reality with the principles of sustainable development.

In this regard, when there is the intention to conduct a new project, be it extractivist, civil construction or any other nature, a licensing process is necessary. This process is known as "Environmental Licensing" and deals, among other issues, with those ones related to the environment.

The two main documents necessary to obtain an environmental license in Brazil are the Environmental Impact Assessment (EIA) and the Environmental Impact Statement (EIS). However they deal with the impacts on communities and on the lives of people, the focus of these documents is the environment and, as a general rule, the established contrasts are rarely environmental.

When social issues and the impacts on the lives of people are discussed, there is a strong reaction contrary such movement from the communities and traditional peoples.

Companies still see the Social License to Operate as an additional cost to the project; however, in any stage it is possible to invest in this project, the results are extremely favorable.

FPIC is an advance in the Social License to Operate and, when implemented in a way that considers the communities as interested parties in the process and there is the search for the consenting to execute the project, it becomes an excellent deal for the companies because of the minimization of future problems.

Thus, FPIC ends a more advanced stage of community relationship as far as the human rights of the traditional peoples and indigenous communities are amply respected, considering the minimizing of conflicts and environmental disasters.

8 Conclusion

The issue is recent in relation to the involvement of all communities, not the indigenous ones, in the empowerment related to the implementation and building of corporate policies of extraction companies.

Relating human rights to corporate policies starts to increase with the intensification of debates on the sustainability issue and the promotion of sustainable development from the 2010s.

As limitations of paper, it was observed through literature consulted, and there are no papers published in the main research basis related to the Capes Portal (Scopus Web of Science, Scielo) before the 2010s, which represents the relevance of the theme and the need to deepen in the theoretical and empirical studies of the theme, mainly in countries like Brazil where there is the intensive presence of many companies in the extraction sector, whose actions directly impact the environs of their effective operations, short and medium distance.

The empirical research and the observation of the evolution of the use of tools like FPIC as a mediator in the relationship between corporate policies and the engagement of communities need deepening and practical verification to evaluate the effectiveness of tools like this one in company–communities relationships, in the social transformations of such communities, and in the identification of impacts on the environment by part of the communities and companies.

Thus, it is a long way and only now, in Brazil, the search for knowing and applying Free, Prior, and Informed Consent is beginning, through debate promoted by oil industry, based on indications by the Oxfam report. This may represent a huge step in increasing the robustness of the bases created with the consecution of the Millennium Development Goals (MDGs) which, in the post-2015 goes through a phase of consolidation and advancements toward the fulfillment of the Sustainable Development Goals (SDGs) through the operationalization of the 2030 Agenda.

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Local Sustainability Indicators and Their Role in the Implementation of the Sustainable Development Goals in the HE Sector

Victoria Hands and Richard Anderson

Abstract

This research study focuses on the potential role of indicators in encouraging engagement with the implementation of the United Nation's (UN) Sustainable Development Goals, also known as the Global Goals. The UN has a pledge and focus on the need for greater engagement at all levels as a key to the implementation of the Sustainable Development Goals. Engagement is also a major concern for the higher education sector, both internally with staff and students and externally with stakeholders, for example, across research impact and funding, quality assessment and Higher Education support agencies, with the aim to build collaborative partnerships and increase the capacity for evidence-based impact, public benefit and widening participation. In line with the focus on engagement there is also a need to be able to measure progress made towards the Sustainable Development Goals by the Higher Education sector. However, this paper argues that measurement in the HE sector tends to concentrate on 'specialist data' focusing on comparative league tables and key performance indicators, rather than engagement with the global, social and environmental issues of 'public good'. The research is informed by learning from the application of sustainability indicators at a local level to engage specialist and non-specialist communities, encourage participation, and inform policy and strategy. The paper examines the scope and challenges in the introduction of sustainability indicators in parallel with current sustainability

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policies, programmes and projects, and makes recommendations for the greater application of indicators across the HE sector to encourage engagement with the implementation of the Sustainable Development Goals.

Keywords
UN sustainable development goals · Engagement · Indicators · Local indicators · Sustainability · Sustainable development · Higher education · Universities

1 Introduction

The need for the implementation of the intergovernmental Sustainable Development Goals (SDGs) (United Nations 2015) to focus on the encouragement of engagement at all levels is reflected in the UN General Assembly Declaration's statement that

> Ensuring that no one is left behind is at the core of the 2030 Agenda for Sustainable Development, and is a fundamental guiding principle for its implementation. (United Nations 2016; p. 3)

Engagement is also a major concern of the UK Higher Education (HE) sector, for, both internal and external stakeholders, within university curriculum, research and support departments, and across external funding, assessment and support agencies, such as the Higher Education Funding Council for England (HEFCE), the Research Councils UK (RCUK) and the National Co-ordinating Centre for Public Engagement (NCCPE). Such agencies aim to build collaborative partnerships and increase capacity for evidenced-based impact, public benefit and engagement.

For example, HECFE has worked with partner organisations, including the Quality Assurance Agency (QAA), the Higher Education Academy (HEA) and the National Union of Students (NUS), to develop sustainability policies and inform HE institutional practice (HEFCE 2016). In addition, in 2013, HEFCE provided support to the National Union of Students (NUS) via the *Students' Green Fund* (HEFCE 2013), for practical sustainability engagement initiatives, with the key themes of student participation, partnership, impact and legacy. Delivered through the University's students' unions, the aim of the fund was to encourage local collaborative sustainability initiatives, and to support students in their role as "agents for change" (HEFCE 2013). The RCUK regards engagement as a key focus for funding of the research community:

> … engaging the public with research helps empower people, broadens attitudes and ensures that the work of universities and research institutes is relevant to society and wider social concerns. (RCUK 2016a)

The RCUK's aim to establish ongoing relationships between research and 'the wider community' is described in their *Public Engagement with Research Strategy*

(RCUK 2016b). This is also reflected in the requirements of the Research Excellence Framework (REF) that the public and society benefit more fully from the outputs and impact of research, defined as

> an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia. (REF 2014)

The RCUK's work also includes the *Public Engagement—National HE STEM* (Science, Technology, Engineering and Mathematics) *Programme* (RCUK 2016c) to engage the public with research as a pathway to impact. The programme seeks to communicate research findings to the public, and to encourage researchers to enter into 'two-way engagement—interaction' with the public, to inform research and develop potential 'citizen science' where members of the public are active participants in the research process.

The UN SDGs offer significant opportunities to the commercial sector (Hughes 2016) and offer an indication of what future employees, in particular those with a university education, will be expected to engage with. A study by Price Waterhouse Coopers (PwC) (2016) *Engaging with the Sustainable Development Goals* argues that there are compelling reasons for the commercial sector to support the UN SDGs:

> Our results suggest citizens expect business to apply SDG thinking to their core business activity, with less emphasis on peripheral projects or reporting. 50% expect business to embed the SDGs into its strategy and the way it does business (PwC 2016; p. 22)

However, one of the challenges for both the commercial and HE sectors in encouraging greater engagement with the UN SDGs is to be able to measure progress towards impact and benefits within their core business.

2 Background to Sustainability Indicators

The UN has developed 230 indicators to measure the implementation of the UN SDGs (United Nations 2016); however, these Sustainability Indicators (SIs) focus on high-level indicators and statistical information aimed at the national, international, and global scales.

The debate surrounding the role and use of SIs has continued to be a contentious issue among practitioners, policymakers and academics for over three decades. This debate has produced an extensive literature on the methods and approaches aimed at measuring sustainability and the design and development of SIs and their appropriate use. As Turcu comments,

> Sustainability indicators are not isolated pieces of information, but manifestations of local underlying processes and interconnections that can be mapped and which have the potential to expand our understanding of local sustainability. (Turcu 2013; p. 695)

Table 1 Types of sustainability indicators

1. Technical and managerial—monitoring progress towards sustainability policy goals—assessing performance of units—informing planning and decision-making within governmental or other units
2. Political objective setting—helping to set sustainability policy goals
3. Public communication and participation—raising awareness, educating and communicating with public or selected groups—encouraging public participation and motivating civic action

Source Authors

The role of and use of SIs have been recognised as complex, often involving a combination of simple, 'resonant' indicators, capable of engaging and holding public imagination, with the more technically detailed indicators designed to inform more technical managerial and policy issues (Taylor 1998). Pinfield (1997) suggested that SIs can usefully perform three key roles, see Table 1.

Although complex, local SIs have been seen as useful tools to encourage engagement and participation. For example, the Litmus project, a collaboration between The New Economics Foundation and the London Borough of Southwark centred on the development of local SIs based on the broadly sequential, steps of raising awareness; involving people and identifying issues; developing indicators; monitoring and communicating indicators; and taking action. The Litmus project focused on the development of community-based indicators:

> … where local people play a central role in identifying and measuring the things that they care about. This way of working gets local people participating and builds on their expertise. (Lingayah and Sommer 2001; p. 4)

The use of indicators to encourage engagement and participation was also the focus of the EU Pastille (Promoting Action for Sustainability at the Local Level in Europe) project (Pastille Consortium 2002). Pastille was an action research project which explored the role of SIs under four main headings: Institutions and Decision Processes; Legitimation and Conflict of Interest; Knowledge Claims and Role of Expert and Lay Actors; and Improving Sustainability Indicators at the Local Level (Pastille Consortium 2005). Indicators were seen to have different degrees of effectiveness depending on the objectives, goals, stakeholders and target groups they intended to reach. The project noted that indicators are very often used for communication:

> Making stakeholders aware of issues is a good starting point for discussion and subsequent participation. (Pastille Consortium 2002; p. 18)

In addition, SIs have been seen as

> value-laden measures of development performance designed to measure and calibrate progress towards sustainable development goals. (King 2016; p. 121)

The debate surrounding SIs focuses on their potential to inform and encourage communication and participation, and to develop policy and strategy, as opposed to their use in management and operational roles, performance measurement and action plans. For example, Brugmann (1997) argued that

> … at the local level, indicators are ideally suited for performance measurement. Indicators are a sub-optimal tool for technical assessment and even public education. Applications of indicators for these two purposes can compromise the performance measurement function. (Brugmann 1997; p. 185)

The use of indicators in the wider roles of communication, participation, and policy and strategic development has been described as being in danger of pursuing "vague and contradictory objectives" (Brugmann 1997). Indeed, there appears to be little reported evidence of success in linking indicators to policy and strategic formation (Pastille Consortium 2005; Holman 2009). Pinfield (1997) noted at the end of the 1990s that

> … the technical and managerial use of sustainability indicators both for measuring conditions and performance, is not, as yet, well developed. (Pinfield 1997; p. 185)

It could be argued that the balance has swung almost 180 degrees, and currently a significant focus on SIs is of operational, technical and managerial factors, rather than objective setting, communication and participation. Commenting on the current lack of a 'political and participatory' focus Disterheft et al. (2015) have observed that

> Although a great volume of literature about sustainability implementation in higher education exists, studies focusing on participatory processes in this context are rather scarce. (Disterheft et al. 2015; p. 748)

The use of indicators to support sustainability shows a tension between expert-led and non-expert-led models (Turcu 2013). It has been suggested that these two models should be integrated to "tap into various levels of 'knowledge' of sustainability" (Turcu 2013; p. 695); however, she observes that

> … little is known of whether these 'integrated' sets of sustainability indicators work in practice, or indeed reflect the local perspectives, values and understandings of sustainability which they aim to represent. (Turcu 2013; p. 695)

In light of the potential integration of the roles of sustainability indicators, King (2016) has suggested a description based on a functional classification of indicator types, in which indicators are considered as being developed for either intrinsic (governance purposes) or for extrinsic (general public purposes), see Table 2.

King (2016) argues that indicators should be designed to serve the dual functions of indirectly improving governance, operational efficiency and accountability (Intrinsic governance purposes) as well as recognising public goals and aspirations (Extrinsic general public purposes). This difference has been described as the need for management tools versus informative tools (Yli-Viikari 2009).

Table 2 Functional classification table of sustainability indicators

	Leadership functions	Knowledge increase functions	Capacity assessment functions
Intrinsic (governance)	Political and operational	Problem recognition and awareness	Justificatory
Extrinsic (general public)	Normative guidance	Communication and opinion forming	Monitoring, control and reporting

Source Authors based on King (2016)

This dual role is reflected by Lehtonen et al. (2016) who see SIs acting as 'boundary objects', mediating between the various 'social worlds', where they can perform multiple roles and have unanticipated influence, not necessarily intended by the designers or the users. They point out that empowerment has frequently been seen as the key objective of the numerous participatory processes associated with the development of indicators, empowering non-experts through simplification, and by helping to hold experts and policymakers to account; however,

> … indicators can likewise strengthen the position of the experts as the only ones truly capable of understanding and controlling their construction. Furthermore, many of the far-reaching systemic consequences from the application of indicator systems, together with their powerful framing effects, often mean that experts rather than citizens are empowered. (Lehtonen et al. 2016; p. 6)

From this perspective indicators are not necessarily neutral 'tools' of governance; they can be 'misused', and even when used 'correctly', they are capable of producing unwanted outcomes:

> they can empower the already powerful, reinforce rather than challenge dominant framings, push for premature consensus on the lowest common denominator, (and) impose upon local actors, analytical frameworks suitable only at higher levels. (Lehtonen et al. 2016; p. 7)

3 The HE Sector and Indicators

This paper argues that the use of indicators in the HE sector tends to concentrate on 'Technical and Managerial' functions, suitable for monitoring progress towards sustainability policy goals, assessing performance, and informing planning and decision-making within the institution. The focus is on collecting and measuring 'specialist data' related to key performance indicators (KPIs) and comparative league tables, rather than engagement with non-specialist communities to encourage participation and positive action which can inform policy and strategy.

For example, in order to monitor and assist in managing progress towards their sustainability policy set out in the university's vision and strategy, 'Led by Learning' (Kingston University 2012) and the university's 'Sustainability Policy, Institutional Sustainability Goals' (Kingston University 2013), Kingston University

have recently undertaken a review and have adopted a revised operational Sustainable Development Indicator (SDI) set which includes 73 indicators with which to monitor progress on sustainability policies, programmes and projects. These SDIs appear on a 'dashboard' reviewed by the Board of Governors termly during development and then annually with termly review by senior management in a cross-institutional Sustainability Review Group chaired by the Finance Director. Of the 73 SDIs, 47 related to operational measures such as energy and water use, recycling rates, emissions, compliance and risk, and they also included measures for IT use, travel and food (20 of which have been recently developed); and 26 related to ESD measures such as academic involvement, research carried out, social enterprise and social value, and projects and events undertaken (17 of which have been recently developed). It is interesting to note that over 60% of the SDIs cover operational measures and almost 40% venture into the relatively new areas of core business for a Higher Education institution—curriculum, research and enterprise.

These SDIs were designed to not only monitor and assist in managing progress towards the university's internal sustainability policy goals, but also to provide data for numerous external stakeholders such as the requirements of HEFCE, Universities UK (UUK) and Guild HE's 'Carbon reduction target and strategy for Higher Education in England' (HEFCE 2010a) to report on Scope 1, 2 and 3 CO_2 emissions (HEFCE 2010b), or to provide data for numerous university rankings and league tables, such as the *Times Higher Education World University Rankings* (Bothwell 2016) and the *Complete University Guide University League Table* (CUG 2016).

4 Research Questions

The research questions which form the focus of this study are to assess the following:

(i) The scope and challenges in the introduction of SIs to encourage engagement with the implementation of the UN SDGs, in the HE sector, in practice and at a local level, and in relation to existing sustainability policies, programmes and projects and monitoring.
(ii) To make recommendations for the greater application of SIs across the HE sector to encourage engagement with the implementation of the UN SDGs.

5 Research Methods

The research method was chosen to explore the scope and challenges in the introduction of SIs in parallel with current sustainability policies, programmes and projects. It consisted of a background analysis and literature review of the use of indicators and local SIs in the HE sector together with a series of semi-structured interviews with staff and students at Kingston University.

Kingston University, London gained university status in 1992 (Gibson 2001), and can be regarded as typical of a large multi-faculty metropolitan university in the UK, with a student population of 16,092 undergraduate/foundation and 3826 postgraduate students, and 2040 members of staff (Kingston University 2015). The university has 27 schools across five faculties: Art, Design and Architecture; Arts and Social Sciences; Business and Law; Science, Engineering and Computing; and Health, Social Care and Education which is a joint Faculty with St Georges London (Kingston University 2016).

The research method was based on a series of semi-structured interviews conducted over the telephone with each of the interviewees. The interviewees were provided with background information on the UN SDGs, the Kingston University 'Sustainability Policy, Institutional Sustainability Goals' and the interview questions prior to the interview. The aim was for the interview to take the form of an informed discussion. The interviews took place over the period of August to September 2016, and focused on questions regarding knowledge and use of the UN SDGs, and of sustainability indicators, and on their experience of engagement initiatives. The interview questions were divided into the potential role of indicators in encouraging engagement with the implementation of the UN Sustainable Development Goals" as follows:

(i) Knowledge of UN SDGs—the respondents familiarity with the UN SDGs, their importance and specific relevance to the interviewee's role at the university and their work, and how they featured in programmes and projects.
(ii) Use of Indicators—the general use of indicators in the interviewee's work, how they were developed and how they are used to communicate with internal staff and students and with external colleagues, stakeholders and organisations, and how internal and external stakeholders could become involved in the development of the indicators to measure sustainability or sustainable development in the relevant field of work.
(iii) Engagement with Stakeholders—how the interviewees engage on sustainability and sustainable development issues with staff and students and/or externally with colleagues, stakeholders or other organisations, whether and how indicators are used in such engagement, and whether local indicators (could) encourage engagement with the implementation of the UN SDGs.

The findings presented here cover responses from the seven key sustainability managers and student representatives at the university, that is the staff and students responsible for the design and delivery of programmes and projects, including

embedding sustainability at the operational and curriculum level. A larger study of policy and strategy managers and of academic research and teaching staff forms the subject of a later paper, based on the benchmarking of sustainability research at Kingston University (Hands and Anderson 2017).

The transcripts of the interviews were analysed using a composite method using a combination of Content Analysis (Krippendorff 2013) and Thematic Analysis (Patton 2002; Braun and Clarke 2012) using both deductive coding derived from the interview questions and inductive coding derived from the content and themes of the interviewee's responses. The combination of deductive and inductive coding methods allowed the generation of themes and enabled a narrative to be produced exploring the research questions. Table 3 shows the themes developed. In addition, the interview process also provided access to a number of internal and external examples of indicators and engagement initiatives.

6 Analysis of Findings

A major challenge in the engagement with the implementation of the UN SDGs within the HE sector is the limited knowledge of their existence. The non-specialist staff and students appeared generally unaware of the UN SDGs; however, once they were introduced, the general reception to the SDGs was positive. Some of the expert respondents regarded the UN Goals as being so broad that by themselves they would not have a direct use in encouraging engagement. It was felt that there was a need to translate the UN SDGs so that their relevance to the university was made clear. There was an acknowledgement that to encourage wider engagement the SDGs need to be translated into something tangible that the staff and students can see, and make tangible change on matters which are relevant to their everyday life. The approach of 'Real World Learning' (2016) was seen as a positive approach alongside the possibility of using the university as a 'Living Lab'. Making the goals relevant to the everyday life of staff and students and translating and explaining how they link to the university's operations was seen as a key factor in their successful implementation. Without translation it was thought the UN SDGs could remain a high-level framework with which people will not easily engage.

Another challenge amongst the sustainability professionals was a sense of inertia related to the introduction of a new set of goals, targets and indicators, as it was thought that much of what was encompassed in the UN SDGs was already covered by the existing university SDIs. At an operational level, in the case of SDIs which were already well established and where progress was being made, the value of the UN SDGs was seen as being limited to cross-referencing. It was thought that the UN SDGs may be of use to drive forward areas which were currently weaker or in development, being able to reference to the UN SDGs was seen as of benefit when arguing for additional investment of resources (both time and money) in new areas in the future.

Table 3 Deductive and inductive themes generated

Major themes	Sub-themes
Sustainable development goals	Familiarity
	Implementation
	Importance and relevance
	Policies, programmes and projects
Engagement	Collaboration and partnership
	Differing needs
	Ownership
	Participation
	Positive action
Sustainability indicators	Application of indicators
	Data collection
	Development of indicators
	Local indications
	Roles of indicators
	Measurement and monitoring
Experts and non-experts	Best practice
	Compliance
	Continuous improvement
	External organisations and agencies
	Empowerment and control
	Inform policies and strategies
	Key performance indicators
	Measurement of progress
	Specialist and non-specialist communities
	Targets and trends
Communication	Language and terminology
	Translation and mediation
	Stakeholders
	Consultation
	Visualisation
Culture and behavioural change	Social responsibility
	Social pressure and social norms
	Popular culture
	Sense of community
	Everyday lifestyle

Source Authors

In the case of Education for Sustainable Development (ESD) the UN SDGs were seen as being of much greater value. Experience had shown that the UN SDGs could be used as a means to explain sustainability issues by example, and therefore they held significant potential in their use as an engagement tool in their own right, helping to make links with sustainability and different academic disciplines and

interests clearer, and making sustainability relevant to non-specialist staff, showing where there may be scope for cross disciplinary overlaps with other departments.

From the interview responses it was acknowledged that progress was needed in terms of engagement with non-expert staff and students, and that a major focus was on creating awareness and a sense of social responsibility and to enable all staff and students to participate, in order to meet the university's commitment to;

> … creating an institutional culture which collectively works to continually improve our environmental, social, ethical, global and long-term impacts as responsible global citizens. (Kingston University 2013)

Engagement took a number of different forms. Operationally, staff engaged through steering groups which included representatives from a number of faculties, directorates, and the students' union to advise on projects and contracts; however, these groups were very focused in their remit. There was also the internal Sustainability Review Group which comprised managers from a range of different Directorates and Faculties, chaired by the university's Director of Finance. The operational staff also recruited volunteers for specific projects and employed students as 'Green Connectors', part-time staff to work on specific student-facing sustainability projects, such as carrying out surveys, collecting data and conducting environmental audits. The role of the 'Green Connectors' was also to engage with other students, so that students hear about sustainability projects through 'the lense of a student—peer to peer learning. Engagement also took place through a number of different nationally run sustainability projects in collaboration with the Students' Union, such as Green Impact (greening office practices), Responsible Futures (incorportating sustainability in the curriculum), and the Student Switch Off project (energy saving in halls), and a range of sustainability events held during 'Welcome Week' and 'Fresher's Fair', alongside a programme of introductory lectures in student inductions.

The approach appears to be in part 'bring staff and students along on the journey to active implementation of sustainability or 'public good'', and 'encourage staff and students to think about how they can influence sustainability in their own existing areas of activity'. The focus is on awareness raising and education, seeking links with academics through the core business of research and teaching, although such collaborations are at an early stage and are not yet linked explicitly to the SDGs. However, apart from the specialist sustainability professionals there appears to be a lack of knowledge of the extent of sustainable development being undertaken by the university, and limited knowledge of the specific SIs and KPIs which the university has. This is not helped by the wider university population not being involved in the development of these indicators.

The existing SDIs take the form of a number of technical and managerial KPIs which set a number of targets for incorporating best practice. These indicators and targets are of a technical nature which means that non-experts may not make the connection with the SDGs or understand immediately. There are also less technical 'softer indicators' which include for example engagement indicators about the number of volunteers, or students receiving training, or different sustainability opportunities that are offered, and the relevance of these indicators and activities to the SDGs is not made explicit.

The SDIs have been developed in consultation with key internal and external stakeholders, who are described as those as pertinent to the university's operations, people who could potentially influence achieving targets, or who have a role in collecting the data. The SDIs were also developed based on a peer review of what other universities and organisations use such as LiFE (EAUC 2016a) and the Global Reporting Initiative (GRI) (2016). These differing approaches were interpreted and revised to make them appropriate for use at Kingston University.

The operational information collected on each of the SDIs was reported using a 'Dashboard' which included all the 'key indicators' related to sustainability across the university, the information from the 'Dashboard' was reported to senior management and the Board of Governors, showing progress against targets and areas in need of improvement and investment. The SDI data were also reported to HEFCE and the Higher Education Statistics Agency (HESA) who compile reports on how the sector is progressing against national targets, and in university rankings, such as the Association of University Directors (AUDE) 'Green Scorecard' (EAUC 2016b) and the 'People and Planet University League' (People and Planet 2016). The benchmarking of the university's performance against peer group universities was seen as an important measure of progress on sustainability issues. However, this tends to reinforce the trend for the development of SDIs and KPIs to be strongly influenced by external stakeholders and to date, focusing on operational sustainability, rather than the core business of the university sector.

Much of these data were thought of as being too technical in nature to be relevant to non-expert staff and students; much of the communication was not thought of as relevant to the students. It was also noted that the split across 5 faculties, 27 schools and departments, over four campus sites posed challenges in regards to communication and engagement both in terms of location-specific and discipline-relevant communication. Successful sustainability initiatives which were taking place, such as the integration of sustainability into the fashion curriculum, can go largely unnoticed by the rest of the university or indeed fail to be picked up in international benchmarks due to differences in terminology. The subject of modes and means of communication provided much discussion and suggestions for the need to link tailored communication with the everyday life of staff and students, such as the use of e-notice boards in study spaces, and information boards on the bus service between campus sites.

The definition of sustainability and sustainable development remained contentious when engaging with non-experts as this can lead to a perceived lack of relevance (Dawe et al. 2005). It was noted by respondents that the terminology and acronyms surrounding sustainability and SDIs can act as a barrier to engagement. A common observation was that to use SDIs to engage with non-experts it would be necessary to have a form of translation, to be able to talk to them in 'a language' which was directly applicable to them. It was also observed that to the non-expert audience 'buzz words' like sustainability, recycling and carbon emissions have almost become desensitised or neutralised.

It was argued that there is a need to consider the role of social norms and social pressure in encouraging engagement, for example, it was suggested that students do not recycle because of their concern about the environment but rather because they care about what other people think about them, and this sense of peer group social pressure could be used to help communicate with students. It has to become 'cool to do sustainability', and once it is 'cool they will do it'.

Despite a limited knowledge, the students interviewed appeared to have a good appreciation of the principle of local SDIs in terms of public communication, raising awareness, education and encouraging participation, and were able to make reference to the Tidy Streets initiative (Bird and Rogers 2010; Koeman et al. 2014) aimed at public visualisations of local data deployed in urban communities, and the scope of such a project to be replicated at Kingston University. In addition opportunities to integrate such projects into the curriculum and across course areas, such as in the arts, computer sciences, and media studies, were stressed. Key suggestions were the need to promote to the student population what was already being achieved at the university both operationally and through courses and research interests, and to encourage student involvement, ownership and celebration of achievements both institutionally and by the individuals involved, aimed at changing the student culture and social norms towards supporting engagement in sustainability issues.

7 Limitations of the Research

The main limitations of the research methodology were twofold: the relatively small initial survey size; and the subjectivity of interpretations of keywords and their application to the data sources. The study focuses on the responses from sustainability managers and student representatives who were key individuals in the development of the SDI's and in the representation of the student experience and involvement with sustainability initiatives at the university. However, the larger study of policy and strategy managers and of academic research and teaching staff, to be undertaken, will help inform the initial findings of this paper by bringing greater insight into the policy and ESD elements of the research. In addition, the method was necessarily based on the framing of the semi-structured interviews and the 'reading and interpretation' of the content and thematic analysis of the transcripts of the interviews by the researchers carrying out the study. Nevertheless, through the semi-structured in-depth interviews that were conducted, the interviewees have provided sufficient information to meet the objectives of this study, which are to assess the scope and challenges in the introduction of SIs to encourage engagement with the implementation of the UN SDGs, in the HE sector, in practice and at a local level, and in relation to existing sustainability policies, programmes and projects and monitoring, and to make recommendations for their greater application in the HE sector.

8 Conclusions and Recommendations

This study has found that limitations of knowledge of the UN SDGs pose a challenge to the engagement of non-expert staff and students in their implementation; however, once staff and students have been introduced to the SDGs, their is recognition and the general reception is positive. The need to make the UN SDGs relevant to the everyday life of staff and students, and to show how they link to the university's activities was seen as a key factor in their successful implementation; without such translation there was concern that the UN SDGs would remain a high-level framework, with which it would be difficult to engage other stakeholders.

At an operational level, existing SDGs and SIs were thought to be already well established and where progress was being made, the value of the UN SDGs was seen as being limited. Among the sustainability professionals there was a sense of inertia related to the introduction of a new set of goals, targets and indicators, as it was thought that much of what was encompassed in the UN SDGs was already covered by the existing university indicators. The indicators were considered important in their role of reporting expert technical and managerial information to inform senior management decision-making and report to external stakeholders, relating to policy and programme targets both at a university and national levels, and in university performance rankings against peer group universities.

However, in the case of Education for Sustainable Development the UN SDGs were seen as being of much greater value, as a means of explaining sustainability issues for example by linking different academic disciplines and interests, and making sustainability relevant to non-specialist staff and students. From the interviews the need for greater engagement with non-expert staff and students was acknowledged as a major means of creating awareness and a sense of social responsibility and enabling participation. The introduction of local SIs relating to the SDGs offers opportunities for improved communication, awareness raising, education and participation.

The study found that there was a need to consider the role of social norms and social pressure in encouraging engagement, and helping communicate with students. The study also showed a need to promote to the student population what was already being achieved at the university both operationally and through courses and research interests, and to encourage student ownership and celebration of achievements, both institutionally and by the individuals involved, aimed at changing the student culture and social norms and attitudes towards sustainability issues.

Despite limited specific knowledge of sustainability, the students interviewed appeared to have a good appreciation of the principle of local SIs in terms of public communication, raising awareness, education and encouraging participation, and were able to make reference to examples and the opportunities to integrate local SIs into the curriculum and across course areas.

There appears significant scope for the introduction of sustainable development indicators to encourage engagement with the implementation of the UN SDGs, in the HE sector, in practice and at a local level, and the focus should be on Education for Sustainable Development using the potential of local sustainability indicator to engage with non-expert staff and students to support and develop a collective institutional culture which works towards explicitly contributing to the delivery of the Sustainable Development Goals.

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Putting the 'Social' into Sustainability Science

Carolyn Kagan and Mark H. Burton

Abstract

The Global Goals for Sustainable Development (SDGs) were produced in 2015 to end poverty, protect the planet and ensure prosperity for all. Eight of the 17 SDGs address social dimensions of sustainable development, although there are interrelationships between these and environmental, economic and process dimensions. Despite this emphasis on social aspects of sustainable development, sustainability science often neglects *social* science perspectives. In this paper this neglect will be confronted, and the value of both theoretical and empirical critical social sciences to sustainability science will be explored. With reference to an action research project, it will be argued that the framework of ideology–action–structure complexes is a useful one that can help illuminate the social conditions in which strides to achieving sustainability goals are taken. Some core characteristics of a future sustainability social science will be outlined.

Keywords

Sustainability · Critical social science · Sustainable development goals · Ideology–action–structure complexes · Action research

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1 Introduction

This chapter will highlight the role that critical, multi-disciplinary *social* science plays in addressing the challenges of sustainable development as promoted through the Sustainable Development Goals (SDGs). It will be argued that sustainability science places a disproportionate emphasis on biophysical sciences, which are limited in terms of addressing the SDGs, the majority of which focus on social[1] dimensions of sustainability. The consequence of this is that the social aspects of sustainability are relatively underdeveloped, thinking is constrained and the possibilities for achieving the SDGs thereby compromised. The ways in which a particular set of concepts from critical social science can help understanding the current sustainability challenges will be explored both theoretically and empirically.

The discussion will be built on an epistemological position that recognises the importance of human values in scientific endeavours, in this case, the values of stewardship (of environmental and human resources), social justice and solidarity.

The contradictions and paradoxes within the set of SDGs themselves will be examined, followed by an analysis of the sustainability challenges from an interdisciplinary social science perspective. The utility of ideology–action–structure complexes in contributing to understanding of transformative change will be considered. The argument will be illustrated with reference to an action research project developing local sustainability living groups.

1.1 Sustainable Development Goals

The overall aim of the SDGs is to form a "*universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity … [they] … are an inclusive agenda. They tackle the root causes of poverty and unite us together to make a positive change for both people and planet*" (UNDP 2015).

The (SDGs) stem from the United Nations resolution agreed by 193 countries in 2015 (UN 2015). The 17 SDGs and associated 169 action targets embrace the natural environment, the economy and social dimensions of living. Whereas the earlier Millennium Development Goals referred to countries from the global south, the SDGs refer to all countries and so are of relevance to the core capitalist countries[2] as well. It is from the position of the core capitalist United Kingdom that this chapter is written. Not only are there sustainability challenges for the UK, but also there are particular responsibilities to achieve greater environmental, social and economic security. This is due to the historic legacy of industrialisation and the disproportionate contribution made by the UK to extraction from the natural world

[1]In this context 'social' refers to the people aspects of ensuring healthy and flourishing futures, addressing economic and environmental catastrophe and maximising human and social capital, community assets and social networks in pursuit of social equity.

[2]Core capitalist countries are those wealthy, dominant nations that exploit 'peripheral' countries for labour and raw materials. They own most of the world's capital and technology and have great control over world trade and economic agreements (Wallerstein 2004).

and carbon and other emissions in pursuit of capital gain, threatening not only the environment but also, with the stress of climate change, to social solidarity within the country.

The SDGs are ambitious and explicitly grounded in the respect, protection and promotion of human rights and fundamental freedoms (para. 19), and, as the title of the report makes clear, with a commitment to transformation, setting the development agenda until 2030. They clearly present a challenge to not only understand current threats to sustainable futures, but to undertake national and international transformations to enable all to live well, within planetary resources and with greater equity. Importantly, the SDGs seek to link the social, economic and environmental aspects of goals (Stafford-Smith et al. 2016). Sustainability science must similarly integrate and link the social, economic and environmental (Kates 2011), moving beyond the tendency in the field to see the biophysical environmental challenges as superior to the social, which are often relegated to challenges of implementation (Jerneck et al. 2011; Kajikawa 2008). Indeed, a word cloud derived from titles of 20,000 articles between 1974 and 2010, containing the words 'sustainability' or 'sustainable development', rendered economics invisible and the only social terms, '*community based*' and '*health care*', very small (Kates 2011).

1.2 Impossible Contradictions Within the SDGs

The social goals of Agenda 30 include the elimination of poverty and hunger; good health and well-being and quality education; gender equality and reduced inequalities; sustainable cities and communities; peace, justice and strong institutions—all laudable social goals. Equally, goals relating to the natural environment—climate action, life below water and life on land—are indisputably essential for future survival, not just development.

Of course, these social and environmental dimensions cannot be separated from the economic dimensions, and it is here that contradictions and tensions become clear. Goals 7, 8, 9 and 12 explicitly highlight affordable and clean energy, decent work and economic growth, industry innovation and infrastructure and responsible consumption and production.

The take on economic growth is a traditional one, conflating growth in domestic product (GDP) with societal progress. As Esquivel (2016: 11) points out "*Industrialisation is still seen as the main driver of growth, and countries should 'significantly raise industry's share of employment and gross domestic product' (Target 9.2). Economic growth is the 'first and foremost' generator of domestic resources needed to achieve the SDGs (para. 66), tying social protection and other re-distributive policies (Targets 1.3, 5.4, and 10.4) to this 'grow first, redistribute later' proviso.*"

Esquivel goes on to argue that the conceptual approach to growth within the SDGs fails to put growth within environmental limits (Raworth 2014), thereby undermining attempts to achieve the environmental goals. It also fails to respond to, or challenge the macroeconomic and structural drivers of current patterns of

growth, including those of unpaid care and domestic work, making gender and other equalities impossible to achieve. Crucially, the approach does not challenge the ways inequalities in income, wealth and power are produced and reproduced at national and global levels—the province of a critical social science.

Theoretical social science provides an analysis outlining a range of systemic crises threatening sustainability, and the framework of ideology–action–structure complexes (Burton 2013; Kagan and Burton 2014), which both generate and maintain those crises. In both the identification of the crises and the IASCs, it is clear that they are saturated with both power and inequality.

2 Systemic Crises Threatening Sustainability and Contextualising the SDGs

The world is in an unprecedented time of turmoil and crisis, and one of the things that (social) sustainability science can do is try to understand and communicate the nature of these crises. Six crises are outlined below (Burton 2013; Kagan and Burton 2014).

An ecological crisis, with climate change and other planetary boundaries being crossed, which is likely to lead to the collapse of support systems for human life. As people's habitats are squeezed more conflicts of the most basic kinds are expected—competition for resources to sustain life. This is the overarching crisis—the one that supersedes all others.

An energy crisis, with peak oil leading to a rapid escalation of energy costs with profound consequences for the economy, agriculture, supply chains, etc. As people are no longer able to live their energy-rich lives, profound changes will be seen in the ways in which people live together, construct communities and organise work, family and leisure lives.

A demographic crisis, with worldwide population growth and, in many parts of the world, ageing populations, but in others there are missing middle generations; population movements and displacements due to climate shocks, wars, economic shocks and neoliberal strategies. As hitherto stable patterns of populations change rapidly, existing social relations are put under pressure with the dangers of increased political disruption (as illustrated by the 2016 US Presidential election and the UK BREXIT vote), violence and exploitation.

An economic crisis, comprising a structural crisis of capital and the undoing of the most recent strategies to maintain accumulation while accentuating strategies that attack living standards, previous gains, ecosystems, livelihoods. Governments' pursuit of unselective, aggregate economic growth will serve to deepen the crisis—and so might the SDGs in their pursuit of economic growth.

A crisis of work which sees increasingly intensified but at the same time insecure, casualised and precarious work, and high levels of worklessness. Unpaid work, caring and community building, continues to be regarded as predominantly women's work and is undervalued: invisible to economic models. Ageing

populations alongside the retraction of public services and social protection provisions means an increase in informal, unpaid care falling on families, predominantly women. Undocumented and migrant labour has increased and in many places community and solidarity activities have become commodified and moved into the private sphere. At the same time, in many places there has been a growth in the formal care sector workforce, again predominantly women, who are typically low paid and with poor working conditions. They frequently leave their own families in the global south to care for or clean for those in the global north. There has been a decline in real incomes, an increase in people working long hours or holding down multiple jobs, and a growth in poverty amongst working people.

A social and cultural crisis, in which the human and cultural capital of our societies is eroded and the humanising practices of social solidarity and cultural production are displaced by a model of passive consumerism, fuelled by the enormous expansion of consumer credit and household debt, feeding the secondary, speculative, global finance sector whose speculative bubbles triggered the 2008 global crash.

These crises undermine the promise of the SDGs, and share the following characteristics. They

(1) are *interdependent*; and have a *systemic nature* (not easily described, not easily predicted, complex and with properties that emerge). They are nonlinear, having positive ('vicious') feedback loops and quasi-autonomous subsystems;
(2) *differentially affect* the poor, women, disabled people, the elderly, children, the working class and those reliant on the informal economy, peasants and members of minority or dominated ethnic groups;
(3) are *likely to lead to a succession of waves* of misery, conflicts, population movements, hunger and want. Much of this 'future' is here already;
(4) *their nature is not transparent*, partly because of the complexity of global systems and partly due to the result of obfuscation through ideology and propaganda;
(5) *present us with perhaps our greatest challenge as social sustainability scientists*, to understand the contribution that can be made, and not to get disheartened by the scale of the problems.

3 Ideology–Action–Structure Complexes

These crises are a product of, and sustained by people's actions, underpinning ideologies and social structures.

Ideology, here, refers not just to ideas, but also to socially embedded and embodied systems of thought about the way things are and how they should be. Ideologies reflect structure but not in a simple 1:1 manner. They shape and

constrain action without fully determining it. Structure refers to the organisation of power, institutions and ordered systems (for example economic arrangements). Action refers to the socially structured practices and everyday activities—conversations, interactions, behaviours—that people engage with collectively and that produce, reproduce, resist and potentially transform both ideology and structure.

Ideology, action and structure, therefore, are reciprocally determined and inseparable, forming complexes (*ideology–action–structure* complexes, or IASCs) which are both distinct and shared, multiple determining social realities (Burton 2013: 803–804). The articulation of IASCs can help frame empirical social sustainability scientific projects.

Contemporary IASCs can be clustered in terms of some key interconnected dimensions deriving from critical sociology, psychology and political economy:

- capitalism (the system whose central purpose is the accumulation of capital through the maximisation of private profit);
- imperialism or colonisation (the domination and exploitation of large regions of the world by a succession of nation states and clusters of states);
- patriarchy (current and historic unequal power relationships between men and women whereby women are systematically disadvantaged and oppressed and men hold social status and privilege);
- modernity (the adoption of a rationalistic order in society characterised by a set of divisions: between arts and science, economy, law and humanities, ritual and production, humans and nature); and
- naturalism (in which socially constructed divisions and distinctions are taken to be part of the natural order of things).

Kagan and Burton (2014) suggest seven core IASCs within which other IASCs will be embedded. The last three IASCs will be articulated more fully with reference to issues of sustainability.

(1) Linear progress: progress is a culturally located idea, absent in some languages. It implies a linear path from the primitive to the modern, with no detours and no end. It is authoritarian since it defines other paths 'out of scope'. After all, 'you can't stand in the way of progress'!
(2) The primacy of exploitation: the system depends on exploitation. The high levels of consumption of the few (globally), mostly living in the core capitalist countries, depend on labour exploitation of varying degrees of savagery and on the ruthless exploitation of the planet's living and mineral resources.
(3) Mono-culturality and the suppression of other cultural systems: particular cultural forms dominate. Here, culture means the ordinary ways people live, and pass on and share that way of life through traditions, crafts, arts, rituals and the material trappings of everyday life.
(4) Assumed superiority: 'European civilisation' (promulgated, now, largely by the USA) is seen to be the pinnacle. It follows then that other cultures (and hence peoples) are inferior. This is deeply ingrained in our education, culture,

foreign and domestic policies. The assumption appears savagely in the far right and more subtly elsewhere.

(5) The rational administration of complexity: the administrative impulse to order and simplify rather than describing the dimensions and layers of complexity and working with the flow. By reducing complexity to a few elements, controlling them, the hope is to manage the complex system itself.
For example, urban regeneration in the UK focused on developer-led fixing of decaying infrastructure, bringing in private money (and taking out profits)—mostly housing and retail, with a nod to social projects, jobs and resident participation (Power 2012 on unfulfilled promises of regeneration delivered through Olympic infrastructure in East London; Woolrych et al. 2007). And yet the problems in areas of multiple deprivation in which urban regeneration is targeted extend well beyond this and include high levels of unemployment, poverty, crime and fear of crime, high levels of mental ill health, low levels of community cohesion, apathy, and a loss of community and economic resources. These problems are largely the result of the withdrawal of the economy from areas that had poor infrastructure in the first place, alongside a lack of social supports for the population as the local state contracted. Regeneration actions were upheld by structures which determined the allocation of resources over specific timescales and ideologies of personal responsibilities for poverty and self-improvement.

(6) Taming natures: the wild, the natural, is to be controlled, to be mastered, enclosed and channelled, or suppressed. It is seen as, or turned into, resources. It is seen as separate from humanity, and humanity as separate from it. When valued it is appreciated in a distorted version of itself.
For example, in recent years flooding of town centres and homes in the UK has increased. Simple solutions of dredging rivers and building ever-higher flood defences (the rational administration of complexity) have been proposed. And yet, the reasons behind the floods are linked to complex ways in which the natural environment has been controlled, used and abused. Trees have been removed from uplands, jeopardising soil stability and its capacity to absorb rain water. Hillsides are overgrazed, drained for the 'pleasures' of those who see sport in shooting grouse, and biodiversity reduced (Monbiot 2015). Even where upland areas have been reforested, once the trees have been harvested for economic purposes, hillsides are left scarified and incapable of holding water. The ideology of man's (sic) dominion over nature is upheld by actions creating environmental degradation and artificial means of controlling the elements and the structures of technological solutions to water management, and the ways farming and leisure is supported and politically sanctioned.

(7) The dominance of exchange and possession: what was once free is subject to exchange relations. That which was once common is now owned, in private hands, for the purposes of shareholder profit rather than the common good.

The case of water, again, in the UK is a good case in point. Water provision was originally organised by local elected representatives, particularly as towns and cities grew, but now extended to most rural areas. They built reservoirs to provide clean water, pipelines and wastewater and sewage infrastructure and processing. They had collective responsibility for ensuring the asset of water remained a public, commonly owned asset, available to all. With the privatisation of public utilities in the UK in the 1980s, water became owned by profit-making companies with no particular links or responsibilities to the local area from which they extract rent. Water and its infrastructure are no longer in common ownership (see Lobina and Hall 2001; Ostrom 1990). The economic structures of government subsidies at the point of privatisation, regulation, stock exchanges, water extraction and bottling (in the case of bottled water, in a country with no water shortages or purification issues) are upheld by ideologies of efficiency, competition and consumer choice, and the actions of increasing prices, poor customer service and the buying of bottled water, even for home use.

There is no limit to the identification of IASCs, although a potential problem arises in identifying them parsimoniously. A key social scientific task in relation to sustainability is to envisage alternative, counter-hegemonic IASCs and engage in research that takes us nearer the realisation of a sustainable future, and that highlights and addresses power relations and inequalities.

4 What Kind of Research Is Implied by IASCs?

Ideology–action–structure complexes can be examined, disrupted, revised or replaced, through a focus on either ideology, action or structure. The kinds of structures that support current unsustainability and the need for the SDGs are beyond the reach of social science, but, if the interrelatedness of the elements of IASCs is considered, they can nevertheless be influenced by changes in ideology or actions. It is change in all three elements that are needed to achieve the SDGs and there can be no prescription that is right in all circumstances as to which element is most open to transformative change (Harvey 2010). It is clear that complex social issues require complex research approaches, beyond particular methods, and most probably combining methods. The idea of exploring different forms of social relations, the process of de-ideologisation,[3] touching the heart of power differentials and equity, underpin promising research approaches. One such is the approach of action research (Kagan et al. 2008) that embraces different methods of data collection and interpretation as well as reflection and planning across different cycles of activity over time.

[3]A term coming from Latin America and featuring in liberation practices (Burton and Kagan 2009; Kagan et al. 2011).

Action research, therefore, enables small interventions to be tried out. Through reflection, from these small interventions, it is possible to learn about the wider system and possibilities for change within it. This facilitates understanding of the complex system in which the new intervention is situated, so that it can be improved. Following interventions are then more likely to grow and succeed. Let us see how this approach plays out in practice.

4.1 Sustainable Living in an Urban Environment: An Action Research Project

This is an account of an action research[4] project in which support for different actions began to change the narrative and thus the ideology in relation to climate change (Groundwork 2013).

A local authority commissioned a non-governmental environmental organisation and our research team to develop some sustainable living groups in the borough, in the context of previous work carried out by the authority to collect information about carbon saving across the borough. It was recognised that, in the light of the ecological crisis, the task was one of raising the awareness and critical consciousness of local people in relation to environmental issues, changing not just behaviours but hearts and minds, and that this was best achieved through small-scale action projects at local level.

The preliminary stages identified locations for the project in neighbourhoods that differed in terms of community needs, priorities, assets and risks in relation to climate change; vulnerability and adaptive capacity in relation to climate change; economic opportunity linked to environmental activism; levels of existing social capital; and affluence reflecting high and low carbon lifestyles.

Some public engagement days demonstrated that people did not connect with the idea of receiving supports for projects under the banner of reducing impact on climate change. However, presenting the project as stimulating existing and new food growing projects gave people something more concrete to think about, and facilitated engagement.

From the starting point of sustainable food, a number of project ideas emerged and were subsequently developed. Food growing proved a real catalyst for activity so the approach taken was to focus group activities on sustainable practices, low carbon and improved environmental performance more generally. While growing was the frame for the initial involvement, groups also explored other aspects of sustainability such as increasing biodiversity, reducing waste, sharing materials, tools and skills. These kinds of locally focussed recreational activities are expected to have a knock on effect in terms of carbon footprints (although to date this has not been systematically quantified), as does a focus on local food.

[4]Action research and participatory action research has a strong tradition in climate change research. See for example, Harvey et al. (2012) and Campos et al. (2016).

With regard to climate change, participants needed to understand the basics of climate change; the relationship between local action and global impact; the scope of local action; measuring impact; and personal and group action planning for climate change activity.

However, perhaps more important than knowledge and information about climate change was the community development that took place to ensure the widest possible engagement and long-term sustainability of the projects. Different strategies were used to engage people, ranging from information days to fun days to demonstration days. Local groups were introduced to key aspects of organisation and organising, including partnership working, managing internal and external relations, managing meetings (and conflict), decision-making and action planning, monitoring and evaluation and fundraising. This was to ensure that the groups remained sustainable beyond the period of support. (Four years later, groups were still operating.) The involvement of local people in the projects and their delivery was essential and the community development strand of the project included gaining trust and building local relationships.

4.2 What Was Learnt?

An eclectic, 'bricolage' approach (Rogers 2012) was used to gather data from the projects. Different types of information were collected from a wide range of participants in the research. Photographs, accounts, interview and questionnaire responses all combined to provide a holistic picture of both the processes involved and outcomes of the work. In addition, detailed field diaries, kept by the main project facilitator as well as the university researchers, provided additional information (see Kagan et al. 2008 for plurality of methods in participative action research).

A minority of projects were slow to develop or did not take off, although others did and 4 years later are still in existence. Issues of power and control at local level impeded wider participation in some projects, as some influential local people exerted control over developments. The '*sustainable living*' angle was too vague and amorphous to get people involved in large numbers. Taking action against '*climate change*' and for '*environmental sustainability*' does not motivate the majority of people if they are not already concerned about the issues. On the other hand, '*resourcefulness*' and '*resilience*' are concepts that can easily be made locally relevant, i.e. not wasting resources, supporting local businesses, growing your own fruit and vegetables. It was easier to develop a wider programme of sustainable living activities where there were already existing groups with relevant activities with which to connect and on which to build. In areas with no such groups, even more effort would be needed to stimulate interest and find the points of connection from which to motivate people.

It was clear that it was important to have a catalyst project to get people together, inspire them to action and to galvanise a group. People do not form groups first and then decide to do something afterwards, as is well known in community

development practice. People were given the opportunity to come forward with ideas and suggestions for new projects—to co-design and co-produce the projects—rather than have projects thrust upon them.

The project funding came to an end, and although there were some wider impacts of the programme in terms of citizen involvement in the city's food board and enhanced networking between projects across the boroughs, resources were not found to build on the momentum that had been created. It was not possible to deliver further training and capacity building around food growing, skills sharing and community development, or to extend the project into new neighbourhoods.

How best, then, to explain this successful action research project which stalled? The climate messages and understanding of some of the dimensions of sustainable living in a wider context had been achieved, but this was only a start: there was much more to be done to develop sustainable living across the city. At the time (2013), local authorities were in the throes of a savage austerity programme in which their funding was cut drastically and they were being reduced to providing only essential services. Action on climate change and sustainable living, instead of taking its rightful place at the top of the priorities, disappeared from immediate priorities, and thereby from support at both local and central government levels. What was learned at a more macro-level was that there was little appetite, nor funding, for sustainability research to continue in the borough, or, indeed, nationally.

4.3 What Roles Were Played by the IASCs?

IASCs permeated the research discussed above. First, the *rational administration of complexity* was in play in the very commissioning of the research—dealing with the challenges of the complexity of climate change through the simplistic development of sustainable living groups, in practice, growing projects. (In fairness, this was only one strand of the borough's work on climate change, which included monitoring of, for example, transport and energy use. But no funds were allocated to linking the sustainable living projects with other things going on.) Nevertheless, it was clear that the IASC was challenged by the participants in the study. Far from confining their interests to the relatively narrow, and in and of itself the non-transformative business of small food growing projects, it was clear that understanding and action in some cases extended beyond food growing to more complex ideas about sustainability and a quest for broader-based action. The IASC was beginning to weaken in favour of a more holistic, albeit still local, approach to sustainability.

Second, *the taming of nature*. The very essence of the project, food growing, ran counter to this dominant IASC, positioning participants differently in relation to the natural world and the production of food. The growing projects helped people gain a new respect for the natural world and the rhythms of the seasons. More than this, an outcome of the set of projects was to bring people closer together in communities and to enable the forging of new relationships between people and nature. One

participant described the area in her neighbourhood, now full of flourishing edible plants as "*now a perfect place to just sit and simply 'be'*". Another claimed the project "*has brought us together and been a fantastic catalyst for a really useful community movement*".

Finally, *exchange and possession*. Many participants in the community projects had only ever known food bought in shops. They did neither forage, nor did they cultivate food in their gardens. Indeed, some did not have access to gardens until community gardens and allotments were supported within some of the projects. Discovering a new way to relate to food was captured by a participant who said "*I have learned skills that I can pass on to my children to help us grow food for free into the future*". Thus the projects began to enable the recovery of historical memory and the restoration of cultural traditions and non-rationalised, subsistence[5] production.

The three IASCs outlined above began to change through new sets of actions and new ways of thinking about elements of sustainability at local levels. Counter-hegemonic IASCs may well arise as more, small, community development focused projects grow and link with others nearby and further afield. An action research orientation helps identify the systemic and structural blocks to achieving changes implied by the SDGs, through the learning from small-scale explorations and offer the prospect of transcending the scale limitations of a project-based strategy (Kagan and Burton 2000).

5 What Now for Sustainability Social Science?

The above discussion has shown that sustainability social science can offer new ways of understanding the challenges of sustainability, including those characterised by the SDGs. It has been argued that there are merits in understanding the current sustainability challenge as a series of systemic crises supported by deeply ingrained ideology–action–structure complexes. It is not enough to look at either the ideas people hold and the thoughts they hold about the world; or about the structural inequities that exist; or the actions contributing to environmental and social degradation. The three elements of social experience have to be examined together and sustainability social science is well placed to effect changes that can become transformative. An action research stance to social experimentation, prefiguring the possibilities for change, is useful for learning about the social forces enabling and constraining transformational change. It is only then that the ways in which the exertion of different kinds of power, permeating transformational change, can be understood, changed, and possibilities for achieving the SDGs reached.

Martens (2006: 38) outlines the possibilities of a new paradigm of sustainability science "*one represented as* ***co-evolution, co-production*** *and* ***co-learning***". Opportunities will be missed if co-everything remains between like-minded people

[5]See Mies and Bennholdt-Thomsen (1999) who argue that a subsistence perspective on science, technology and knowledge is one that leads to a revaluation of older survival wisdoms and traditions.

(Richardson and Durose 2016). To reap the benefits of this kind of jointly achieved research it is necessary to involve groups of stakeholders or participants with different world views. And this in itself requires different skills of researchers, and an understanding of how to be open, inclusive and participative; how to be people centred, sensitive to power and inequality with a focus on the poorest and most vulnerable—they who are not the cause of the ecological crisis but may have some solutions—and be able to provide the necessary capacity building and support for participation (Kagan et al. 2011).

These are the skills of community development: community development in the service of a sustainability social science, and it is inconceivable that even the smallest of innovations, as discussed above, can be achieved without this.

Furthermore, a sustainability social science must

- be able to demonstrate the interrelationships of different sustainability elements;
- articulate the ideology–action–structure complexes that maintain the status quo;
- introduce small-scale social innovations through which counter-hegemonic IACSs can form; and be open to learning from those who live the lowest carbon lifestyles and about the social forces affecting any innovation.

A sustainability science without the *social* will be unfit theoretically, and unable empirically to deal with the complex crises facing humanity, as reflected in the SDGs.

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Part II
Environmental, Social and Technological Dimensions of Sustainable Development

Implementing the Global Sustainable Goals (SDGs) into Municipal Strategies Applying an Integrated Approach

Sara Gustafsson and Jenny Ivner

Abstract

The UN emphasises the importance of collaboration and integrated approaches to effectively implement the SDGs. Much of the action will have to take place locally where municipalities will play an important role in coordinating the efforts towards SDG fulfilment. They are constant local actors close to citizens and they can also influence other actors through their strategies. This paper reflects on how the SDGs can be integrated into existing strategies in order to avoid parallel non-effective processes and to avoid the risk of the SDGs to become marginalised. Furthermore, the paper discusses roles and preconditions of municipalities in the SDG implementation process. This study focuses the implementation of the SDGs into a regional municipality's strategic planning and management, Region Östergötland, Sweden. The challenges and opportunities connected to implementing the SDGs will be problematized, and the paper gives recommendations on how this type of organisations can implement the SDGs taking advantage from qualities in already existing management and working procedures.

Keywords

Sustainable development goals · Region · Strategic planning

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1 Introduction

In September 2015, 17 sustainable development goals (SDGs) were adopted, as part of the 2030 Agenda: Transforming our world, by the countries of the world at the United Nations (2015). The UN emphasises the importance of collaboration between different levels and actors in order to meet the new goals. However, the 2030 Agenda is unprecise in where responsibilities lie and who should do what in the process of realising the SDGs (Lo 2014; Weitz et al. 2015; Hoornweg et al. 2016). Stating from the content of the goals, however, it is fairly evident that many of the goals will have to be dealt with locally. UNDP Sweden (2016) cites Helen Clark in their tweet: "#SDGs must be localized … Even where central authorities fail, governance may continue locally". This means that municipalities will continue to play an important role in the efforts towards sustainability.

Sweden has an outspoken ambition to be a leading nation in forwarding sustainability through the SDGs and it is therefore interesting to study how Swedish municipalities approach SDG implementation. In this study we analyse how a regional municipality (which has a broad spectrum of responsibilities, from medical care to public transports, regional economic growth and strategic spatial planning) may contribute to the SDG implementation.

The implementation of the SDGs is so far little studied in practice, which is natural since they are newly launched. Fenton and Gustafsson (2016) conclude that the knowledge gap related to the implementation and integration of the SDGs into municipalities' existing strategies, policies and practice need to be elucidated by research in order to enhance for rapid and effective implementation. This paper explores this gap through a pre-study of the ideas and reflections of the regional municipality of Region Östergötland (hereafter RÖ) on how they could go about to implement the SDGs. It will reflect on how the SDGs can be integrated into existing strategies in order to avoid parallel non-effective processes and to avoid the risk of the SDGs to become marginalised.

The aim of this paper is to reflect on the role of regional authorities in implementing the SDGs into the different levels of the organisation—from politics to practice—and to present ideas on how these can be approached in this type of organisation. Which are the challenges? And what are the potential gains? This study focuses on a regional authority in Sweden, which, like other local and regional authorities in that country, is decentralised. This means that this authority has a significant degree of self-governance. The variety of tasks and responsibilities handled by this authority, however, reflect the challenges of adopting an integrated approach to sustainability issues that are relevant for many actors, regardless whether they act on the local, regional or national level.

2 The Role of Swedish Regions and SDGs and Strategic Planning

Tasks and responsibilities for Swedish Regions vary widely. In all Swedish geographical regions there are regional health care authorities[1] with responsibility to provide the regional territory with medical care. These organisations are governed by democratically elected politicians. Several of these regional authorities also host administration and planning of the region's public transports, because of its trans-municipal nature. Other trans-municipal issues that need regional coordination are, for example, transport infrastructure planning and regional development and growth. These responsibilities are handled by different regional or trans-municipal bodies in different geographical areas. This means that integrating sustainability issues into the strategic planning and the regional responsibilities can be a challenging as tasks and responsibilities differ. Therefore, it is of interest to explore the opportunities for SDG implementation at the regional level in Östergötland, where RÖ has been formed to embrace several important regional tasks, for example, strategic spatial planning and regional development.

2.1 RÖ's Responsibilities and Management

RÖ was established in 2015 as a regional umbrella organisation for health care, dental care, regional development and public transports. It is governed by the regional assembly with 101 democratically elected politicians. The regional assembly decides on overall objectives and guidelines for regional services as well as county tax and budget. Executive power lies with the Regional Executive Committee, which also coordinates work in three thematic committees: Health Care, Transport and Urban Planning, and Regional development. The main functions of RÖ are illustrated in Fig. 1 and the following subchapters give an overview of its responsibilities and tasks.

2.1.1 HealthCare Responsibilities

RÖ is responsible for meeting the inhabitants' need for health care and dental care and allocating resources accordingly. This assignment means providing equal and high-quality health and medical care for all citizens. It has also been decided that health and medical services should be accustomed to individual wishes and needs. The health care and medical care organisation both purchase services from private providers and provide health care at hospitals and primary health care. The internal organisation thus manages facilities (such as hospital buildings) as well as medical production units. With the medical production units RÖ is the largest employer in the geographical region with more than 12,000 employees. This means that for health care RÖ embraces the whole management chain, from strategic decision-making to executive power at the operative level.

[1] In Swedish 'Landsting'.

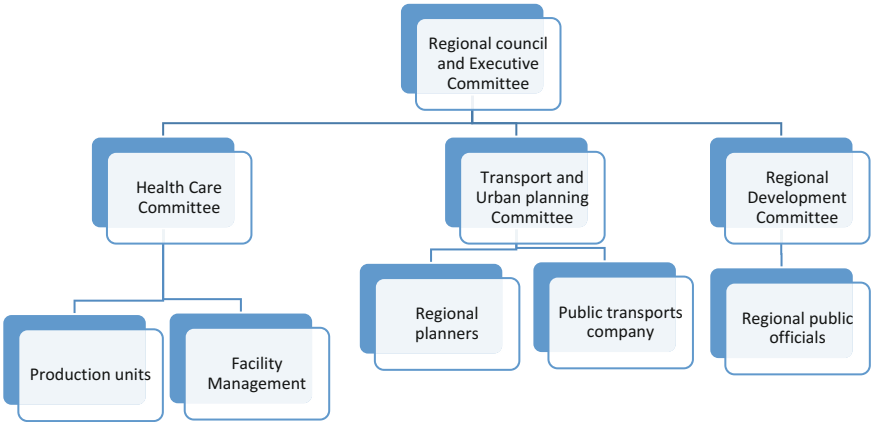

Fig. 1 Schematic organisational chart of the central functions of Region Östergötland. *Source* Region Östergötland

2.1.2 Transport and Urban Planning Responsibilities

RÖ has two main planning responsibilities assigned by the Swedish government: Regional Development Planning (RDP) and Regional Transport Planning. RDP includes trans-municipal spatial planning with elaborated strategies for several areas, e.g. rural development, energy and climate and general public health. Swedish legislation, however, stipulates municipal planning monopoly, with local spatial plans developed and adopted by local councils. RDP therefore serves as a guideline to a common approach to planning at the local level rather than stipulating planning conditions.

Regional Transport Plans stipulate the how government grants for the regional road network shall be invested. Contents in regional transport plans are predefined by the state and should embrace a 12-year planning horizon.

2.1.3 Responsibilities for Regional Development

The main objectives for the area of regional development are to strengthen Östergötland's competitiveness and developing regional leadership in collaboration with other actors and national, regional and local level. Regional competitiveness is addressed in the Regional Innovation Strategy and by hosting a Regional Competence Platform with the aim to secure a skilled labour market and the development of new applicable knowledge.

3 SDGs and Potential Challenges for Their Local Implementation

A number of different global initiatives and strategies have been launched during the recent decades to encourage local sustainability (Levett 1997; Lafferty and Eckerberg 2013). Agenda 21 and the Millennium Development Goals (MDGs) are two such examples. These have, even though they had had different impacts in different countries and municipalities, contributed to a step-wise, and limited but still evident impact on local governance (Barrutia et al. 2015).

The SDGs have similar themes as previous initiatives, however, dressed in a new costume. The new SDGs reframe how sustainability discourse has developed over the years and how it has influenced policy. So far, we know little of their implementation and monitoring. What we do know is that the SDGs call for integrated solutions and a broad systems perspective. This means that the goals and work towards fulfilling them must be integrated into overall management as well as daily work and procedures. It also means a cross-sectorial approach, where actor collaboration is key. Given that the goals require actor collaboration, it will be interesting to observe how they will be implemented, what impact they will have on local governance and how they will be converted into local action. There is therefore a need to understand and analyse how local and regional governance is formed and how to support interaction between local and regional actors in order to forward sustainability (Zeemering 2012; Lucci 2015).

In terms of both participation and scope, the process of developing the SDGs has been broader than the process of developing the MDGs (which was heavily criticised for being an exclusive and technocratic process) (Barnett and Parnell 2016; Clegg 2015). However, there is a risk that, like with other similar initiatives, there will be a gap between the policy level and implementation. Weitz et al. (2015) stress the importance of having a national ownership of the SDGs and to translate the goals into a national context. Otherwise, they mean that there is a risk that the SDG implementation becomes "… an indicator-based reporting exercise".

The risk with global goals and indicators is that they become too general and vague to be relevant on the national and local levels. In parallel to the definition of "sustainability", it could be good to have vague formulation in order to force the users to interpret the concept/goals according to their ambitions and understanding. On the other hand, with too vague definitions/goals, there is a risk that they are perceived of as less relevant and therefore are neglected—they could mean everything and nothing. Furthermore, at present there are no tools or methods for measuring and monitoring the progress with the SDGs (Simon et al. 2015; Arfvidsson et al. 2016; Graute 2016). One of the challenges that SDG implementation will have to fend off is the risk of the SDGs only serving political ends rather than facilitating practice (Graute 2016).

As mentioned earlier, RÖ has a wide range of tasks and responsibilities and many of them have clear connections to the SDGs. As a new organisation it will also need to develop its approach towards the SDGs more or less from scratch. It is therefore interesting to reflect on how this type of organisation approaches the SDGs; how the SDGS could be internalised in the already existing strategies and tasks of the region and also how it can learn from challenges and success factors for local and regional organisations who implemented the Agenda 21 and MDGs. For example, earlier research indicates that it is important to acknowledge existing structures and practice in order to develop an effective sustainability management (Eklund and Gustafsson 2015). Perhaps the SDGs could be a way of improving already existing sustainability efforts through coordination and collaboration between functions and competencies and perhaps the SDGs could provide a structure for reporting the Regions sustainability performance in a different way, enhancing for benchmarking with other similar organisations.

In order to distinguish between different organisational levels and to structure different strategies/activities that are linked to the SDGs, the, authors of this paper used the framework/model of Kemp and Loorbach (2007), where they talk about four different levels of transitions: strategic, tactical transition, operational and monitoring/follow up. In this paper, however, the last level is not addressed due to the SDGs being a new phenomenon for which follow up processes are yet to be implemented. The strategic level encompasses visions and overall strategies, while the tactical level includes networking, and coalitions on how to come closer to an operationalization of the visions. The operational level is more hands-on and addresses implementation at a process or project level. In the context of this study, the different levels have been used as a tool to help sorting out how the strategic planners in RÖ perceive the authority's strategies and initiatives in relation to the SDGs. To relate to the different levels in the context of RÖ means that it is possible to differentiate on what is in the scope of the authority's direct action space (operational level), where the authority could facilitate through structural mobilisation (tactical level), and where RÖ act through political leadership and political will.

4 Methodology

This paper is based on a comprehensive literature review on current journal articles related to the SDGs, a documentation study of management of sustainability-related tasks of the organisation RÖ and a workshop with strategic planners and officials representing different departments and functions in the region.

To start with, a scan of relevant literature was performed. This served as a foundation for the study. In this scan, current literature was identified (some of it has been compiled and analysed more in depth in Fenton and Gustafsson 2016). The purpose of the literature scan was to get a basic understanding of the research field and how the SDG implementation at the local and regional levels is discussed

among scholars. Key words such as "SDGs, post-2015 Agenda, Agenda 2030, Municipalities, Urban sustainability" were included in this scan. The compilation and analysis of this scan contributed with a basic understanding of the SDGs and challenges for their implementation at the local level.

Thereafter, RÖ steering documents were collected and analysed in order to identify how these currently address sustainability issues and to get an understanding of sustainability management processes in the organisation.

These first two steps served the study with important input to the third step, in which a workshop with seven strategic planners and officials at RÖ was held. These were selected to represent different parts of the organisation and to cover a broad range of competencies and functions. Primarily officials working at management level were chosen as they were assumed to have an overall perspective on their respective area of responsibility. At the time of the workshop, the SDGS had not been addressed as such in the organisation and there were no internal SDG steering documents or routines on how to address them in the daily work at RÖ. Therefore, the participants were sent general information about the SDGs prior to the workshop (even if the SDGs were familiar to most of them).

The purpose of the workshop was to identify how the officials perceive that their activities and management relate to the SDGs. The input from this workshop could be seen as a general screening that gives an overview of the initial perception of how and within which areas the Region already contributes to the SDGs.

At the workshop, the participants were asked to, individually and in silence (10–15 min), reflect on which activities that could be related to which SDG and on what organisational level, and to write this down. Thereafter, the participants presented their activities and motivated at which level it fitted best (see Fig. 2). In some cases one activity was plotted at several organisational levels. The organisational levels (the structure that was based on Kemp and Loorbach 2007) were introduced as "what", "how" and "do" with reference to the differences between tasks and responsibilities that are within the direct and indirect power and daily work of RÖ's employees.

The matrix (Fig. 2) was the main output of the workshop and based on this matrix discussions were held on how the tasks and responsibilities of RÖ are perceived. The reflections from the workshop were analysed using the results from the literature review and the documentation studies, and were synthesised into the discussions and conclusions of this paper.

The results that are presented in this paper mirrors an early stage (2016) in an organisation's discussion regarding the SDGs. It is also important to remember that the results are a product of a selection of strategic planners' and officials' spontaneous associations to how their organisation contributes to the SDGs. This means that different results would have been achieved if the same study was performed with other workshop participants or in a few years' time when the SDGs are more settled in society in general and if doing this exercise with different persons.

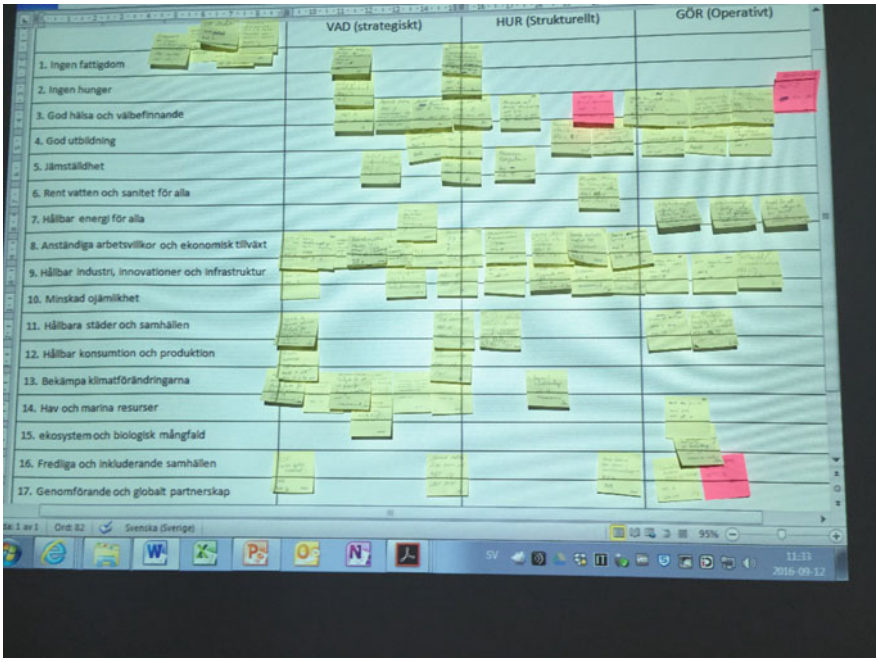

Fig. 2 The workshop participants placed the activities in relation to the SDG and the organisational level that they perceived was the most appropriate. *Photo* Jenny Ivner, 2016

5 An Overview of RÖ's Activities in Relation to the SDGs

The existing sustainability management at RÖ is extensive and covers many areas. Some documents cover the same issues but in different ways and in some documents there is a need for further clarification of definitions. The screening workshop carried out in this study was one of the first occasions where the SDGs were jointly discussed among several different functions at the Region and, at the time when this paper was written, there was no political decision on how to approach the SDGs in the regional organisation. However, given the richness in the results from the brief and general screening exercise, it is clear that the SDGs are relevant for RÖ (see Table 1).

Some of the activities (plotted in Table 1) were general strategies covering several goals and several organisational levels, while others were more concrete operational projects and initiatives. An example of initiative that was plotted at the strategic level is the regional Cycle Strategy (SDG 9). Drug prevention scheme (SDG 3) is an example of something that was seen as tactical. As to the operational level, issues such as fossil free vehicle fleet (SDG 13) were identified. Note that the initiatives were plotted against the SDG that the individual workshop participants perceived was the most relevant in the context.

Table 1 Results from the workshop exercise where the participants plotted the organisation's activities (at different levels) against the SDGs

	Strategic level	Tactical level	Operational level
1. No poverty	○ ○	○	
2. Zero hunger	○ ○	○	○
3. Good health and well-being	○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○ ○ ○
4. Quality education	○	○ ○ ○	○ ○
5. Gender equality	○ ○	○ ○ ○	○ ○ ○
6. Clean water and sanitation		○	○○
7. Affordable and clean energy	○○		○ ○ ○
8. Decent work and economic growth	○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○	○
9. Industry, innovation and infrastructure	○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○
10. Reduced inequalities			
11. Sustainable cities and communities	○ ○ ○	○ ○ ○	○ ○ ○
12. Responsible consumption and production	○	○	○
13. Climate action	○ ○ ○ ○ ○	○ ○	
14. Life below water			○
15. Life on land			○
16. Peace, justice and strong institutions	○	○ ○	○ ○
17. Partnerships for the goals			

Each ring corresponds to one activity

In some cases the workshop participants found it difficult to decide whether an activity should be categorised as "strategic", "tactical" (which both imply a more indirect possibility to influence) or "operational" (which means a more direct possibility to influence). Sometimes they argued that activities were relevant for all three levels. For example, for some participants, the cycle strategy is seen as operational since this is something concretely produced by the organisation, while for others it is tactic. Furthermore, as shown in Table 1, no participants placed notes for SDG 17. Partnerships are central for this type of authority and one explanation for this result is that partnerships are key in order to realise all visions, strategies and projects that the region deals with and that partnerships therefore are part of many of the other goals. As for SDG 10, this is addressed in a strategy for the region that the workshop participants perceived of as being overarching all SDGs (Östgötakommissionen). So the lack of notes at SDGs 10 and 17 does not mean that there is no activity for these goals; it is just a result of how the participants perceived that their activities matched the SDGs.

The screening done in the workshop gives an initial hint of the relevance of SDGs for RÖ and also the importance to discuss the actual power to influence related to the Region's three main areas of tasks and responsibilities (i.e. health care, transport and urban planning, and regional development). The next sub-chapters give a brief summary of the activities that were identified in the workshop. This summary is not entirely coherent with the quantitative overview of the results presented in Table 1 as the rings in the table may represent doubles and overlapping activities.

5.1 Activities and Opportunities to Implement the SDGs Within the Responsibilities for Health Care

Providing equal health and medical services to all citizens, including refugees and asylum seekers, relates to SDGs 1, 3 and 5. Everybody, regardless economic or social status can and should be offered medical care and thus one dimension of perceived poverty can be avoided. Free high-quality medical care is also one cornerstone to ethnical, religious, sexual and gender equality.

Also as employer, service provider and purchaser RÖ can implement strategies to contribute to the SDGs: treating employees equally (SDG 5); actively preventing and reducing contaminants in waste water (SDG 6) and the use of energy and other resources (SDGs 7 and 12); implementing purchasing requirements related to CSR and resource efficiency (SDGs 8 and 12); and actively reducing GHG emissions from vehicles, nitrous oxide and energy use (SDG13). This means that there is potential to substantially contribute to the SDGs within the direct power of the organisation.

5.2 Activities and Opportunities to Implement the SDGs Within the Responsibilities for Transports and Urban Planning

Public transport is an area within the direct power of the Region: public. Equal, affordable, accessible and available public transports can contribute to decreasing the feeling of relative poverty (SDGs 1 and 5) but also increase availability to recreational activities and areas (SDG 3). The use of fossil free fuels and clean, efficient vehicles contribute to reduced emissions of pollutants (SDGs 13, 14 and 15).

Transport infrastructure planning and urban plans may have an impact on several SDGs. Strategies for increased biking and efficient inter-modal travelling affect possibilities for a healthy lifestyle (SDG 3), but also reduce the demand for fossil-based transports (contributing to SDGs 7, 13, 14 and 15). Urban planning with a holistic approach can be a tool to address several SDGs. Planning for available digital services for a broad range of societal functions facilitate openness, access to information and possibilities to influence decision-making contribute to

increased equality (SDG 10); planning for mixed residential areas prevent social exclusion (SDG 5); closeness to services reduce the demand for transports; and taking decentralised energy production (such as solar power) into account in spatial planning facilitate the transitions for energy consumption to energy 'prosumers' (SDG 7). In all, the regional planning responsibilities possess significant potential to contribute to most of the SDGs. Implementation of the plans is, however, to a large extent outside the Region's direct influence, which puts high demands on participative and inclusive planning processes for the plans to be legitimate and accepted.

5.3 Activities and Opportunities to Implement the SDGs Within the Responsibilities for Regional Development

Among other things, RÖ coordinates vocational training, a smart specialisation platform, funds for rural development and regional development funds that can be used for co-funding relevant development projects and initiatives in order to strengthen the role of the geographical territory's competitiveness. Vocational training can be seen as a tool for preventing drop-outs from school (SDG 4), speeding up introduction to labour market (SDGs 1 and 10) as well as matching skills and competence to industrial needs and potential (SDGs 8 and 9). The smart specialisation platform is a triple-helix arena (i.e. collaboration between business, public organisations and academia) for innovation and business development that supports implementation of SDGs 9 and 10. This arena can, however, also contribute to SDGs 11–15 as clean and resource efficient system solutions for energy and waste services, clean energy and sustainable cities are all covered by Östergötland's Smart specialisation strategy. Regional development funds are pinpointed to support implementation of smart specialisation strategies. To summarise, RÖ possesses strong means to contribute to the implementation of SDGs when it comes to vocational education and skilled labour. The smart specialisation platform and development funds can facilitate innovation and provide possibilities to, for example, create test beds. The actual development of new business and innovation, however, lies outside the power of the organisation.

6 Discussion

As this paper has illustrated, RÖ has a vast range of responsibilities and tasks related to sustainability with a significant number of strategies, structures and projects related to sustainability, which apparently could be difficult to have an overview of. The SDGs could serve as a coordinating framework to elucidate in which areas action is taken and, in the longer run, how it is taken by whom and when. This could help increase the effectiveness of the Region's sustainability management. When having a clearer idea of what is done, double work could be

avoided as well as gaps could be identified. The SDGs could be a way of visualising RÖ's collected sustainability efforts which could serve as a basis for developing a more integrated and comprehensive sustainability management. Hence, the SDGs could be seen as a way of coordinating the sustainability efforts and also make them a part of day-to-day activities.

The picture outlined in Table 1 is not perhaps the right one, nor is it complete, but it gives an idea of some of the officials' and strategic planners' apprehension of how their organisation contributes to the SDGs. For examples, sometimes the workshop participants related activities and responsibilities to goals and managerial levels differently. The reason for this could be that they are biased by their own roles and individual frames of reference. This indicates that the organisation has a journey to make, towards shared and joint views on its tasks and responsibilities as well as interpretations of the SDGs.

The screening exercise could be seen as the first step towards internalising the SDGs. UN emphasises in their Agenda 2030, that it is important to have an integrated approach to the SDGs, and build on existing structures and strategies. This means that they are not implemented in parallel systems that may lead to that organisations become confused by all the different initiatives that they have to adapt and relate to.

The Swedish national delegation for the SDGs has the mission to launch a national action plan by March 2017 (Swedish National Government 2016) and once this action plan is out it is probably easier for regional/local actors to develop their regional/local strategies in order to contribute to the goals. Furthermore, with a national action plan, it is easier to choose indicators and tools for measuring and follow up the progress and thereby avoiding a situation where the SDGs only serves political ends (Graute 2016) or become a reporting exercise with little effect (Weitz et al. 2015).

RÖ is one (however important) actor among many at the regional level and one actor alone cannot take on all responsibility for the regional sustainability performance. As stressed in Agenda 2030, there is a need for a broad systems perspective and an integrated approach to fulfil the 17 SDGs (UN 2015). This means that RÖ has to implement new goals and methods into existing management structures and to collaborate with other actors. There is a need for a regional leadership for sustainability, but different themes could be led by different organisations depending on mission, competencies, etc. (as sketched out in Fig. 3). Therefore, screening in a similar manner as presented here, along with deeper gap analyses, will have to be performed for other regional and local actors too. The regional and local actors need to develop a common understanding of what they already do in relation to the SDGs, what issues that they can develop collaboration around and decide on the different organisations' roles for a regional leadership for sustainability. There are already some arenas for these types of discussions, but there is a need for a more coherent and broad approach for these discussions, and the actors in the organisations need clearer mandate to work with these issues internally and over organisational and sector boarders.

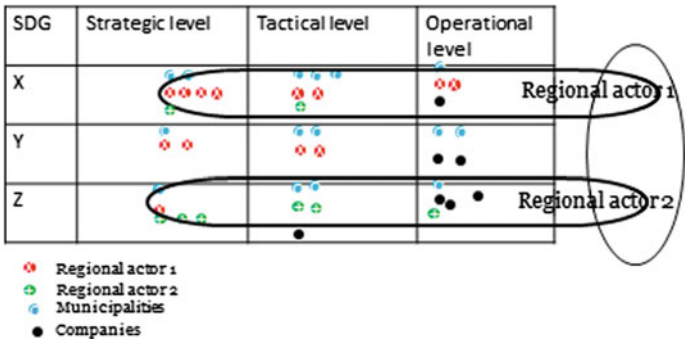

Fig. 3 Schematic illustration of how different activities towards three fictive SDGs could be distributed between the regional actors, municipalities and industry. *Source* The authors

The illustration in Fig. 3 shows a conceptual sketch of different regional and local actors that have different stakes at different levels contributing to different goals. It is of utmost importance that the regional actors are synchronised and have a good collaboration and common understanding of the regional actions towards the SDGs in order to develop an effective process. Different regional actors take the responsibility for different goals depending on the relevance of the SDGs to their respective organisations. In this, the actors have to develop an understanding of each other's agendas and world views in order to find common themes for collaboration (Eklund and Gustafsson 2015). Furthermore, they have to acknowledge that different actors have different possibilities or ambitions when it comes to sustainability management and that it is accepted that they have different goals with the collaboration. As mentioned, earlier, it is important to build on already existing structures, but not only when it comes to strategies and management. It is also important to use already existing channels and arenas for collaboration between local and regional actors and try and avoid developing new and parallel ones. There is, for example, an arena for cleantech companies (in which also a few of the municipalities and the region participate) and there are collaboration arenas for smart specialisations.

To conclude, when reflecting on Fig. 2, different actors do different things in relation to the SDGs on different levels. With what and to what extent they contribute to the SDGs vary depending on their organisations' missions, action space, agendas and ambitions. For example, the municipalities have monopoly on spatial planning in the cities; therefore, they have significant impact on such planning processes and RÖ (among other things) have an overall health care responsibility in the region. All actors cannot and should perhaps not address all SDGs, but together as a region and in collaboration, all SDGs could be covered. Having a broad systems perspective within the region is central. How this is to be organised and which actors that should be responsible for taking lead for which SDGs have to be further defined and analysed in future research. It is important to get a general overview of which actors that do what in relation to sustainability and the SDGs.

RÖ could be seen as a coordinator and a facilitator of action, being a regional actor with a broad range of responsibilities, functions and power and a broad overview of regional and local actors. However, there are also several challenges to create a shared view of the SDGs and how they should be approached related to the complexity of the RÖ organisation and its wide variety of tasks and responsibilities. The regional actors have to understand each other's worldviews and accept and acknowledge that they have different agendas when it comes to sustainability issues. This could be used as a strength and also an opportunity since it could contribute to creative collaboration relations where competition or rivalry does not hamper the process.

7 Recommendations

This paper is based on a study on RÖ; however, several of the results and reflections are probably valid also for other types of local/regional authorities or other organisations. This study therefore concludes with a set of early recommendations to organisations that are about to adopt the SDGs:

- Do not reinvent the wheel—build the SDG work on already existing structures, activities and collaboration arenas.
- To get an overview—perform a gap analysis of existing internal activities and compare this with other regional and local actors' similar gap analyses. Use this as a basis for developing the regional approach to the SDGs.
- Differentiate between possibilities to directly and indirectly influence the SDGs and develop the local and regional work based on these preconditions.
- Political support is important for the coordination and collaboration between regional and local actors—ensure that the actions are sanctioned and also budgeted for.

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Dr. Jenny Ivner is an experienced expert within the field of energy strategies and public management. She has a background in energy engineering and work experience from the building sector. From 2001 to 2011 Jenny was engaged as researcher at Linköping University, pursuing Ph.D. and post-doctoral studies within the field of local energy strategies and environmental management. Thereafter, she has been active as a consultant, senior lecturer in Energy Systems and head of development at East Sweden Energy Agency. She now works as senior adviser within energy and environment issues at Region Östergötland.

United Nations Sustainable Development Goals for 2030 and Resource Use

Ronald Wennersten and Sun Qie

Abstract

The 17 UN 2030 Sustainable Development Goals (SDGs) have a clear focus on social issues, mainly on eradicating poverty. This is concluded to be the greatest global challenge and an indispensable requirement for Sustainable Development. Some of the SDGs also include resource use, e.g. water, energy, and sustainable consumption. It is obvious, however, that if developing countries should reach the material standards of the developed countries, it will increase global use of resources dramatically. Western-style consumer lifestyles cannot be sustained globally just by transitions to systems of renewable energy and by producing goods more cleanly and efficiently. One has also to take into account an increasing global population growth, which is mainly expected to take place in developing countries. In this paper this increased resource use is analysed using the IPAT equation. It is shown that, if the UN goals should be reached, and the consumption patterns are similar as today on a global scale, resource consumption will most probably increase dramatically on a global level. This would probably lead to international conflicts and further serious effects on ecosystems. The development in China has been analysed and it is concluded that China cannot be a role model for other developing countries. This is because the Chinese development has been accompanied with huge increases in resource use and environmental degradation. In order to achieve a necessary reduction of our resource use, we need a fundamental change in how our economies deal with natural resources and the services they provide. Basically, this problem has no technical solution, but involves moral and ethics on a global scale. It is important

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to find ways away from this trend of increasing resource use, when there are still strong economies in the developed countries to support the developing countries. The developing countries will need increasing resources for their development and this will include fossil fuels for a longe perios of time. New pathways for Sustainable Development have to be found before serious international resource conflicts have developed, which will make it difficult to reach global agreements.

Keywords
SDGs · Resource use · China · Role models · Devloping Countries

1 Introduction

During the last 200 years, a fundamental and dramatic change has occurred in the world compared to human history as a whole. The large-scale exploitation of fossil energy and the technical innovations as heat engines allowed a rapid liberation from low intensity and local energy sources like biomass, wind, and water streams. This also allowed for the exchange of goods and people on long distances. The starting point for this was the industrial revolution in England around 200 years ago. This resulted in a fast growth of urban settlements. Urbanisation then started to form a global network of urban systems which we now call anthroposphere. The reason for this new concept is that the large-scale exploitation of energy-rich fossil fuels together with the fast development of technology has created a new situation in the biosphere. Humans are now affecting the environment on a global scale, and the new time period has been named antrophocene. From being only local, physical flows and stocks of energy and matter are now transported on a global level. The abundance of cheap fossil fuels has led to a situation where our production systems have been constructed in a linear way. We extract virgin resources from nature and at the end there is a waste. Most of the solutions to this are still pollution prevention that is end-of-pipe solutions.

The industrial revolution also involved a general rise in living standards and a possibility to support an increasing population. It is important to keep this development in mind when we today advocate for a return to renewable energy sources and a halt in using fossil fuels. It might be relevant to ask two fundamental questions—Is it possible and is urban development the key for success? The existing development has increased the global demand for resources like energy, materials, and water and this increase continues. At the same time, it has led to vast inequities in the world between developed and developing countries.

People in the developed countries need lots of resources to sustain their high levels of consumption, whereas people in developing countries sometimes have limited access to basic resources such as food and water. Developing countries on the other hand in many cases have rich natural resources, such as large forests and deposits of valuable minerals.

We are thus facing a situation where fast growing demands of resources have severe effects on global environment, and at the end ecosystems which are the basic support for all services to mankind.

In order to meet many of the challenges on global level, UN has launched the 2030 Sustainable Development Goals (SDGs). The goals should involve raising living standards for people in the developing countries in a way that also reduce global resource use and environmental degradation. This is done in a situation where we already can see growing competition for resources at the global level. If and how this equation can be solved is discussed in this paper.

2 Aim, Objectives and Methods

- The aim of this paper is to analyse how the UN 2030 SDGs could affect the use of resources globally in the future, and if this is compatible with sustainable development at a global level. Resources referred here are mainly energy, materials, and water, all which are central for a modern society. Part of the aim is also to analyse the situation in China, and if this development can be a role model for other developing countries?

Main research questions are as follows:

- Which are the trends and impacts of resource use on a global level?
- How will the fulfilment of the SDGs affect global resource use and which conflicting goals around resources can we find in the SDGs?
- How has China, the country with the largest population, succeeded in reducing poverty and how has this affected resource use.
- Is it possible to achieve the SDGs globally goals without a fundamental change in societal metabolisms?
- Is urbanism part of the solution for sustainable development?

The analysis is mainly based on existing statistics, which can be found in the given sources. To highlight the challenge of the problems, the IPAT equation is used. The approach taken in the paper is broad and interdisciplinary. The intention is to mainly raise some important questions around the possibility to achieve the UN SDGs without immense increase in resource use and environmental degradation.

3 Sustainable Development—Increasing Resource Use and Impacts

3.1 Sustainable Development—A Difficult Concept to Define

Sustainable development is a development toward higher degrees of sustainability in human societies and it is the focus for the UN 2030 SDGs. A more precise definition of the concept is difficult to find, but basically it has to do with finding long-term solutions where human societies globally can stabilise development, so that we are safely within the carrying capacity of the earth system. This means that the societies should develop their economic systems so that the population today, as well as future generations, can have decent lives and avoid serious conflicts. What makes Sustainable Development difficult is that it essentially involves moral and ethics. Morals refer to an individual's own principles regarding right and wrong and ethics refer to rules provided by an external source, e.g. codes of conduct in workplaces or principles in religions. To agree on beacons for ethics and moral is maybe the biggest challenge for sustainable development on a global level. There is no scientific solution to how resources and bio-capacity should be allocated among individuals or countries, e.g. between developed and developing countries.

A lot has been written about sustainable development and the relation between economy, social system and environment. It is important to know that these three factors are not interchangeable and equal in importance. Ecosystem services are the base for our existence and form the overarching boundaries for development. Economy and technology are tools for developing our societies within these boundaries.

3.2 Sustainable Development and Impacts from Resource Use—The IPAT Equation

As a starting point we have to figure out where we are. The ecological footprint (EF) is a measurement of the current state of resource use and waste generation. It asks, in a given year, did human demands on ecosystems exceed the ability of ecosystems to meet these demands? The EF shows that already today we need 1.5 Earths to meet the demands we currently make on nature (WWF 2014). The EF is also unevenly distributed globally between developed and developing countries. Several research programmes as "The Planetary Boundaries" show that we might be close to exceed the boundaries of the biosphere, where irreversible processes can take over our degrees of freedoms to make changes (Steffen et al. 2015). In 2016, the level of CO_2 in the atmosphere has passed 400 ppm, a level where it is probable that we will reach a temperature rise of more than 2 °C.

Humans today extract and use around 50% more natural resources than only 30 years ago, at about 60 billion tonnes of raw materials a year. Given current trends of growth, our extraction of natural resources could increase to 100 billion

tonnes by 2030 (Friends_of_the_Earth 2009). We have already reached a critical point where the impacts on the earth have to start to decrease, not increase and that we continue to increase resource use.

Human impact on the environment is a function of how we use resources and can be illustrated by the well-known IPAT equation where impact equals the product of population, affluence, and technology.

The terms in the equation can be written in different ways and one way is

$$\text{Environmental Impact}(I) = \text{Population}(P) \times \frac{\text{GDP}}{\text{Person}}(A) \times \frac{\text{Environmental Impact}}{\text{Unit of GDP}}(T).$$

The equation is mainly qualitative and cannot easily be used in a quantitative way but more to show relations between influencing factors. Environmental impact is directly related to resource use in the equation.

Affluence (A) is basically related to the consumption of material goods per capita and one assumption is here that people will consume more with increasing GDP. Technology (T) is a factor describing how much we can dematerialise the production by making goods by using less materials and energy. Below these factors will be analysed more in detail.

3.3 Sustainable Development and Population

The relation between population growth, poverty, and resource use has often been debated starting from Thomas Robert Malthus in his *Essay on the Principle of Population* (1798), through paper "Tragedy of the commons" (Hardin 1968), and the report "Limits of Growth" (Meadows et al. 1972). The essence of the debate has been if the effect of population growth on resource use and poverty can be counteracted by more effective use of innovation and technology.

Currently, the world population is somewhat over 7 billion and it continues to grow though more slowly than in the recent past. The world population is projected to increase by more than one billion people within the next 15 years, reaching 8.5 billion in 2030, and to increase further to 9.7 billion in 2050 and 11.2 billion by 2100 (United Nations 2015). Population growth will mainly take place in developing countries which means it will have a significant impact for the UN 2030 SDGs.

Arguments against that resource constraints will be a problem with a growing population are mainly that we always have solved the problems historically. This is, however, no guarantee that we can solve them tomorrow. The pace of resource use now is high, and the problems historically have mainly been solved with input of more fossil energy, which has not been regarded as a problem until lately. As discussed below technology development, which is an important driver for economic development, also creates many new products that demand energy and materials.

Population growth is expected to take place mainly in developing countries in Asia and Africa, while it will be slow in developed countries. The only country that has tried to control population growth through legal instruments is China, with huge moral and ethical implications. Today, China has more or less abandoned their "one child policy". One reason for this is that the demographical situation will end in problems to support the growing number of old people.

3.4 Sustainable Development and Affluence

Global demand for resources has increased substantially since the start of the twentieth century, driven by a number of closely related trends. Across the world, countries have undergone structural economic change, shifting from agrarian societies, primarily reliant on biomass to meet energy and material needs, to urban, industrialised economies.

The technological advances that accompanied economic development have provided many more uses for resources, and greatly improved methods for locating and extracting them. Innovation has underpinned a 25-fold increase in economic output bringing radical changes in consumption patterns.

As demand for water increases across the globe, the availability of freshwater in many regions is likely to decrease because of climate change, and warns the latest edition of the United Nations' World Water Development Report (WWDR4). The Report 'Managing Water under Uncertainty and Risk' was launched today at the 6th World Water Forum in Marseille (France). It predicts that these pressures will exacerbate economic disparities between certain countries, as well as between sectors or regions within countries. Much of the burden, it says, is likely to fall on the poor.

3.5 Sustainable Development and Technology

Innovation and technology development have been key factors to solve resource problems up till today. However, the effect has been the use of more energy, mainly fossil energy. There has obviously been a development of more efficient technologies. The world economy today uses around 30% fewer resources to produce one Euro or Dollar of GDP than 30 years ago; however, overall resource use is still increasing. As we consume growing amounts of products and services, this positive trend is more than outweighed by the overall growth of our economies (Friends_of_the_Earth 2009). One reason for this is the rebound effects.

Rebound effects refer in general that the increase in energy efficiency and dematerialization is to a certain degree reduced because consumption increases. Rebound effects can be described in terms of:

1. Direct Rebound Effect—where increased efficiency and associated cost reduction for a product/service results in its increased consumption because it is cheaper.
2. Indirect Rebound Effect—where savings from efficiency cost reductions enable more income to be spent on other products and services.
3. Economy wide Rebound Effect—where more efficiency drives economic productivity overall resulting in more economic growth and consumption at a macroeconomic level.

A practical example of a rebound effect is that, when people's incomes increase, they buy bigger apartments with better indoor, climate which increases energy consumption. Another example is that products, e.g. mobile phones, have gradually been produced using less energy and materials, but more people can afford to buy a mobile phone today compared to 20 years ago. These trends are especially strong in developing countries.

There is generally a clear recognition of the rebound effect's existence, but the rebound effect is hard to measure and varies depending on the intervention (policy, technology, practice), the type of products/services/resources investigated (energy, food, transport, etc.), as well as other related factors, e.g. income level, productivity, price elasticity, saturation, location and time.

In evaluating the consequences of achieving the UN 2030 SDGs it is important to consider that there are rebound effects. They can be seen in the Chinese analysis in Sect. 5.

4 The United Nations UN 2030 Sustainable Development Goals

4.1 Challenging Targets

On 25 September 2015, countries in UN adopted a set of 17 goals (SDGs) to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable development agenda (UN 2015). Each goal has specific targets to be achieved over the next 15 years. This programme is a continuation of the earlier eight Millennium Development Goals (MDGs), all by the target date of 2015. The global objectives of the SDGs are aimed at eradicating poverty and hunger, realising human rights for all, achieving gender equality and empowerment of women and girls and ensure lasting protection of the planet and its natural resources. It is from the beginning obvious that the SDGs involve conflicting targets in many dimensions. Taking into account the global political situation, this is a huge challenge which can easily be going towards a blind alley if not realistic measures are taken. One central conflict in the SDGs is around global use of resources like energy,

One of the great strengths of the SDG framework in its current formulation is its recognition of the intimate links between human well-being, economic prosperity, and a healthy environment. In its adoption, it must send out a clear message that restoring and maintaining the health of the natural resource base is a necessary condition for eradicating poverty and sustaining economic progress for all (UNEP 2015).

4.2 Goal Conflicts

The UN SDGs involve many goal conflicts which will be difficult to formulate quantitative goals for. It is easy to formulate qualitative goals which are not really binding because they have general and fuzzy formulations. The 'water-food-energy nexus' illustrates the difficult choices, risks and uncertainties facing policymakers today. There are many examples of intended or unintended consequences of promoting one cause over others (e.g. food security rather than energy or water security). A key challenge will be to integrate the complex interconnections into response strategies that take into account the various trade-offs and the interests of different stakeholders.

Other conflicting goals to be handled are as follows:

- How should resources be used concerning today and for future generations?
- How should responsibilities be distributed between developed and developing countries?
- Which should be the balance between exploiting resources and that the environment should be preserved, when boundary conditions for healthy ecosystems cannot be clearly formulated?
- Should developing countries restrict consumption in order to give space for consumption in developing countries?
- How should the conflict of land use for energy or food purposes be handled?

4.3 Which Specific Goals Will Affect Resource Use and How?

The UN 2030 SDGs have a clear focus on social issues like health, education, and poverty reduction. However, it is clear that these goals are linked to an increased use of resources like energy, materials and water. In Appendix, there is a result of a qualitative analysis which goals affect resource use in different degrees. This analysis is mainly based on looking at the development in China. The Chinese example is also used in order to see if China can be a role model for sustainable development and poverty reduction.

4.4 Which Measures are Taken to Avoid Increasing Use of Resources in the SDGs?

Several of the goals set out in the document refer explicitly to matters of resource use and its effect on the environment (Perchard 2016):

- Goal 6 aims to halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.
- Goal 9 revolves around 'building resilient infrastructure with increased resource-use efficiency and greater adoption of clean and environmentally-sound technologies and industrial processes' by 2030.
- Goal 12 seeks to 'ensure sustainable consumption and production patterns'. Member states agreed to achieve the 'sustainable management and efficient use of natural resources' and 'halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses' by 2030. This goal also seeks to 'substantially reduce waste generation through prevention, reduction, recycling and reuse' and 'ensure that people everywhere have the relevant information and awareness for Sustainable Development and lifestyles in harmony with nature' by this date.

Other goals include reducing the 'adverse per capita environmental impact of cities' (including by paying 'special attention' to municipal and other waste management), increasing the number of cities adopting resource efficiency policies, boosting renewable energy and energy efficiency. Highest priority must now be given to policies and actions that promote and enable radical decoupling of economic growth from natural resource consumption and environmental impacts. Such measures will need to lead to great increases in resource efficiencies of the world's production systems and increased sustainability in the lifestyles its peoples lead. This requirement is so fundamental that Sustainable Consumption and Production (SCP) has been given both an overarching status and a specific goal among the 17 SDGs, from UNEP (2015). How this can be done will be discussed further on.

4.5 Are the UN 230 SDGs Realistic Without Fundamental Changes in Economic Growth Models?

The UN 2030 SDGs have ambitious goals to reduce poverty and raise health conditions for people in developing countries. However, the means to do this without also increasing resource use are very general formulated and not anchored in the practice we see today. There is a tendency to believe too much in 'leapfrogging' which may accelerate development in developing economies by skipping inferior, less efficient, more expensive or more polluting technologies and

industries and move directly to more advanced ones based more on service industries than manufacturing. Using China as an example the realism behind these assumptions is discussed in Sect. 5.

The current discussion of climate change and resource problems is generally based on the assumption that technology development plays a central role and that the task is essential to determine the most effective ways. This view relies heavily on the expectation that renewable energy sources can be substituted for fossil fuels. Little attention has been given to the critical assessment of the potential and the limits of renewable energy. This discussion improves on an earlier attempt to estimate the investment cost that would be involved in deriving total world energy supply from renewable sources. It is concluded in some reports that the investment cost would be unaffordable also if technology development and price reductions are taken into account (Trainer 2012).

A conclusion here is that population and consumption in developing countries will continue to rise. Even if we would assume a levelling out of consumption in developed countries (Which is highly uncertain), it will lead to a huge increase in global consumption if developing countries would approach the consumption patterns in the developed countries. In order to develop these discussions more in practice, the next section will give an analysis of the development in China in relation to the UN 2030 SDGs.

5 China—A Specific Example for Analysis Regarding UN SDGs

5.1 How is China Developing in the Area of Sustainable Development?

For several reasons, it is interesting to look closer into the development in China in relation to the UN SDGs. Is it so that China can be a role model for Sustainable Development to other Developing countries concerning the fulfilment of the SDGs?

Since initiating market reforms in 1978, China has shifted from a centrally planned to a more or less market-based economy and has experienced rapid economic and social development. GDP growth has averaged nearly 10% a year—the fastest sustained expansion by a major economy in history—and has lifted more than 700 million people out of poverty. China reached all the Millennium Development Goals (MDGs) by 2015 and made a major contribution to the achievement of the MDGs globally.

In the end-of-mission statement on China, by Professor Philip Alston, United Nations Special Rapporteur on extreme poverty and human rights, it is concluded that (Alston 2016):

‘China’s achievements in alleviating extreme poverty in recent years, and in meeting highly ambitious targets for improving social well-being, have been extraordinary’.

And further on:

'Although its leadership continues to grapple with enormous challenges in terms of slower growth rates, dramatic inequality, deep-rooted environmental degradation, and a struggle to define the rule of law, its determination to build a 'moderately prosperous society' free of extreme poverty cannot be doubted'.

It thus seems that China is a successful story when it comes to social development and reducing poverty but is less successful when it comes to decoupling economic growth from increasing resource use and environmental degradation. Another problem in China is, although the living standard is raising in general, the gap between rich and poor is increasing. China is becoming more unequal as it gets richer, with about a third of the country's wealth now concentrated in the hands of 1% of its citizens. The Gini coefficient, a widely used indicator of economic inequality, has grown sharply over the past two decades.

5.2 Chinas Economic Development and Resource Consumption

China for many years had a remarkable economic growth in terms of GDP. One reason for this is the growth of the manufacturing industry producing low and medium tech products which are exported worldwide. Linked to this development, China's per capita consumption of materials grew from one-third to over one-and-a-half times the world's average levels from 1970 to 2008.

According to a report released by the United Nations Environment Programme (UNEP), China has surged ahead of the rest of the world in material consumption, creating intense environmental pressures (West et al. 2013). The report found that China's growing affluence has made it the world's largest consumer of primary materials (such as construction minerals, metal ores, fossil fuels and biomass), with domestic material consumption levels four times that of the USA. Domestic consumption of natural resources per capita increased at almost twice the rate of the whole of the Asia Pacific region due to massive investments in urban infrastructure, energy systems and manufacturing capacity.

Compared to Japan, China's material intensity of GDP is very high. However, this is mainly because Japan is importing already processed materials at a higher end of the value chain, thus exporting material intensity to other countries like China. Global trade has made it difficult to evaluate figures for resource use and GHG emissions since many developed countries have exported their use of energy and materials to developing countries.

China is undergoing a massive process of urban development. In 2008, more than 600 million people were living in 655 cities, pushing the urbanisation level to around 45%. According to the Chinese Governmental report, issued at the beginning of every year, the urbanisation rate will reach 60% by 2020. With the process of urbanisation continuing at such a rapid rate, a further 300 million to 400 million rural residents are expected to move to urban areas in the next 20 years.

This development is part of the Chinese government's strategy to modernise China, but it is also a strong driver for increased resource consumption.

5.3 Resource Consumption Patterns in China

In Sect. 3.2 the IPAT equation was used in order to describe how environmental impact and resource use consumption depending on population, affluence and technology.

In relation to this, Table 1 reveals some Chinese statistics for the period 2010–2014. While the population growth is moderate the growth in GDP/capita is remarkable. Following this growth we can also see how incomes have increased and how consumption of goods and energy follow the same trend.

A more detailed analysis of the Chinese development for resource consumption using the IPAT equation can be found in a report from UNEP (West et al. 2013) where some central conclusions are as follows:

- China's great advances in economic development over the last decades have greatly increased China's demand for natural resources, and so the environmental pressures associated with extracting, processing and using those natural resources.
- Increasing affluence is by far the most important driver of resource pressures in China, far more important than population growth. During the period 2000 to 2008, affluence had over twenty times the influence that population growth had on domestic material consumption per capita

Table 1 Statistics for consumption development in China 2010–2014

Factor/year	2010	2014	Increase in % (integer figure)
Population	1,340,910,000	1,367,820,000	2
GDP (Yuan)/Capita	408,903.0	636,138.7	56
Total consumption of energy[a]	360,648	426,000	18
Mean income per capita (Yuan)	10,046	20,167.1	101
Household expenditure rural (Yuan/household)[b]	4941	8744	77
Household expenditure urban (Yuan)[b]	17,104	25,499	49
Total resale of consumer goods[c]	156,998.4	271,896.1	73
Possession of private vehicles[d]	5938.71	12,339.60	108
Annual per capita energy consumption of households kg SCE	273	346	27

China statistical yearbook 2015
[a]10,000 tonnes of SCE
[b]Level in this table are calculated at current prices
[c]Data for 2010 and 2011 from the 2012 statistical yearbook
[d]10,000 units

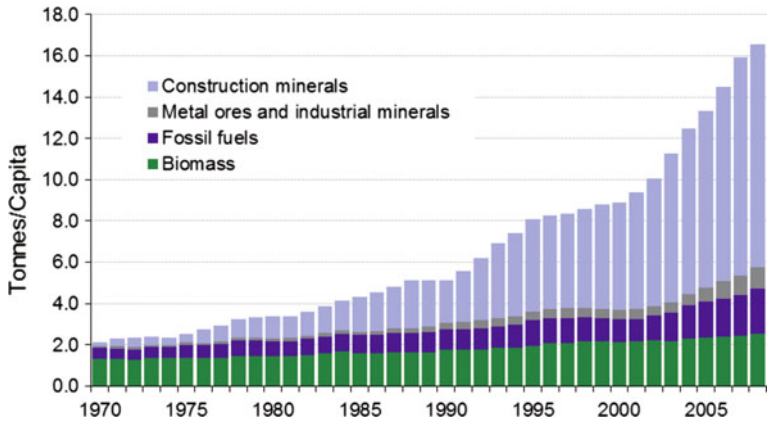

Fig. 1 China's domestic material consumption per capita, by major material group, from 1970 to 2008 (West et al. 2013)

- Despite massive increases in material requirements, China still continued to meet the great majority of new demand overall from domestic sources of supply. Its reliance on imports for some key materials is, however, increasing rapidly.

This development in China has been accompanied by an increase in the use of material resources which can be seen in Fig. 1.

The development in energy consumption follows a similar trend as for materials such as metals and minerals. Several international reports have concluded that China is on the way to replace coal with renewable energy. In a report from Greenpeace it is written as (Greenpeace 2015):

"In China, which has been responsible for half of global demand, coal consumption levelled off in 2014 and has been falling rapidly in 2015, driven by economic rebalancing, a war on pollution and an astonishing growth in renewable energy."

In another report from WWF (2016) it is written as:

"Despite 2016 set to be another hottest year on record, global CO_2 emissions have stabilised over the last two years, with some arguing they may even have peaked, and it looks like China's huge coal burning may have finally peaked too. Economists say this is likely a permanent trend."

It is difficult to see how these conclusions can be drawn looking at official statistics where it can be seen in Fig. 2 that coal keeps its dominating role as the primary energy source.

During the years 2014 and 2015 there is not much change in these figures. The share of coal in total energy went down with around 2%, but the total amount of coal is increasing. Oil and natural gas are increasing and the total figures for wind and PV are less than 1%.

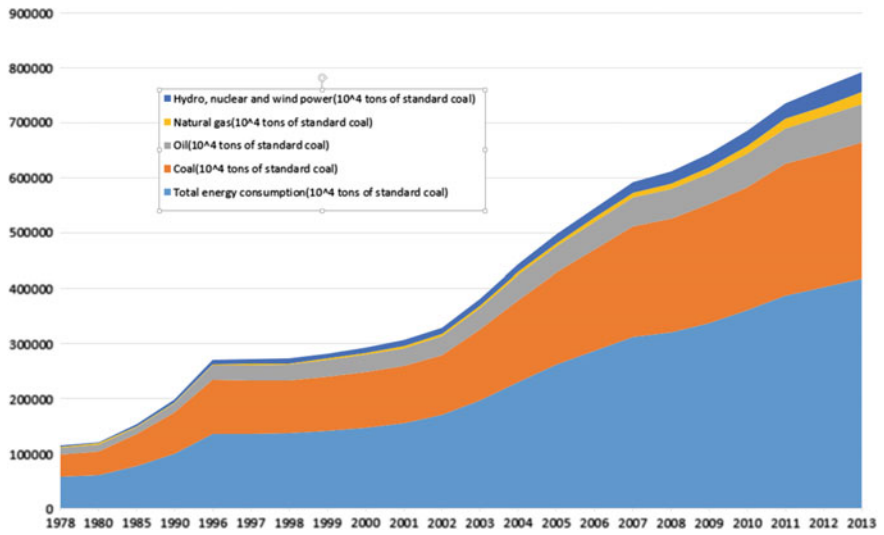

Fig. 2 China's total energy consumption constitute up till 2013 (the National Statistics Bureau in China)

Looking into the future China has signed the Paris agreement from 2015 and it has nationally determined its actions by 2030 as follows (Wei 2015):

- To achieve the peaking of carbon dioxide emissions around 2030 and making best efforts to peak early;
- To lower carbon dioxide emissions per unit of GDP by 60 to 65% from the 2005 level; and
- To increase the share of non-fossil fuels in primary energy consumption to around 20%.

This means that the use of coal will continue to increase till 2030 and it is highly uncertain what happens after this.

5.4 Counteracting Trends

One conclusion from above is that China has a high material and energy intensity in its manufacturing industry, but on the other hand it also remains among the most successful in improving resource efficiency. China is also one of the first countries to embrace the circular economy approach as a new paradigm for economic and industrial development. China's Circular Economy Promotion Law came into force in 2009 and aims to improve resource efficiency, protect the environment and achieve sustainable development.

According to a UNEP-backed study released earlier this year, China consolidated its position in 2012 as the world's dominant renewable energy market player-up 22% to US$67 billion—thanks largely to a jump in solar investment. However, impressive these figures might look, renewable energy sources except from hydro have no significant role in the Chinese mix, as can be seen in Fig. 2.

A conclusion from the UNEP report concludes (West et al. 2013):

"Relative both to its region, and to the World, China's performance in improving resource efficiency has been exceptionally good. Unfortunately these improvements have not been sufficient to offset the additional resource demands created by increasing per capita income. Furthermore, the rate of improvement has slowed somewhat in recent times."

5.5 Has China Decoupled Its Economy from Environmental Impacts?

Decoupling, or eco-economic decoupling, refers to the ability of an economy to grow without corresponding increases in environmental pressure. In many economies, increasing production (GDP) raises pressure on the environment. An economy that is able to sustain GDP growth without having a negative impact on environmental conditions is said to be decoupled.

The OECD has made decoupling a major focus of the work of its Environment Directorate. The OECD defines the term as follows: the term 'decoupling' refers to breaking the link between 'environmental bads' and 'economic goods'. It explains this as having rates of increasing wealth greater than the rates of increasing impacts.

It is notable that there is a difference between relative and absolute decoupling when using the term.

Relative decoupling refers to a decline in the ecological intensity per unit of economic output. In this situation, resource impacts decline relative to the GDP, which could itself still be rising. However, in this situation, total environmental impacts would still be increasing, albeit at a slower pace of growth than in GDP.

Absolute decoupling refers to a situation in which resource impacts decline in absolute terms. Resource efficiencies must increase at least as fast as economic output does and must continue to improve as the economy grows, if absolute decoupling is to occur.

Decoupling can also be related to the use of specific or general resources or it can be related to emissions often Green House Gas emissions, and then mostly CO_2 emissions.

Taking global trade into account, it can be difficult to calculate data for decoupling. Data can only be related to production but also to consumption. One country which has claimed it has decoupled its economic growth from CO_2 emissions is Sweden. Sweden has the highest level of CO_2 tax worldwide, and it is argued that Sweden provides strong evidence that decoupling GDP growth from

CO_2 emissions is possible and that CO_2 tax is an efficient way of achieving a decrease in CO_2 emission with fossil origin. However, in a recent report from Statistics Sweden it is shown that Sweden has emitted less and less greenhouse gases for the past 20 years. On the other hand, the emissions assigned to the Swedish consumption, which is emitted in other countries like China, increased by 50% during the same period.

The question is then if China has decoupled its economy from environmental impacts.

When it comes to construction materials, metal ores and industrial minerals, we can see from Fig. 1 that this is not the case. When it comes to CO_2 emissions from fossil fuels it is rather clear from Sect. 5.3 that the use of fossil fuels will continue to increase till 2030. There have been signs that the use of fossil fuels for energy use has levelled out during 2013–2014, but it is too early to conclude that this is a trend.

5.6 Conclusions for China

China has taken a huge step forward in reducing poverty, one of the main goals in UN 2030 SDGs. This achievement has been reached through massive inputs of material and energy resources (mainly coal).

It has been argued that the massive use of resources for infrastructure development in China has already been done and we can now expect a period with use of less resources (West et al. 2013). However, this is highly unlikely for several reasons:

- Much of the needed infrastructure on the countryside and especially in the western parts still remains to be built.
- The fast development of buildings with questionable standards probably has to be rebuilt in the future with higher comfort demands and energy requirements.
- The already built infrastructure will also require maintenance, a factor often overlooked in China with short sighted investments.
- Large investments in domestic water infrastructure and others to handle climate change adaption have to be done.

One important factor for social development and poverty reduction in China is that the manufacturing industries have kept up employment among the increasing urban population.

China is now entering a period where its domestic resources will not be enough to support its own development. The Chinese government is well aware of this and it is seeking alliances internationally to support further import of resources. However, it is likely that developing countries will need these resources for their own development, if it should follow the Chines model. Developing countries, e.g. in Africa, have a huge deficit in all aspects of infrastructure, from power capacity, with some of the most expensive electricity in the world, to a lack of highways, with trade between neighbouring countries and region sometimes almost impossible. Could then other developing countries follow other models?

In the UN SDGs there is a belief that developing countries could skip the manufacturing stage and move directly from primary industries like agriculture and mining straight to services which are less resource consuming. This would completely contrary to China becoming the workshop of the world in the 1990s after first reforming its agricultural base.

Vera Songwe, regional director for western and central Africa for International Financial Corp, the World Bank Groups investment arm, insists it has to develop both manufacturing and services. "Africa is 1.1 billion people, and the idea that you can put 1.1 billion people to work without mass manufacturing is not credible" (Moody 2016).

Contractors, developers and designers from China are already having a tremendous impact on African development. Not far from the Angolan capital of Luanda lies arguably one of the most impressive examples: Kilamba New City. A massive housing development designed to accommodate 500,000 people was built by the China International Trust and Investment Corporation. The repetitive compound design is very similar to housing units being constructed all across China. This raises the question if really China's own experience in fast, large-scale urbanisation will benefit Africa.

When it comes to energy it is obvious that China's dependence on coal will remain for a long period with large GHG emissions. It seems that the Chinese government has realised this situation when it comes to investing in R&D. In 2016 there is a lot of research funding going into clean coal technologies. From a global perspective, clean coal would also need reduction of GHG emissions. To reach this goal it will probably be necessary to develop Carbon Capture and Storage (CCS) on a very large scale (Wennersten et al. 2014). The question is if China is willing to do this without international agreements because it will reduce the efficiency of the coal power plants and raise the price of electricity.

Finally, it is important to look at the Chinese development using absolute, not relative figures, where percent development in a specific area, e.g. in renewable energies, is used to create an impression of very fast development in a positive way. It often seems like people use these relative figures on renewable energy to support a thinking that the ongoing development is possible and that we just switch to renewable energy sources.

6 Towards a Growing World with Shrinking Resources and Serious Conflicts?

6.1 Increasing Use of Resources and the Idea of Decoupling

The use of resources like energy, materials and water is increasing globally. Global materials used are estimated to have increased almost tenfold since 1900, accelerating from annual growth of 1.3% in 1900–1949, to 2.6% in 1950–1999, and 3.6% annually in 2000–2009. Developing regions account for an increasing

proportion of global resource use, whereas Europe was responsible for 19% of total resource extraction in 1980 and the US accounted for 18%, by 2009 both had fallen to 10%. Asia's share increased from 41 to 57% over the same period (EEA 2015).

The outlook for energy use worldwide presented in the International Energy Outlook 2016 (EIA 2016) continues to show rising levels of demand over the next three decades, led by strong increases in countries like China and India. In the IEO2016 Reference case, total world energy consumption increases with 48% over 2012–2040. Most of the world's energy growth will occur in the non-OECD nations, where relatively strong, long-term economic growth drives increasing demand for energy.

6.2 Economic Growth Models and Urbanisation

Important factors in this development of increasing use of resources are economic growth and urbanisation which are linked to each other.

The basic assumptions in the UN SDGs are essentially going the same way. Economic growth of around 7% in the developing countries and urbanisation are the important factors for reducing poverty in the world. The development, however, shows that the price for this will be increasing use of resources and environmental degradation.

At the same time, however, there is a hope that some of the drivers of past increases in resource use could alleviate demand in the future. For example, continued structural economic change—away from industrialised systems and towards services and the knowledge economy—could offer ways to decouple further economic growth from resource use. There is just not any example of this in the world today. Similarly, a continued shift from diffuse rural living to compact urban settlements could translate into less resource-intensive lifestyles. There seems to be a common belief that urbanism is the way towards sustainability. Urban life attracts the young generation with its life styles. It is just to compare how many products are sold with the prefixes urban and rural. The city stands for speed, change and high technology and identity construction. The opportunity to realise oneself in the city's flow of goods and lifestyles seems to be a key driver of global urbanisation, which in 2006 passed the point where there are more people in the world's cities than in rural areas. In the Chinese case, urbanisation is part of a development to reduce poverty but it is obvious that it is connected to increasing use of resources. A Finnish study (Heinonen et al. 2013) showed that city dwellers are on average less sustainable per capita than rural residents. One of the reasons was, according to the study, the city's large common rooms and extensive infrastructure. When showing figures for sustainable development in developing countries it is also so that private consumption is not taken into account because of difficulties in finding consistent models to evaluate this.

In the comprehensive 2012 report, People and the Planet by the Royal Society of London (The_Royal_Society 2012) included as one of its main conclusions that there is a need "to develop socio-economic systems and institutions that are not dependent on continued material consumption growth".

The most developed and the emerging economies must stabilise and then reduce material consumption levels through dramatic improvements in resource use efficiency, including reducing waste; investment in sustainable resources, technologies and infrastructures; and systematically decoupling economic activity from environmental impact. One argument is that developed countries can show the way so that developing countries can leapfrog. In the context of sustainable development and in particular for developing countries, leapfrogging refers to skipping inferior, less efficient, more expensive or more polluting technologies and industries and move directly to more advanced ones which are more resource efficient. However, the Chinese example shows that this is difficult to achieve.

6.3 Is Decoupling of Our Economies a Way Out of This Dilemma?

Decoupling of our economies actually involves both decoupling of increasing resource use and environmental impacts from economic growth (Fischer-Kowalski et al. 2011).

In order to estimate the need for dematerializing economies and to use less resources, the Factor X method has been used. Starting with Factor 4 we now consider Factor 10. Factor 10 involves a reduction of resource turnover by 90% on a global scale. To achieve dematerialization with Factor 10 which proposes that within the next generation, human energy use must decrease by a factor of 10, and resource productivity and efficiency must increase by a factor of 10. Is Factor 10 enough if we consider the existing pace of development in the world? In a longer perspective than 2030 we can consider what will happen if the now developed countries will grow at 3% until 2070, and by that stage developing economies have attained similarly high living standards—which seems to be the aim of the global development agenda (SDGs consider 7% growth for developing countries)—total world economic output and impact could be 60 times larger than it is today. If we assume that sustainability requires that fossil fuel use and other resource consumption must be half of what they are today (and the greenhouse problem would probably require a far larger reduction than this), then what is needed is something like a factor 120 reduction in the per unit impact of GDP, not merely a Factor 10 reduction.

It seems more and more that decoupling does not have pure technical solutions but involves more focus on developing socio-economic systems and institutions that are not dependent on continued material consumption growth.

At the world summit held in Rio de Janeiro in June 2012, the United Nations Organization presented a proposal supposedly aimed at leading the global economy towards a more sustainable and equitable economic pattern. This proposal is UNO's third attempt to modify our dangerous economic model based on predatory use of renewable resources and intensive use of non-renewable resources that reduce the planet's resilience.

7 Results and Conclusions

Trends show that the global use of resources including energy, materials, and water is increasing and that this increase has serious effects on local and global ecosystems. Current global development is characterised by increasing resource use and growing inequalities between the rich and poor parts of the world population. These inequalities are in both monetary income and resource consumption. The world in which the major part of the population lives in poverty cannot be sustainable. The current development can lead to serious national and international conflicts. The UN 2030 Sustainable Development Goals is an ambitious step to solve problems around poverty and resource use. Billions of people, mostly in developing countries, legitimately demand further economic growth and increased resource consumption in the future. However, a brief analysis shows that fulfilment of the SDGs will be accompanied by a huge increase in the use of resources if the developing countries will follow the historical pathways. One country which has succeeded in its goal to reduce poverty to a high extent is China. Can then China be a role model for other developing countries? The Chinese development has been achieved through fast economic growth and urbanisation, a pathway which is also suggested in the UN SDGs. However, the achievements in China have been linked to massive increase of the use of energy and materials and environmental degradation. There are no clear signs that China has decoupled its economy from resource use and CO_2 emissions. In relation to China it is also possible to see that urbanisation is a driving force for increased consumption. Can then urban development be done in another way to improve resource efficiency? There is an ongoing discussion of the role of the concept Circular Economy which is also lifted in the UN 2030 SDGs. However, one should realise that recycling materials involve the large input of energy even if the amount of energy can be reduced for some materials compared with using virgin resources. This leads to the conclusion that an established economy built on recycling materials will also need large amounts of cheap energy which cannot be obtained from renewable energy sources. There is just too much materials going around in our societal metabolisms to solve this equation in a sustainable way. There are also no signs that China, which has adopted several policies to promote Circular Economy, can show significant results from this.

In a world with limits, economic growth and related growth in resource use will only be possible in those world regions if the currently high-consuming countries significantly reduce their per capita consumption and their share of global resource use. This is a moral and ethical problem which cannot be solved with scientific methods, but will require global agreements of which we have not seen yet. There is a strong belief by many people, also shown in the SDGs, that Western-style consumer lifestyles can be sustained and even globalised, provided the world transitions to systems of renewable energy and produces goods more cleanly and efficiently. This assumption is reflected especially clearly in political discussion on environmental issues, which consistently pushes the message that we can grow our economies while

reducing ecological impact. This view relies heavily on the expectation that renewable energy sources can be substituted for fossil fuels, but very little attention is given to the question of whether that expectation is realistic or not.

Increasing resource uses in a limited world will inevitably lead to further environmental degradation and international conflicts. It is important to find ways out of this trend when there are still strong economies in the developing countries to support the emerging economies to find new ways of development. These new pathways cannot really be detected in the UN 2030 SDGs where economic growth an urban development are in focus.

In order to achieve a substantial reduction of our resource use, it seems we need a fundamental change in how our economies deal with natural resources and the services they provide. We need to profoundly transform the way we produce and consume products and services. Such an ambitious vision cannot be realised within a timeframe of only 15 years. Economic growth and high urbanisation rates will not solve the problems with resource us, but can contribute to reduction of poverty in developing countries. In order to reach both social and environmental SDGs, it will be necessary to find new ways for development which are not necessarily built on massive urbanisation. In relation to this, it should be discussed if the Chinese export of its model to Africa is really a way forward. Models for a society's development forward cannot be imported, but is a step-by-step move where you have to start from a collective experience and maturity of individuals, companies and government agencies with a base in a cultural history.

Appendix: Analysis of Effects on Resource Use in the UN SDGs

See Table 2.

Table 2 A qualitative analysis of the influence of the goals of resource use

Goal	Effects of resource use from a qualitative analysis of targets	Importance factor for resources
Goal 1: end poverty in all its forms everywhere	Housing development and maintenance	High+
Goal 2: end hunger, achieve food security and improved nutrition and promote sustainable agriculture	Increased food production and agriculture productivity	High+
	Development of rural infrastructure	
Goal 3: ensure healthy lives and promote well-being for all at all ages	Minor effects on resources	Low
	Build, upgrade, and maintain education facilities	Medium+

(continued)

Table 2 (continued)

Goal	Effects of resource use from a qualitative analysis of targets	Importance factor for resources
Goal 4: ensure inclusive and quality education for all and promote lifelong learning		
Goal 5: achieve gender equality and empower all women and girls	Minor effects	Low
Goal 6: ensure access to water and sanitation for all	New and upgraded water and waste water treatment plants. New and upgraded landfills	Medium+
Goal 7: ensure access to affordable, reliable, sustainable and modern energy for all	New and upgraded energy production units, and infrastructure for energy services	High+
Goal 8: promote inclusive and sustainable economic growth, employment and decent work for all	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7% gross domestic product growth per annum in the least developed countries	High+
Goal 9: build resilient infrastructure, promote sustainable industrialization and foster innovation	Develop quality, reliable, sustainable and resilient infrastructure Upgrade infrastructure and retrofit industries to make them sustainable	High+
Goal 10: reduce inequality within and among countries	Progressively achieve and sustain income growth of the bottom 40% of the population at a rate higher than the national average	High+
Goal 11: make cities inclusive, safe, resilient and sustainable	Ensure access safe an affordable housing and upgrade slums Disaster protection	High+
Goal 12: ensure sustainable consumption and production patterns	Halve per capita global food waste Substantially reduce waste generation through prevention, reduction, recycling, and reuse	High−
Goal 13: take urgent action to combat climate change and its impacts	Strengthen resilience to climate related hazards and natural disasters	Medium+
Goal 14: conserve and sustainably use the oceans, seas and marine resources	Prevent from land-based activities, including marine debris and nutrient pollution+	Medium+
Goal 15: sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss	Minor effects on resources	Low

(continued)

Table 2 (continued)

Goal	Effects of resource use from a qualitative analysis of targets	Importance factor for resources
Goal 16: promote just, peaceful and inclusive societies	Minor effects on resources	Low
Goal 17: revitalise the global partnership for sustainable development	Minor effects on resources	Low

H high, *M* medium, *L* low

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A Critical Analysis of the Sustainable Development Goals

Ranjula Bali Swain

Abstract

The ambitious UN-adopted sustainable development goals (SDGs) have been criticized for being inconsistent, difficult to quantify, implement and monitor. Disparaging analysis suggests that there exists a potential inconsistency in the SDGs, particularly between the socio-economic development and the environmental sustainability goals. Critiques also raise questions on the measurability and monitoring of the broadly framed SDGs. The goals are non-binding, with each country being expected to create their own national or regional plans. Moreover, the source(s) and the extent of the financial resources and investments for the SDGs are ambiguous. This chapter quantifies and examines the inconsistencies of the SDGs. It further inspects which of the underlying social, economic or environmental pillars are that most effective for achieving sustainable development. Analyses of the data reveal that the developed countries need to remain focused on their social and environmental policies. The developing countries, on the other hand, are better off being focused on their economics and social policies in the short run, even though environmental policies remain significant for sustainable development.

Keywords

Sustainable development goals · Sustainable development incompatibility · Structural equation modelling · Factor analysis · UN data revolution

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1 Introduction

Referred to as comprehensive, far-reaching, people-centred and universal, the sustainable development goals (SDGs) have also been described as the 'transformative agenda' (UN 2014). The SDGs aim to eradicate poverty, establish socio-economic inclusion and protect the environment. Disparaging analysis suggests that there exists a potential inconsistency in the SDGs, particularly between the socio-economic development and the environmental sustainability goals (Spaiser et al. 2016; ICSU and ISSC 2015). Critiques also raise questions on if and whether the SDGs can be measured and monitored. The SDGs are non-binding with each country being expected to create their own national or regional plans. Moreover, the source(s) and the extent of the financial resources and investments for the SDGs are ambiguous. Addressing these questions, this paper investigates and presents the evidence quantifying the inconsistencies within the SDGs. It further examines alternative measures of SDGs and investigates which of the underlying pillars of SDGs (economic, social or environment) are the most effective in achieving sustainable development.

The new global SDGs are not neoteric. About 56 years ago, the OECD Convention (Article 1) targeted sustainable development to achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability and contributing to the development of the world economy. By the early 1970s, OECD began to focus on all three pillars: economic, social and environmental. It was about two decades later that the Brundtland Commission Report (WCED 1987) defined sustainable development as the *ability* of the present generations to meet their own needs without compromising the ability of the future generations to meet their own needs.

It was during the Rio + 20 summit in 2012 that an Open Working Group (OWG) with representatives from UN member countries was mandated to create a draft set of goals. The goals were to replace the Millennium Development Goals (MDGs), while providing continuity to them and motivate policymaking on both the national and local scale towards sustainability. Unlike the MDGs that had been criticized for being set in an ad hoc, insulated manner, the SDGs are a result of the largest consultation process, resulting in 17 main goals and 169 sub-targets (Ranganathan et al. 2017; UN SDSN 2015). The UN unanimously approved its new global SDGs or Agenda 2030 in New York in September 2015.

The universal SDGs have been heavily criticized. They envelop a broad range of ambitious sustainable development agenda that covers poverty to urban development to marine life. While defenders of SDGs claim that the goals reflect the complexity of development, detractors argue that the breadth is at odds with the need to prioritize (The Economist 2015). The Economist describes the SDGs as so broad and sprawling as to ' …amount to a betrayal of the world's poorest people'.

There has also been concern that the targets included in the SDGs are not the right ones. For example, the Copenhagen Consensus Centre has led an initiative to conduct cost–benefit analysis on the SDG targets, highlighting that efforts to achieve some of the targets would be 'poor value for money' and suggesting that either they should be changed or dropped entirely (Lomborg 2014). Others have been less worried about the targets per se, on the assumption that these will be further negotiated at the country level. Another issue raised has been the wording with claims that a number of targets could be constructed more clearly (UN SDSN 2015; ICSU and ISSC 2015). Some of the goals and targets use ambiguous language. The Center for Global Development (CGD) dedicated an entire blog series on how many of the targets could be improved if small changes were made to the language (Kenny 2015). Despite these issues, the SDGs stand as new global development goals agreed to by world leaders.

The IPCC (2007, 2014) has recommended that our planet's temperature should be limited to less than 2 degrees by the end of this century. This requires large-scale changes in energy systems and land use, by cutting emissions by 40–70% of the 2010 levels, by 2050 and emissions levels at zero by 2100. This necessitates immediate improvements in efficient and renewable energy by a factor of 3–4 times as compared to the current levels. It also demands greater afforestation and a reduction in deforestation. A major additional challenge is to ensure adequate investments and financial assistance for the developing countries (Campaginolo et al. 2015; OECD 2014; UN SDSN 2015). While some believe that the SDGs are financially unviable, others estimate that this would require about $2 trillion–3 trillion a year of public and private money over the next 15 years. This is roughly equivalent to 15% of the annual global savings, or 4% of the world GDP (The Economist 2015). At the moment, the Western governments promise to provide 0.7% of GDP in aid, but only a third of that materializes.

Easterly (2015) is overtly critical of the SDGs describing them as, '… beauty pageant contestants' calls for World Peace'. He argues that the whole point of the SDGs is to answer 'what should we do?', which suffers from at least three major fallacies: First, that the answers do not lead to actions; second, it is unclear that who are the ones responsible for undertaking the actions; and third, that action recommendations are the only way to induce progress. The SDGs are non-binding with the signatories committed to 'respecting national policies and priorities' with 'each Government setting its own national targets'. The shared responsibility for SDGs outcomes is collective, extending to all the leaders, UN agencies, multilateral and bilateral aid agencies, and numerous other private sector, nongovernmental and civil society actors. And the action plans are the only way to progress. Easterly (2015) forcefully reasons that the SDGs illustrate that action plans do not necessarily lead to action, collective responsibility may not necessarily be the right way to act, and there exist alternative paths to progress than the action plans.

2 Inconsistencies in SDGs and Other Challenges

By its very nature, economic growth leads to a depletion of natural resources and deterioration of environmental service (Repetto et al. 1989; Pearce and Atkinson 1993; Hamilton and Clemens 1999). In the quest for growing economic growth and higher standards of living, nature is under-prioritized (Managi and Kaneko 2009; Jorgenson 2010; Pao and Tsai 2010; Redclift 2010; Rich 2013). The very concept of sustainable development reflects the inherent conflict between the human and natural systems (Redclift 2005; Dasgupta 2013). While reviewing the SDGs, the International Council for Science (ICSU) critically pointed towards the internal inconsistency between the ecological sustainability and the socio-economic progression (ICSU and ISSC 2015). However, there is limited evidence about the nature and extent of this repeatedly claimed incompatibility of sustainability and development (ICSU and ISSC 2015; Stern et al. 1996; Redclift 2005).

Spaiser, Ranganathan, Bali Swain and Sumpter (2016) is one of the few, if not the only, study that quantifies and models these potential inconsistencies in the SDGs. Their analysis is based on an extensive dataset of 1423 economic, social, environmental and political indicators for 217 countries, covering the period 1980–2014 (including data from the World Bank, Polity IV, CIRI Human Rights Data Project, Freedom House and the Heritage Foundation/The Wall Street Journal). Spaiser et al. (2016) first employ confirmatory factor analysis (CFA) to test the consistency of an abstract unobservable construct like sustainable development. Choosing one indicator for each of the three SDG pillars a latent variable for sustainable development is estimated. These selected indicators: Child Mortality, Education and CO_2 emissions, have the highest factor loadings for sustainable development. Figure 1 (source: Spaiser et al. 2016) reveals the stark incompatibility within the SDGs framework as the CO_2 emissions load in the opposite direction on the first-factor dimension (with a proportion of explained variance of 73.5%) than economic and social pillar indicators.

Spaiser et al. (2016) further model these inconsistencies by employing the Feature Selection Algorithm (Variable Elimination Algorithm[1]). A large number of potential indicators are inspected to find the most relevant predictors of latent sustainable development data and the three selected indicators of SDG pillars. These most relevant variables are then used to fit a dynamical system model. The best model is identified according to the Bayes Factor. Based on their results, they argue that the GDP per capita has an overall positive effect on reducing poverty and increasing socio-economic, but a mainly negative impact on CO_2 emissions. Thus given the business-as-usual scenario, growth and consumption lead to incompatibility between the SDGs. However, the models also suggest some common factors that contribute to beneficial effects on one SDG dimension without having simultaneously adverse effects on other dimensions, such as, extensive health programmes for reducing child mortality, government spending on education and

[1]Variable Elimination Algorithm is a supervised feature selection machine learning method based on partial least square regression.

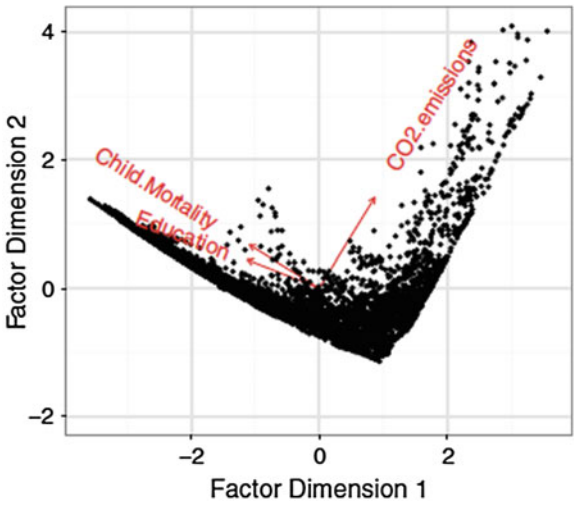

Fig. 1 EFA-Biplot of sustainable development (latent factor), comprising of the three underlying SDG pillar indicators, child mortality, Education and CO_2 emissions. *Source*: Figure 3, Spaiser et al. (2016)

environmentally friendly technologies. Thus, they conclude that future policy and efforts should shift the focus from a consumption-based economic growth to investment in human well-being (health, education) and environment-friendly technologies.

3 Challenges in Quantifying SDGs

The MDGs were appealing because they were precise and measurable (Easterly 2015). It is pointless to define goals that cannot be quantified, measured and monitored. Quantifying a multidimensional concept like sustainable development, however, is fraught with challenges. In the 1970s, Agenda 21 formulated the need for sustainable development indicators. Agenda 21 was adopted by 183 governments at the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (United Nations 1992). It was later reaffirmed at the World Summit on sustainable development held in Johannesburg, South Africa in 2002, and 2012 Rio de Janeiro conference. On sustainable development indicators, Agenda 21 (paragraph 40.4) states that: 'Indicators of sustainable development need to be developed to provide solid bases for decision-making at all levels and to contribute to a self-regulating sustainability of integrated environment and development systems'.

Focusing on an integrated economic, environmental and social framework, OECD (2004) developed indicators that could be used for sustainability. Eurostat also established a task force of national experts in 2001 in support of the European Union sustainable development strategy and the first set of indicators were adopted in 2005 and reviewed in 2007 (OECD 2008).

Initially, sustainable development was about ensuring optimal consumption that could be maintained in the long run without depleting the generated capital (where the optimal rate of consumption was equal to growth rate of population plus growth rate of technical progress). Sustainability was thus a dynamic optimization problem of intergenerational equity (Pierantoni 2004). According to Pierantoni (2004), *ability* may include a wider definition of capital that goes beyond economic capital to include human capital, environmental capital (natural renewable and non-renewable resources), and social capital. Sen's theory of development as freedom and capabilities approach also provides a wider interpretation of social capital and human capital. Sustainable development is a thus a complex, multi-domain issue that combines efficiency, equity and intergenerational equity across economic, social and environmental pillars. Sustainable development may be measured by well-being, which may be defined as the discounted present value of future utility. For it to be measured in terms of well-being, the concept of consumption needs to be broadened (OECD 2008). Dasgupta (2001) argues that well-being includes welfare and the additional benefits derived from intangibles other than consumption; for instance, presence of fundamental human rights, forest products, beautiful sunsets, etc. To a certain degree, sustainable development also remains anthropocentric as a concept.

A recent body of literature defines sustainable development in terms of Inclusive Wealth or intergenerational well-being (Arrow et al. 2012). Inclusive Wealth measures a society' s stock of all its capital assets (reproducible/productive capital, human capital and natural capital) and their changes over time accounting for population growth and technological change. Empirical evidence shows that unlike GDP per capita and Human Development Index (HDI), Inclusive Wealth Index is better able to capture sustainable development through changes in intergenerational well-being (Dasgupta, 2013). However, this measure is severely limited by cross-country, time series data availability (Arrow et al. 2012; Dasgupta 2013).

Several researchers suggest that physical capital, social capital and natural capital are the three underlying assets of sustainable development (Hamilton et al. 2004). A path is sustainable if the future per capita value of these assets is not less than the current well-being. Pearce et al. (1989) define this as weak sustainability. Determining values of these assets is difficult as for some markets may not exist. Furthermore, it is also difficult to determine the threshold beyond which an irreversible change takes place. To circumvent some of these difficulties, Pearce et al. suggest strong sustainability, which demands that some critical amount of the non-substitutable natural capital be preserved, independent of any increases in value of other social or physical assets. For instance, substitutes do not exist for global natural assets like the ozone layer. Thus, sustainability measures should include both concepts of sustainability, measuring weak sustainability in monetary units and strong sustainability in biophysical ones (tones, hectares or joules). Hamilton (2004) argues that measurement of sustainability is required for extending national accounting systems. Nordhaus and Kokkelenberg (1999) motivate sustainability measurement because for several developing countries the combination of low

saving effort, high resource depletion, high population growth, and ineffective public investments, particularly in education is critical.

Besides operationalization of SDGs, their implementation includes monitoring and measuring sustainable development indicators. Three notable publications in the emerging literature are: the GGKP Report on 'Measuring Inclusive Green Growth at the Country Level' (2016); the SDG Index and Dashboards—Global Report prepared by the UNSDSN and the Bertelsmann Stiftung (Sachs et al. 2016); and the Overseas Development Institute Report (Nicolai et al. 2015).

The GGKP Report on Measuring Inclusive Green Growth[2] (IGG) at the country level focuses on the main reliable sources and constraints for data collection at the country level. The report, however, is not limited to the SDGs but to the Inclusive Green Growth (WB 2012). Instead of the social, environmental, economic dimension, the IGG context with 'inclusive, green, growth', emphasizes their interaction in a dynamic perspective.

The Overseas Development Institute's report (Nicolai et al. 2015) develops a grading system for each of the SDGs, classifying them broadly into three levels in terms of their chance of reaching the targets by 2030. The report classifies them into reform, revolution, and reversal. SDGs that are classified at reform levels are more than halfway to achievement by 2030. These include ending extreme poverty, strengthening economic growth in least-developed countries and halting deforestation (SDGs 1, 8, 15). Goals that require progress by multiples of current rates were categorized as revolution. Nine targets belong to this group: ending hunger, reducing maternal mortality, secondary school completion, ending child marriage, access to sanitation, access to energy (electricity), industrialization in LDCs, reducing deaths and domestic resource mobilization (SDGs 2–7, 9, 16, 17). Targets classified under reversals are moving in the opposite direction and require a reversal of current trends. They include inequality, slum populations, climate change, waste management and marine (reef) conservation. (SDGs 10–14). Nicolai and others are optimistic that the least-developed countries are halfway towards their 2030 targets of ending extreme poverty, economic growth in least-developed countries and halting deforestation. In terms of regional projections, sub-Saharan Africa requires special efforts in SDG implementation.

Spaiser et al. (2016) employ a data-driven approach to measure and monitor sustainable development. They construct two separate measures of SDGs. The first model assumes a true latent variable (for sustainable development) with the three components of child mortality, education and CO_2 emissions (representing the three underlying pillars of SDGs—economic, social and environmental) as observable indicators for this latent phenomenon, which ultimately goes beyond those three indicators. Thus, the first model seeks to predict changes in this latent sustainable development variable primarily and not changes in its components. The second model primarily predicts changes in the three components and to a lesser extent changes in the true latent sustainable development variable. Spaiser et al. (2016)

[2]The GGKP report identifies five broad characteristics of IGG: Natural Assets; Resource Efficiency and Decoupling; Resilience and Risks; Economic Opportunities and Efforts; and Inclusiveness.

compare the performance of these two SDG indices with GDP per capita and HDI, in terms of the how well these indices predict changes in the three components (Child Mortality, Education and CO_2 emissions). They find that both their SDG indices perform better than the common indices for used development and economic growth, namely, HDI and GDP per capita.

Easterly (2015) argues that SDGs are encyclopedic where everything is top priority, which means nothing is a priority. He importantly points out that it is unclear how the U.N. is going to proceed in achieving the unactionable, unquantifiable targets for the SDGs, as also the unattainable ones like 'ending poverty in all its forms and dimensions', 'universal health coverage', 'ending all … preventable deaths [related to newborn, child, and maternal mortality] before 2030', '[end] all forms of discrimination against all women and girls everywhere' and 'achieve full and productive employment and decent work for all women and men'. Even staunch supporters of the SDGs will acknowledge that there is substance to Easterly and other critics. Spaiser et al. (2016), quantify the incompatibility and inconsistency in the SDGs. Most studies are sector-specific and typically ignore the synergies and trade-offs identified in multisector assessments (ICSU and ISSC 2015; van Vuuren 2015). Policy makers cannot assume that policies targeting SDGs would lead to zero-sum trade-offs (Nilsson et al. 2012).

Obersteiner et al. (2016) argue that trade-offs within the global SDG agenda will manifest as obstacles to progress at regional and national levels. For instance, in the Congo Basin satellite, data has identified that agricultural expansion and fuel wood and timber extraction are the leading drivers of deforestation and habitat degradation (Celine et al. 2013). Similarly, in Sumatra, the rising agricultural commodity prices are detrimental to tropical forests and their biodiversity (Gaveau et al. 2009).

In an attempt to address some of these criticisms, Bali Swain and Wallentin (2017) construct a latent sustainable development variable to investigate which ones of the underlying pillars: economic, social and environment have the largest causal impact on improving sustainable development. Evidence on this is critical for the path that developing and developed countries and regions might take to attain SDGs. For instance, given the limited available resources, should developing countries focus on all three pillars to achieve SDGs, or are they most successful by emphasizing development and growth in the economic and social pillar?

Bali Swain and Wallentin (2017) further compare their SDG construct with SDG indices from Sachs et al. (2016) and the Human Development Index (HDI) to investigate if these different measures suggest conflicting policy inferences to the developing and developed countries in terms of achieving SDGs. Employing Structural Equation Models (SEM) to the Sachs et al. (2016) data set, the model described by the path diagram in Fig. 2 is estimated. The ellipses in the figure (with the arrows) represent the structural model. The three underlying pillars of sustainable development are represented by the latent variables: economic, social and environment. The causal impact of these three latent variables on the latent sustainable development variable (right-hand side ellipse) is estimated in the structural model. The measurement of the three pillars of SDGs (in ellipses) is in estimated in two steps. Using the UN SDSN (2015) data, in Step 1, the Principle Component

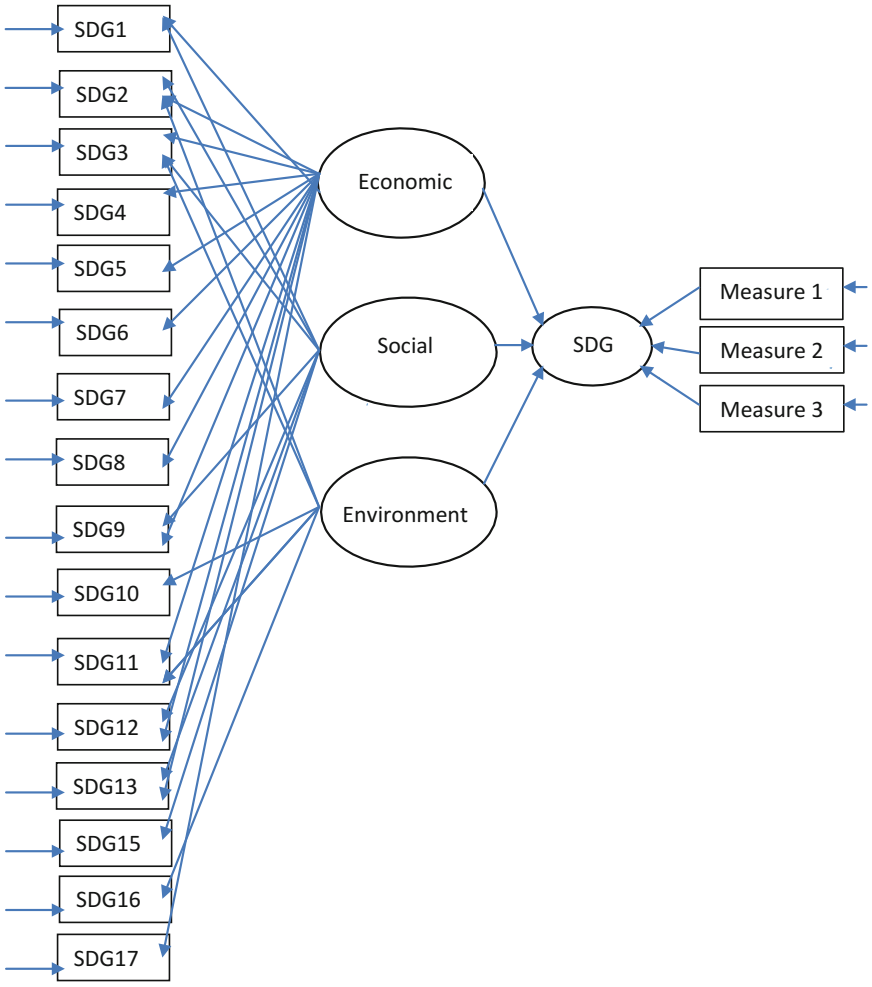

Fig. 2 Path diagram for SEM of sustainable development. *Source*: Adapted from Bali Swain and Wallentin (2017)

Analysis (PCA) is employed. The Principle Component Scores are calculated for each of the SDGs using the set of observed indicators for that specific goal. In Step 2, Exploratory Factor Analysis (EFA) is conducted to determine the SDGs (in rectangles) that measure the latent factors or sustainable development pillars (in ellipses). The other measurement model (on right-hand side) of the path diagram determines the latent sustainable development (in ellipses) using indicators (measures in rectangles).

Preliminary evidence suggests that while all the three latent factors have a significant and positive impact on sustainable development, their magnitude of impact varies (Bali Swain and Wallentin 2017). For both, the developing and the

developed countries, the social pillar remains an important feature of any policy that successfully wants to achieve SDGs. Though the environmental factor is significant for the developing countries, their impact is small as compared to the social and economic factors. Developing countries will thus attain the largest impact on sustainable development by focusing on policies that lead to economic and social development. In the short run, they may be able to decrease their emphasis on the environmental side. The developed countries cannot grow sustainably unless they focus on both their social and environmental policies. Results obtained by Bali Swain and Wallentin (2017) are in line with the literature that visualizes SDGs as an interlinked set of policies with trade-offs and synergies.

4 Big Data and Sustainable Development

Quantifying SDGs requires data and data in the developing countries is often remarkably poor. In fact, there is not a single 5-year period since 1990 where countries have enough data to report on more than 70 percent of MDG progress (UN Independent Expert Advisory Group 2014). More worryingly, about half of this data is based on firm country-level surveys; the rest are comprised of estimates, modelling and global monitoring.

Missing data is a major problem in developing countries. For instance, even for well reported variables like child mortality, 136 of the 161 countries track data on this goal (Rodriguez-Takeuchi 2014). About two-thirds of the 75 countries accounting for more than 95% of all maternal, newborn and child deaths do not have records of births and deaths, whereas twenty-six countries have no data on child mortality since 2009 (Stuart et al. 2015).

Data on ethnic minorities, regional groups and indigenous populations and slum dwellers are often left unrecorded in data sets. For example, data is rarely collected from women 50 and over; and little is available on the division of money and labour within households (UNICEF 2013). Governments and national statistics offices need better funding and training, and data collection should be more frequent, rigorous and universal.

Data challenges have implored researchers to test if big data may be used to monitor the SDGs. Big data produces large volumes of massive data generated from satellite images, social media, online commercial transactions, bank transactions data and cell phone record, etc. As Alex 'Sandy' Pentland, of the MIT Media Lab explains 'the power of Big Data Community Big Data is that it is information about people's behavior instead of information about their beliefs' (Letouze 2015). For instance, monitoring poverty or food security may be done by using cell phone activity, Call Detail Records (CDRs) analytics or satellite data (Steele et al. 2017; Elvidge et al. 2009; Smith-Clarke et al. 2014; Eagle et al. 2010; UN Global Pulse 2015). Most big data is currently owned by banks, mobile phone internet providers, social media providers, etc. To exploit its full potential, it, therefore, needs to be standardized and accessible so that the users may be able to effectively use it for

monitoring, evaluating and analysing its impact on sustainable development policies (UN 2015). Letouze (2015) points to the perils of the use of big data as there exists a potential risk to individual and group rights, privacy, identity and security. In addition to this, the legality and legitimacy of this is also questionable. Even when the data is anonymized it is possible to deanonymize it, making it very hard for any given individual to hide digitally in the data. Another problem of employing big data analyses is the risk that the focus moves towards correlation and prediction and away from the diagnostics or causal inference. Without causal analysis and the factors that affect policy impact, framing policy becomes difficult. Finally, there are fears that a 'new digital divide' might arise as a result of analytical capacities and access to data that only a limited number of institutions, corporations and individuals have. Paradoxically this would result in disadvantage for the countries and individuals that it intends to help in the first place.

5 Conclusion

The path to quantifying and monitoring SDGs is fraught with challenges. It requires a profound understanding of sustainable development, comprehension about how to operationalize and implement the SDGs, access to all forms of data and the expertise to analyse and interpret the results. This critical analysis of SDGs quantifies and examines the inconsistencies of the SDGs. The pursuit of economic growth and consumption underlies the inconsistencies between the economic and social development and the environmental goals. However, there are common denominators like health programmes and ecological sustainability that can lead to achieving SDGs without initiating the inconsistencies. Further investigating, which of the underlying social, economic or environmental pillars are the most effective for achieving sustainable development, reveals that the policy focus of the developing and the developed countries should be different. The developed countries are better off focusing on their social and environmental policies. The developing countries, on the other hand, should focus on their economic and social policies in the short run, even though the environmental policies remain significant for sustainable development.

Lack of limited availability of the data is a major constraint for quantifying and monitoring SDGs. The studies mentioned here are limited due to a data-driven approach. While data on economic indicators is widely available for most countries, data on environmental and social indicators is incomplete and of poor quality. Furthermore, studies using data-driven approaches usually lack an underlying theoretical foundation. SDGs are no exception and have often been criticized for a lack of underlying comprehensive theoretical framework. Finally, SDGs are long-term development agenda and have the potential to be exposed to unforeseen positive and negative shocks. The inferences derived from the data are based on the business-as-usual scenario using historical data. These may change in the future

while responding to positive changes by providing, for instance, incentives or adopting technological innovations.

While being a transformative agenda that is universal, people-centric and comprehensive, SDGs are also constrained by these characteristics. A situation that is made more acute by the lack of appropriate data. While future studies may explore alternative approaches to quantify and monitoring SDGs, additional challenges require emphasis on raising required resources to finance Agenda 2030 and exploring alternative Action plans at the national and regional level and ways of implementing the agenda even though it remains non-binding on countries.

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Managing the Growing Kuala Lumpur Mega Urban Region for Livable City: The Sustainable Development Goals as Guiding Frame

Abdul Samad Hadi, Shaharudin Idrus, Ahmad Fariz Mohamed, Mohd Raihan Taha, Mohamad Raffi Othman, Syed Mohammad Fitri Syed Ismail and Shaharuddin Mohamad Ismail

Abstract

In the last three decades, Malaysia has witnessed fast urban growth and spatial spread at a rate never experienced before, in response to overlapping industrial, social, economic and policy drivers. The paper will analyse the urban spatial spread from the productive towns and cities in the country, in particular, taking the Kuala Lumpur mega urban region as focus to demonstrate the spread of urbanization surfaces and the dimension of modernity among the urban people associated with urban life. The approach taken is the framework of the sustainability science, specifying issues and then taking a transdisciplinary stance to those issues. Data were then gathered from published sources supported by our own field observations of urban land use spread in parts of the Kuala Lumpur mega urban region. Despite the increasingly glittering showcasing of the state of the art development in infrastructures, housing and economic diversity there are challenges that the Kuala Lumpur mega urban region has to pay attention to, to make the city livable. Looking beyond the physical achievements to date there remains to develop what has been discussed lately about grooming the soul of the city, to instil the urbanites with globally accepted values related to what we believe should be the essence of a livable city, such that the urbanites will take responsibility to be with the authority to ensure, for example, cleanliness, safety and making the city more vibrant and attractive.

Keywords

Urban growth · Spatial spread · Urban livability · Productive city · Mega urban region · Kuala Lumpur · Malaysia

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1 Introduction

This paper is to trace the emergence of the Kuala Lumpur mega urban region amidst the growing number of large urban agglomerations in Malaysia today. The study focusses on managing the vibrant growth of the Kuala Lumpur mega urban region with its challenges to the central of the demand of the Sustainable Development Goals (SDGs). Only as far back as the 1960s observers of urbanization and urban Malaysia described the urban centres in the country as mere 'sleepy hollows' with administrative functions and offering limited hopes for modern salaried jobs in the modern market for rural migrants. Persistent in-migration of rural workers to the urban areas contributed to the excess of urban workers in relation to the ability of the somewhat limited urban infrastructures, modern shelters and amenities and jobs, producing a condition of over-urbanization (McGee 1971). Today these sleepy hollows of yesteryears have grown to become 'productive cities' coupling of course development with resource use, to show case Malaysia's attempt at embracing meaningful modernity. Urban regions consisting of urban centres from which modern urban land use spreads out far beyond the boundaries of the original urban centres have become visible on the Malaysian space economy. Indeed, mega urban areas have emerged on the Malaysian urban landscape. The most dominant among these mega urban regions leveraged on the Greater Kuala Lumpur with a population around 8 million in 2010 population census. However, urban land use has diffused to the surrounding peripheries to embrace a large area (by Malaysian standard) about 220 km from south to north and about 80 km east, the mountain range to west, the coast. Today, this Kuala Lumpur mega urban region leads the rest of the rising mega urban areas and agglomerations in Malaysia as a centre of wealth creation through its export industries, educational hub, leading financial services and infrastructural development among others. Indeed, the Kuala Lumpur mega urban region leads in the dimensions of the framework proposed by Wong (2015) for City Prosperity Index-integrating productivity, infrastructure quality of life, equity, social inclusion and environmental sustainability. In the spaces of achievements, there are challenges that need careful management.

The approach taken is the framework of the sustainability science, specifying issues and then taking a transdisciplinary stance to those issues. Data were then gathered from published sources supported by our own structured field observations of urban land use spread in parts of the Kuala Lumpur mega urban region. The secondary data such as population, land use and development plans were gathered from manuscript and published documents by various government agencies to show the transformations of the study area.

2 Urban Growth, Expansion and the Emerging Kuala Lumpur Mega Urban Region in Malaysia

As mentioned above, overlapping drivers have contributed to the emerging and fast growing of the Kuala Lumpur agglomeration into a mega urban region. These overlapping drivers are best situated in the frame of the sustainability science that emphasizes inter-connectivity of ecological, social, economic, political and institutional, local to global links and a more engaging governance (Kates et al. 2001; Komiyama and Takeuchi 2006; Marten 2006). In order to have a more global relevance for Malaysia, the frame has to engage the sustainable development goals that will focus all efforts at achieving sustainability by 2030 (Griggs et al. 2013; Nilsson et al. 2016). The emphasis on the interconnectivity of drivers strongly demands cross-disciplinary approach to the issue at hand. A disciplinary explanation is insufficient to unravel the complex interaction of the influencing drivers to understand the path dependence nature of the Kuala Lumpur mega urban area (Batty 2002; Allen 1996).

2.1 The Spread of Urbanization Surfaces in and Around Kuala Lumpur City

It is widely accepted in the literature that modern towns in Malaysia emerged with the British intervention in the Malay States in the eighteenth century, with the port towns of Penang and Singapore founded earlier, as centres of the British East India Company (British Malaya 1930). The beginning of modern towns in Sabah was linked to the British North Borneo Company whilst towns in Sarawak were associated with the Brooks family who administered the state then. Later on, these townships in the Peninsula were connected by good roads and railway lines covering the whole Peninsula such that by the early twentieth century, a national system of towns had evolved in the Malayan space economy (Lim Heng Kow 1978). In Sarawak, and less so in Sabah, the main rivers provided the easiest route of least resistance.

Independence from the British colonial control for the Federation of Malaya was in 1957, and the Federation was expanded when Singapore, Sarawak and Sabah joined the Federation in 1963. Singapore left the Malaysian federation in 1963. In both Sarawak and Sabah, townships were already vibrant, serving their respective districts but at best then they were, like the towns in the Peninsula, were sleepy hollows, known strongly for their administrative command for stability and security and safety in addition to act as local trading centres.

In 1970, the New Economic Policy with two related prongs was adopted by the country, aiming to eradicate poverty and to restructure the society such that no one race is identified with a particular dominant economic activity as in the past (Malaysia 1971). This policy provided the framework in which the globalization of Malaysian development took roots and functioned. The immediate effect of the policy was seen in the rigorous urbanization strategy of pursuing to develop the

country further. The active nation-state involvement in pushing the country's development has been summarized as the developmental state paradigm (Sundaram and Hui 2014), relegating the private sector to a secondary role at times but playing leading role at other times. Development is pursued with resource use.

By 2010, the national Population Census reported that about 72% of the Malaysian people of 28 million was already urban dwellers, with some states such as Selangor and Penang reaching almost entirely urban. If the authority defined 'urban' is relaxed to include the modern commercial agricultural areas, the rubber estates and the FELDA schemes and the urbanized urban–rural areas, more Malaysians could be categorized as urban then.

In the last two decades, continuous urbanized areas have spread out from major centres merging with smaller towns and new towns forming agglomerations that can be labelled as urban regions. The largest urban region, the subject of this discussion, the Kuala Lumpur mega urban region emerged into dominance based on its status as the national capital. Figure 1 provides a summary of the growth, development and distribution of these urban centres over those 20 years.

There is a need to look at this particular mega urban region with an extended areal urban inclusivity in history, functions and importance (McGee and Robinson 1995; McGee 2009). It has the built-up complexity and the social dynamics befitting its dominant role in the country. Moreover, the urban has become the centre of prosperity to which Malaysians and nowadays migrant workers from the surrounding countries move.

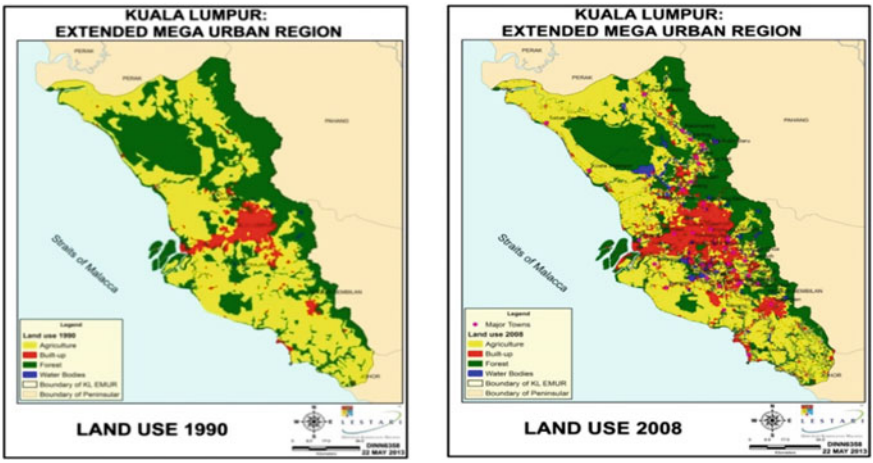

Fig. 1 The land use change in the Kuala Lumpur extended mega urban regions (KLEMUR), 1990–2008

2.2 The Kuala Lumpur Mega Urban Region: Rising to the Fore

The largest urban region as stated earlier in Malaysia centres on the Kuala Lumpur city. It literally stretches from the central mountain spine to the west coast, expanding all round to emerge as a potential mega urban region in the 1980s, covering the diffused urban area from the Bernam river basin in south Perak to the Linggi river basin in Negri Sembilan bounding an area of about 200 km, north—south, and about 40 km east-west, from the mountain spine to the Straits of Melaka with an estimated population today around 9 million people. The Bernam-Linggi embraces the combined drivers to propel the region into a prominent mega urban region in Malaysia in coming years (Fig. 1, earlier).

Historically, the seed to the growing prominence of the Kuala Lumpur mega urban region with extended urbanized area diffusing from the Bernam to the Linggi river valley in the Malaysian urban landscape could be traced back to the rise of tin producing activities in the Lukut-Sungai Ujung area in the Linggi river basin and later on in the Kanching area in the hinterland area of Selangor and also in the Klang valley around Ampang on a larger commercial scale in the early part of the nineteenth century (Khoo 1972). Khoo Kay Kim stated also that from the early twentieth century rubber growing in the areas after the failure of tapioca and coffee ventures became another economic driver to the growth of the urban areas. Khoo Kay Kim observed too that mercantile capitals from the established port town communities of Melaka, Penang and Singapore invested in these commercial activities that promoted the founding and growing of those new towns.

Thus, the townships founded during the British colonial administration time had grown and expanded in the periphery over the decades, prompted by new industrial areas and commercial functions to accommodate the inflows of global investments. Supporting service functions had slowly moved in Hadi et al. (2008). A dominant character of the extended Kuala Lumpur mega urban region is the low density of people in the outer Greater Kuala Lumpur area. Partly, this is the outcome of the availability of all weather roads connecting the kampongs, small towns, regional towns and state capital and of course Kuala Lumpur, about five decades ago and allowing for easy commuting from small towns to Kuala Lumpur.

In terms of social infrastructures, education, industrial concentration and others, the area leads the rest of the urban regions in importance in the Peninsula and in the country. In this leading position, the region can be projected to sustain its importance in decades to come. The sustaining drivers will be the fact that the region houses the national capital at Putrajaya, the largest port at Port Klang and the main industrial areas of the country, and the largest international airport, KLIA in Sepang to the south of Kuala Lumpur. Foreign embassies and heads of some large corporations are firmly established in the region. Not least, foreign visitors, shoppers and tourists in the main will use the region as the entry door to the country.

Moreover, the Kuala Lumpur mega urban region has attracted about 45% of the total people in the Peninsula, and about 34% of the total Malaysian population.

Such a large convergence of people can be related to the available opportunities in the forms of industries, services and retailing.

3 Challenges of the Kuala Lumpur Extended Mega Urban Region

At the core of the Kuala Lumpur, mega urban region remains the challenge of the governance with the relevant and right institutions to work for overall sustainability in line with the call of the sustainable goals, 2030. What sort of governance should be in place in the Kuala Lumpur mega urban region? As it is the urban land use spreads in all directions. This has put into question the overlapping responsible agencies in administering the whole urbanized stretch lying outside of each of the present administration of a town. The existing governing structures within each urban administrative entity cannot cope with the urbanization process to meet the targets of the sustainable goals.

Overall, the Kuala Lumpur mega urban region needs to produce the quality of life commensurate with the region's leading position in the Malaysian urban landscape. This falls within the broader concept of city livability, and it concerns with a search for a new way to come to grip with complex situations in the region, involving complex interactions of factors at the local level—the individuals, families and communities' in their everyday decision-makings that have produced the temporal and spatial growth patterns within the mega urban region in the past.

Thus, a recurrent issue about city growth and development in the region revolves around its sustainability in the context of sustainable development (WCED 1987). The framework has been contested widely but it still stands without rival and therefore remains useful (Dovers 2009). A window to city sustainability is best captured in the future through meeting the sustainable development goals. The concept of city livability, about shaping the city people's quality of life, about the daily lives of city people, about their decision-making, that all contribute to the people's daily life in the region, is a step towards achieving that sustainable goals. We have articulated the concept of city livability, stated in passing above, for Malaysia elsewhere (Hadi et al. 2007, 2011) to capture the essence of city's economic and social vibrancy within the framework of sustainability. The city needs also to be healthy, socially attractive to live in, safe, green with an enabling framework for an ethical living which is necessary in a world often gripped by extreme social, political, economic and weather variabilities.

The Kuala Lumpur Mega Urban Region is shaped by local and global investments to grow, as capital of a fast developing country in a relatively short time. Of the challenges faced by the mega urban region, we have identified about 10 dimensions of challenges; two associated with the environment, two with social sustainability, two with economic sustainability, two spatial with management and institutional need. On the environmental dimension, the Kuala Lumpur mega urban region has to pay attention to both the natural resources and the built environment.

Expanding urban areas means more lands are converted for housing, infrastructures, more minerals especially sands will be extracted for building construction. More water supply and energy have to be made available to meet the increasing domestic, commercial and industrial consumption. In the built-up environment, more needs to be done to control the carbon foot prints through more greening landscape, green buildings, green infrastructures and carbon emission control including wastes from food base to chemical. As the country progresses economically and socially, the invisible chemical dangers are everywhere threatening the health of the people and the ecosystems (Peterson 2013).

Moving next to the economic sustainability dimension, one dimension is to promote sustainability in economic vibrancy to meet the increase in demands for work especially among the youth. The second dimension of the economic sustainability should pay attention also to the small and medium production industries, including those small-scale agricultural producers in the urban region outside the built up area, currently involving a growing number of people. Their role is important in increasing the vibrancy of the industry and also in helping to increase the range of food security and for export products from Malaysia, and consequently providing more jobs. At the local level, the urban communities have been encouraged to engage in urban agriculture with respect to supplementing food productions.

Moving on to the two social dimensions? One direction is on the social infrastructures and the other on the inter-ethnic relations and the nagging issue of inclusivity of all people in development that has troubled Malaysia in its quest for a truly multi-ethnic society living in harmony. With respect to the social infrastructures, there is a need for sufficient affordable housings, efficient services in health care which is getting expensive, access to education from the kindergarten to the institutions of higher learning, training institutes, and centres to give a second chance to the school drop outs, and also for recreation and sports. On the challenges of the inter-ethnic issue, it is more difficult to handle because it leverages on many sensitivities related to religions, cultural norms and habits. The government concept of social inclusivity is useful and it has to be implemented with care. But to date, the Malaysians have not ‘gone on killing spree on streets and in open spaces’. However, at issue is that all Malaysians need to embrace the culture of living in harmony to forge the country ahead in the global spaces.

In addition, there are still problems with subregional inequality. The industrial subregions, perhaps, are able to showcase the accumulated wealth compared to other subregions. More opportunities are needed for the poorer subregions to enable the folks there realize their potentials in life. Closely related to the issue of regional inequality is the problem with resource scare subregions. Such subregions need to be pushed out by specific development programs.

4 Looking for Solution

There are options: one, to go on managing it as it is practiced at all levels of administration, or two, to develop partnership between the public, private and the mega urban region citizen. Another option is to develop an entirely new governing structure with shared responsibilities among the whole hierarchy of institutions, stakeholders and the government (Pierre 1999). Certainly, there is a need to decouple development from over use of resources as seen in pursuing of development and urban growth about five decades ago. While researching the Seremban urban area, we argued for an entrepreneurship approach to managing the city (Hadi et al. 2011). If the entrepreneurial approach is cast in a more open multi-level partnerships with shared common core values for a livable extended mega urban region ordered by a more ethical consideration of sharing the wealth, the Kuala Lumpur mega urban region may grow for all people in the area—the native city people, transients and visitors; The social dynamics can then be channelled to realize the promise of city livability amidst a high quality of life.

Through the viewing window of the Kuala Lumpur mega urban region, we hope to showcase a call for a system to manage people—the inhabitants and transient population—visitor from within and outside the Kuala Lumpur, Malaysians going out in their everyday life immersed in the culture of sustainability. Across the social strata and spatial domains, individual Malaysian will act in the interest of the commons to propel a sustainable life in a world full of contestations from the people. There is a need for behaviour change to accommodate considerations for other people. Malaysia now is putting forth to the world communities, the concept of 'moderation', taking the middle path always, neither extremist nor one for oneself. The ideology of moderation fits rather well with the concept of mega urban region livability in which the emphasis is on creating a mega urban region with a quality of life that emanates from the essence of sustainable development.

City well-being should be connected with the well-being of their everyday life about their neighbourhood, their families and individual activities. All can be pursued in a safe environment—safety for individual, family, household, neighbourhood, accessible to work place, to schools, to healthcare centres, to green areas, to sport and to spaces for social interaction and networking. Ease to spatial and social mobility should also be a priority. In the end, what the city people require is a happy atmosphere to bring up their children, free from the grip of fear.

5 Assembling a Framework for Urbanization Sustainability in Malaysia

5.1 The Indicators to Manage the Sustainability—A Guide

As discussed earlier, the Kuala Lumpur mega urban region has to be managed for sustainability. A framework for managing the growing Kuala Lumpur mega urban

region that should serve the current situation and long-term needs of the area is to contain two sets of indicators. One set of indicators should summarize the characteristics of all the visible layout, design, physical as well as human infrastructures, especially for inter and intra-urban mobility, amenities for the locals and also transient population including visitors and tourists. Attention is required to match the increasing number of city people with the availability of open spaces for future requirements as more people are coming to settle in the region. Another set of indicators should embody the humanizing side of the people, containing the people's positive values that will ensure sustainability of the mega city region.

The two sets of indicators are summarized in Table 1.

From the list of possible indicators above, it is asserted that to concentrate mainly on the well-being and the availability of the 'physical' indicators, that is—concentrating on what can be seen physically in the city region, it is insufficient to embed all efforts by the authorities into shaping the city livability and realizing the

Table 1 Two sets of indicators for sustainability of the Kuala Lumpur mega urban region

	Dimensions	Indicators
1	The physical indicators	• Layout of city, design high density or low density, related to mobility
		• Indicators associated with social needs; schools, health centres, hospitals, university
		• Sports and green areas
		• Retail shops and shopping complexes, wet market
		• Housings
		• Amenities; water, energy
		• Industries including small and medium industries
		• Easy accessibility to information about city condition and well-being
2	Indicators on human values to embed sustainability	• Educating individuals and community from being aware to taking action in looking after the city well-being
		• Ethical consideration for the right and needs of fellow human beings, animals and the city environment
		• Upholding the principles of keeping the city always attractive
		• Governing for sustainability—working in tandem with all stakeholders in the city
		• Using the accessibility to information about city condition and well-being for taking action
		• Avoiding extremism to preserve the general well-being of city
		• Living in harmony with fellow human beings, animals and the urban environment
		• Upholding the idea of togetherness, always offering helping hands to the needy

broader frame of sustainability. The call for the active role of the urbanites to come forward actively in helping to keep the city region always in top form is necessary. The people living in the region need to lend active supports to the authorities in the urban region to show case always for themselves and for visitors including tourists. All the positive values of the people can help to upkeep the best for the urban region. Thus, the urban region, for example, is always clean, healthy and attractive to all people.

The human and social values should begin with the individuals, transmit through the community and inhabitants of the mega urban region at large. These values can be nurtured through the dialogic model (Appleton 2014) whereby all the people, should in the end, are ever willing to show the mega urban region the best.

6 Managing the Mega Urban Region

Beyond planning for the livable mega urban region, there is a need to manage and govern the region. The main issue is who is to do what, and whether should there be sharing of responsibility in making decisions about many things in the mega urban region. There are options: one, to go on managing it as it is practiced at all levels of administration, or two, to develop partnership between the public, private and the mega urban region citizen. Another option is to develop an entirely new governing structure with shared responsibilities among the whole hierarchy of institutions, stakeholders and the government (Pierre 1999). While researching the Seremban Urban Region, we argued for an entrepreneurship approach to managing the city (Hadi et al. 2011). Given that each city and township in the Kuala Lumpur extended mega urban region house multiple forms of capital that generate the economy serving their respective owners, they will still remain the main player in the city. But if the entrepreneurial approach is cast in a more open multi-level partnerships with shared common core values for a livable extended mega urban region ordered by a more ethical consideration of sharing the wealth, the extended mega urban region may grow for all people in the area-the native city people, transients and visitors; the social dynamics can then be channelled to realize the promise of city livability, showcasing urban citizen living amidst high quality of life.

It has become clear that more Malaysians are now making the urban areas as their home base. Equally clear is the trend that major cities and municipalities in the area stretching from the Bernam river basin to the Linggi river basin are growing out from their periphery into the surrounding rural areas, creating extended mega urban. Such extended urban areas always lie outside the administrative boundaries of existing cities and municipalities but therein lies a number of contested problems such as conflicting land uses, environmental conflict, social issues, transport demand and on assessments (McGee 2009).

The existing urban management with respect to urban services and others end at the city or municipality's administrative boundary. Beyond the boundary, the land comes under a different administrative body. An urgent issue arising from the

circumstances is about policy matters. Currently, the Malaysian urbanization policy is more about the urban physical wellness, while the National Physical Plan concentrates more on delimiting the physical boundaries, more for the purpose of development. There is a need for a more inclusive urban policy that will see to it that the extended urban areas will be integrated with the city or municipality's management system.

7 Conclusion

Malaysia is now not only witnessing fast urban expansion but also the rise of urban agglomerations albeit somewhat insignificant in terms of population concentration when compared with, for example, the greater Jakarta into which the entire Malaysian population numbers can fit into. Overlapping drivers for over four centuries support the formation of the area as a huge urbanization areal unit in our spatial imagination.

In relative terms, the Kuala Lumpur mega urban region has become the most vibrant and most important urbanized area in the country. It will continue to attract people of all shades and origins, including foreign workers—legal and illegal. Above all the country has come face to face with layers of problems which are essentially urban in nature. These problems range from aspects of the environment, resources, social, economic, political, physical infrastructural and humanistic consideration. The Kuala Lumpur mega urban region faces all these layers of problems that the Federal, state government and the local authorities are working with researchers and the Institutions of Higher Learning in a partnership that will enhance science to policy outcomes for Malaysia.

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Integration of Ecosystem Services as Part of the Nexus Approach into the Applied Teaching of Ecological Engineering

Petra Schneider and Volker Lüderitz

Abstract

Sustainability awareness plays a crucial role for the practical implementation of sustainable development strategies in a globalised world. Universities have a special responsibility to take over this task within their educational mission according to SDG 4 on Higher Education and Life Long Learning. Subject of the contribution is the upgraded study course "Ecological Engineering" at the University of Applied Sciences Magdeburg-Stendal, Germany. The scientific and educational approach for the development of the upgraded curriculum is highlighted in this paper, starting with the methodology, followed by the description of the steps to an integrated resources management under the Nexus approach as framework. The main objective of the upgrade and revision was the intention to unlock the full potential of the study course for the practical implementation of sustainability for a resource efficient future. In this frame, the further scope of this paper is to highlight how the concept of Ecosystem Services, in the frame of Ecological Engineering and the Nexus approach with consideration of Material Flow Analysis, can facilitate sustainable development through its incorporation into an engineering curriculum.

Keywords

Sustainability implementation · Integrated resources management in teaching · Ecosystem services under the Nexus approach

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1 Introduction

Ecological Engineering is concerned with the development of sustainable systems in accordance with ecological principles, whereby human activities are integrated into the natural environment for the benefit of both under the scope of sustainable use of the natural capital. This approach focuses on diversity, resilience and adaptation capacity with the scope of enlarging sustainability in semi-natural and anthropogenic cycles. In this context, Ecological Engineering is concerned with both, the basic ecosystem processes as well as the engineering solutions that lead to the improvement of sustainability on all scales, and form the link between a conceptual ecological solution and the respective engineering design. Having as background the increase of environmental problems on global level, this new scientific discipline, based on engineering principles, developed rapidly. The basic idea of Ecological Engineering was already established in the early 1960s by Odum et al. (1963), the broader recognition as a new paradigm, however, is relatively new and has therefore developed particularly over the past 15 years. Teaching Ecological Engineering means to work at the interface of scientists and engineers. This requires an adapted and holistic approach in a more and more globalised and linked world, and in parallel opens up the possibility to integrate classical educational courses into the frame of the new requirements, as indicated in O'Byrne et al. (2015).

A core issue of the Ecological Engineering is the topic of resource efficiency, which is embedded in the ecosystem context. The scope is to close natural and anthropogenic material cycles as far as possible and thus reduce the environmental impact in order to achieve a better utilisation of resources as well as to reduce emissions. In this context, the efficiency of the sub-components of a system inside its system boundaries can be described and optimised by the use of management approaches, if the functional mechanism of the sub-components is well understood. The more complex a system, the more challenging is the definition of the inter-sectoral interfaces and to link them in a customised management approach. In order to implement sustainable development are needed fundamental ecological operating and management rules, as given by Daly (1990), and complemented by the Enquete-Kommission (1994).

The description of the complexity of the relationships in the management approach is usually done through indicators as suitable measurable proxies for the abstraction of the entirety of the factors. In the field of biodiversity, this concerns typical habitat indicator species as index for the population stability, while for the description of aquatic and terrestrial ecosystem services, engineering indicators are rather used, which enable strategic planning. Ecosystem services (ES) are the "benefits" that mankind are provided from ecosystems. In the Millenium Ecosystem Assessment (2005), four types of ES were derived which are provisioning, regulating, cultural and supporting ES. Different services of an ecosystem have been allocated to those types of ES, like direct provision of water and food, as well as regulation of water balance and climate. In case of disturbed ecosystems, reflected

in unbalanced substances and energy cycles, these ecosystems can no longer provide these benefits or only to a limited extent.

Striving for a more holistic management approach than the existing ones like for instance Integrated Water Management (IWRM), the Water-Energy-Food Security Nexus (WEF) was proposed linking the decision-making processes of the different sectors and examining the "trade-offs" between them in order to solve the sector's supply risks and the resulting political challenges (Hoff 2011). The concept of IWRM combines the impacts at the catchment scale with an interdisciplinary approach to ensure the best management option for man and nature regardless of political boundaries. However, with its focus on water, the IWRM often neglects the needs of users from agriculture and/or energy services. The Nexus approach to environmental resources' management examines the interrelatedness and interdependencies of environmental resources and their transitions and fluxes across spatial scales and between compartments (Huelsmann and Ardakanian 2014). Instead of just looking at individual components, the functioning, productivity and management of a complex system are taken into consideration. Further, coherent governance approaches are needed within the three sectors and cross-sectoral in order to understand, assess and manage supply risks. Taking a closer look on the WEF approach indicates the missing link to a sustainable approach: natural capital and its services. The further integration of biodiversity led to the extended Nexus-term Water-Energy-Food-Ecosystems (UNECE 2014; de Strasser et al. 2016) with the ecosystems being the interrelating factor. In order to account more fully for the benefit of ES in spatial planning in Europe, the concept of blue and green infrastructure was developed as an implementation tool for the ecosystem restoration and the spacious improvement of ES, being part of the ecological engineering approach (Lammerant et al. 2013, 2014).

A basic approach to the closure of unbalanced material cycles is the cradle-to-cradle concept by Braungart and McDonough (2002), which aims to provide the fundamental idea of a circular economy, even it does not primarily focus on a reduction of resource consumption but on a different form of usage. Practically, resource efficiency measures can even lead to a higher environmental impact due to higher consumption, which is characterised in the literature as rebound effect of resource efficiency measures (Schettkatt 2009). The cradle-to-cradle concept was developed as framework for the sector-specific life cycle optimisation of resource consuming activities in economic value chains, like products and services. The implementation of the circular economy principles was started in water and waste management, even there is still improvement potential.

Practising circular economy does not only mean the understanding of the life cycle of a product, but also to understand the mechanisms how to transform an end-of-life cycle into a circular life cycle. In the particular field of Industrial Ecology, the apparent contrary research directions of industry and ecology are merged. The basic assumption of the Industrial Ecology is that a socio-economic development can be established without larger breakdowns of the economy, society and environment only in case the interests of all these three focal parts of the sustainability concept are in line. This means to equilibrate the interests of the

respective sectors with the capacity of the ecosystems using as example the over millions of years developed strategies and structures of ecosystems as natural analogues for orientation, ideally through a "benefit sharing" approach (UNESCO 2010). The long-term scope is to transform the base of resources from non-renewable sources into a renewable one and to limit the resulting emissions to the level of compliance with the buffer capacity of the environment.

The purpose of this paper is to present how the concept of ES, in the frame of Ecological Engineering under the Nexus approach with consideration of material flow analysis, can facilitate sustainable development through its incorporation into an engineering curriculum. Basically, the scope of the study course "Ecological Engineering" at the University of Applied Sciences Magdeburg-Stendal is to integrate the wide spectrum of thematic topics, reaching from Ecosystem Restoration until Industrial Ecology, under the roof of the Ecological Engineering through a holistic approach. Even interdisciplinary and integrated teaching courses on the practical implementation of sustainable development are needed, there are existing only a small number of options in Germany. The study course "Ecological Engineering" as such exists in Germany only twice, even it is innovative and actually needed for the implementation of the UN Sustainable Development Goals (SDG). The reason is that by now exists not too much practical experience regarding the implementation of integrated ecological engineering approaches.

2 The Study Course "Ecological Engineering" at the University of Applied Sciences Magdeburg-Stendal, Germany

Founded in 1991, the University of Applied Sciences Magdeburg-Stendal in the Federal Stae of Saxony-Anhalt, Germany has a long-term gained reputation in academic education and a motivated student body. Interested students can choose from some 50 study programmes taught at three departments in Magdeburg and two departments in Stendal. About 130 professors guarantee a very good staff-to-student contact ratio, with approximately 4200 students in Magdeburg and 2100 in Stendal. Since the winter semester 2005/2006, the University has exclusively offered Bachelor and Master study programmes.

The master course "Ecological Engineering" was founded in the year 2000, being the first accredited master course at an applied university in Saxony-Anhalt. It received the first accreditation certificate in 2004, with re-accreditation in 2010. Having between 3 and 7 students per year until 2005, the number of students per year increased to 10 up to 15 in the last years. In 2005, the type of graduation changed from an M.Eng. to an M.Sc. by now. Starting in 2016, the contents of the course have been under a new revision in the frame of the re-accreditation process finalised in 2015.

In the existing curriculum the two parts, which are main working fields of Ecological Engineering, ecosystem restoration and the engineering application (in the current situation this means resources and flux management), are not integrated. This leads to the situation that the students focus on ecosystem rehabilitation (ecological planning) or Material Flow Analysis MFA (Brunner and Rechberger 2005) including Life Cycle Assessment (LCA). The current teaching modules are "Mathematical Basics", "Ecotechnology", "Biotechnology", "River development", "Planning", "Management", "Social Basics", "Inter-module project" and the Master thesis. The ecological part and the engineering part, which are necessary for the implementation of sustainability issues, are not crosslinked. The structure of the upgraded curriculum of the Master Course "Ecological Engineering" at the University of Applied Sciences Magdeburg, passing the re-accreditation process, is shown in Fig. 1. The scope of the upgraded structure of the study course was the consideration of all dimensions of sustainability. Preconditions for attending the study course are an appropriate bachelor degree with at least 180 credits and an appropriate knowledge level of the English language. The teaching staff are internal as well as external professors from research institutions. About 30% of the students graduate with international topics. By now, about 15 students continued their study with a Ph.D.

Besides lecturing, the teaching methods also include seminars with group work, field work and lab work, further home work and the master thesis preparation including a kolloqium and a poster. The study course aims to include sustainability in education and to enable the students for the implementation of sustainability in their professional life. The study course "Ecological Engineering" is innovative having the holistic approach of sustainability implementation and exists as such only two times at German universities (a study course with comparable contents is run in Munich). The holistic approach to the teaching methodology of Ecological Engineering, which integrates between disciplines and sectors, is the scope and focus of the upgrading activities of the study course.

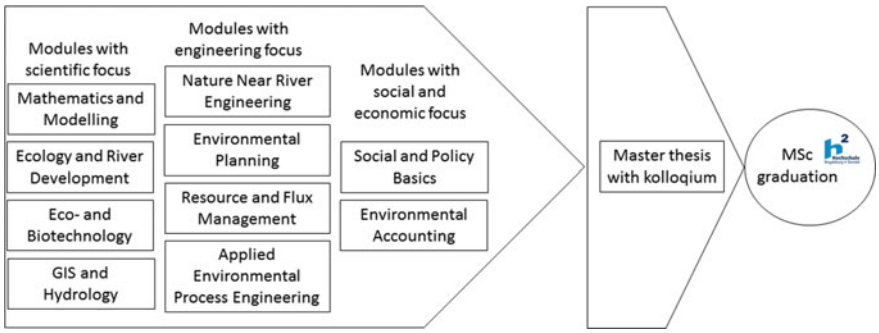

Fig. 1 Structure of the upgraded study course "Ecological Engineering"

3 Methodology

The methodology used for the development of the upgraded curriculum consisted of a background analysis (with a literature review), complemented with the collection of empirical evidence. Further, the background analysis was supported with the tools of SWOT and DPSIR analysis. The research topics for the background analysis considered the state of the art in terms of methodologies for ecosystem restoration, resource efficiency planning tools, sustainability implementation approaches and teaching approaches for interdisciplinary topics.

The SWOT (**S**trength, **W**eakness, **O**pportunities, **T**hreats) analysis is an instrument for positioning and strategy development (David 1993; Helms and Nixon 2010). The existing strengths, weaknesses, opportunities and risks are compared. The goal is a view of the situation on the basis of strategic decisions that are taken by Strengths—*obtained or expanded*—, Weaknesses—*to be reduced*—, Opportunities and Threats—*to be eliminated*. The SWOT analysis is used in educational units as a tool for analysing the overall position of work-based learning (WBL) and its environment. Generally, the SWOT analysis is carried out after taking the decision to implement or improve WBL and before the planning stage takes place in order to assess the deficiencies and the improvement needs. The results of a SWOT analysis support the process of finding critical points during the transfer of good WBL practices. Even, the methodology was developed for strategic decisions in the business field, its application to socio-scientific issues was widened in the last years (Hovardas 2015).

The DPSIR assessment approach is a causal framework for describing the interactions between society and the environment, which was adopted by the European Environment Agency. The DPSIR framework was developed to describe relationships between environmental pollution, environmental measures and socio-economic measures (OECD 1993) as a causal chain of the following factors:

- Driving forces (causes): activities that may cause pressure on the environment,
- Pressures: resulting stress,
- State: state of environmental factors,
- Impact: specific effect caused by environmental stressors,
- Responses: response to stress.

According to the DPSIR framework, there is a chain of causal links starting with "driving forces" (economic sectors, human activities) through "pressures" (emissions, waste) to "states" (physical, chemical and biological) and "impacts" on ecosystems, human health and functions, eventually leading to political "responses" (prioritisation, target setting, indicators) (Kristensen 2004). The description of the causal chain from driving forces to impacts and the respective responses is an interdisciplinary approach to assess complex and interlinked subjects like sustainability approaches.

4 Analysis and Results

4.1 Approach to a Structure of Module and Their Contents for the Curriculum

Basic step for the upgraded framing of the curriculum was a SWOT analysis, which is presented in Table 1. Starting point was a deficiency analysis of the existing curriculum, its structure and its contents as well as the type of examination procedures.

One main result of the SWOT analysis was the recognition, that it is necessary to define an appropriate frame for the different subjects of the Ecological Engineering in order to structure and harmonise the curriculum. Within this subject it must be considered that the challenge of the Ecological Engineering is the integration between natural and anthropogenic resource cycles and the description of the interrelating principles on different levels. In the case of the Ecological Engineering, this is expressed in the working field which deals with natural cycles, the Ecosystem Restoration and that which deals with anthropogenic cycles, the Industrial Ecology. Both disciplines of the Ecological Engineering are characterised by the type of their specific interrelating principles.

The mass and energy balance principle can be recognised as the fundamental interrelating principle of cycles in natural ecosystems, as a type of natural cradle-to-cradle (circular) concept, while the anthropogenic cycles of the Industrial Ecology are usually characterised by (a) the bilateral principle, (b) the core principle, or (c) the cascade principle as inter-relating mechanism, generally being a cradle-to-cradle system. In practise, there exist only a few Industrial Symbiosis sites

Table 1 SWOT analysis as need evaluation for the upgraded framing of the curriculum

Strengths	Weaknesses
• The curriculum contains a high percentage of practical work as there are scientific projects, field, lab and home work • The faculty has highly qualified teaching personnel with long practical experience, partially originating from the industrial sector • The M.Sc. degree is in parallel recognised as engineering degree by the chamber of industry in Saxony-Anhalt	Some lecture series did not have clear content boundaries between each other, a fact that caused irritation to the students Some lecture series neither had a clear content nor a clearly defined scope It did not exist a scientific framework as "organising roof" for the mixture of teaching disciplines inside the study course
Opportunities	**Threads**
• The study course includes a unique combination of subjects with a high future potential for the practical implementation of sustainability in spatial planning, green design and resource efficiency assessment • The study course was up for re-accreditation, a chance which exists each 7 years	• The study course is located at the interface between engineering and science which means a significant challenge in terms of the interlinking approaches • There was a "missing link" to connect the disciplines of the Ecological Engineering study course

where the cycles are completely closed yet. Scope of the Ecological Engineering is to make anthropogenic cycles more sustainable, that is to transform them from a cradle-to-grave into a cradle-to-cradle system.

4.2 Structuring the New Curriculum

Scope of the approach to the upgraded curriculum was the adequate consideration of all dimensions of sustainability, with the starting point of the environment as reservoir of abiotic and biotic resources including ecosystems as reservoir of biotic as general frame of the curriculum (see Fig. 2). Analysing the general framework, it becomes obvious that the Ecosystem Services are the environmental factors which exist in all types of cycles, natural as well as anthropogenic, and with this configuration further interrelating also the time-dependent effects inside a cycle. As a general frame, the interdependencies and links have been visualised as given in Fig. 2. All respective identified core subjects of the new curriculum should find their specific place in this general frame and they should be equally weighted to represent all dimensions of the Ecological Engineering. Under the framed approach in Fig. 2, this becomes feasible.

The result of the allocation of the study subjects to the core issues in the general frame is given in Fig. 3, where are visualised the disciplines under the three pillars "Ecosystem Restoration", "Ecological Engineering" and "Industrial Ecology". For the appropriate description of the interrelations between the environmental factors inside the cycles and the understanding of the spacious interrelations in the Ecological Engineering, common numerical tools like conceptual (or numerical) models and Geographic Information Systems (GIS) are used. These numerical tools form also a crucial subject of the educational training, which are available for all disciplines of Ecological Engineering (see Fig. 3).

As the implementation of Circular Economy (CE) in terms of resource efficiency optimisation is a significant step towards sustainability, the curriculum has a focus

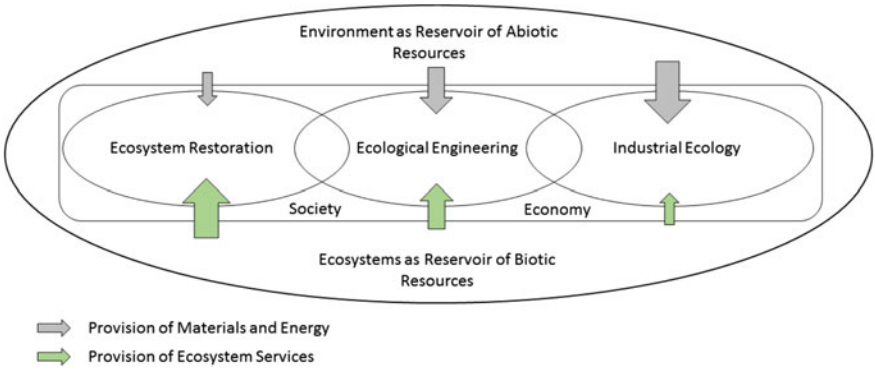

Fig. 2 Framework of the working fields of Ecological Engineering

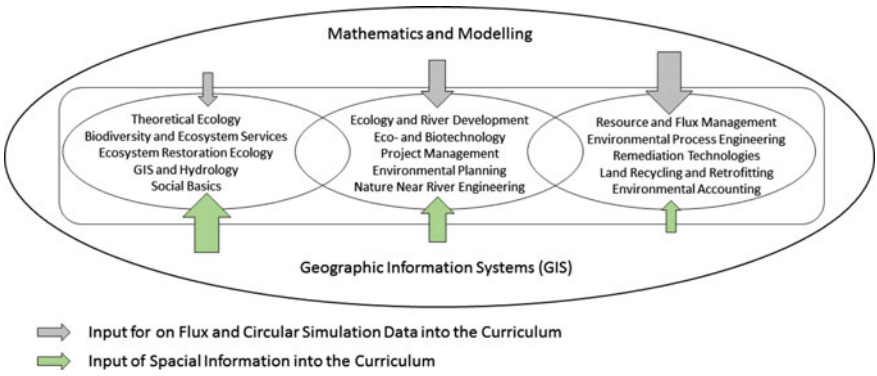

Fig. 3 Allocation of teaching subjects to the working fields of Ecological Engineering

on the cradle-to-cradle concept by Braungart and McDonough (2002) and guides the student via the concept of MFA (Brunner and Rechberger 2005) to LCA according to ISO 14040 as basics for the understanding of the system of CE, ES as interrelating factors and further interlinking principles. An innovation is the combination of the concept of ES with the concept of material flow based LCA. The LCA methodology was designed for products in economic value chains, and analyses their environmental impacts along the life cycle in defined system boundaries, an approach that forms a key concept of the Industrial Ecology (van Hauff 2012).

The approach to the LCA methodology was generally adopted from the system of natural cycles and examines the extent of the use of tangible and intangible natural resources and the impacts of their transitions in, as well as fluxes to the environment in order to arrive to an eco-efficient product design. However, the LCA methodology was developed for *one* product or *one* service, it does not consider the interrelatedness and interdependencies of material flow cycles.

At this point links the concept of Industrial Symbiosis in, focusing on enlarging the sustainability in the economy, which became popular in the past years. In the literature a clear definition does not exist yet, however, the most comprehensive characterisation was done by Boons et al. (2011), based on the definition of Chertow (2007), who summarised "engaging traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and by-products. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity". Boons et al. (2011) went beyond that definition by including a competitive advantage through the exchange of physical substances as complementary aspect as well as the consideration of social and geographical aspects. With this addition, the characterisation of Industrial Symbiosis considers the common aspects of sustainability.

A further inclusion of the concept of Industrial Symbiosis in a Nexus-oriented approach leads to a changed perspective on substances and energy cycles, from the life cycle of a product or service to the life cycle of a resource as compartment of

the natural capital. This perspective change finds its correspondence in the relation between the terms of "Resource Efficiency" and "Resource Productivity". Under consideration of a potential rebound effect of resource efficiency measures, there is the need for a careful assessment of how to distribute the available resources, e.g. for which products to use the respective natural resources. It becomes obvious that a larger demand for consumables, independent of its motivation, forces the need for transformation of the base of resources from non-renewable sources into a renewable one in order to make the ends meet. This situation indicates the appreciation of the natural capital as interrelated knot of interdependent material cycles with the ES as their physical expression.

Teaching the subject of "Industrial Ecology" holds a particular future potential of the study course "Ecological Engineering", having in view the strategy of the European Commission (EC) to increase the proportion of industry in Europe from actually 16–20% by 2020. Further, the EC aims to establish an industry policy in Europe which provides optimum preconditions for the strengthening and upgrading of a strong, competitive and diversified industrial base in Europe, reflected also in the strategic direction of the EC research programme H2020 "Re-industrialisation of Europe".

As economic issues are also driving factors in Ecological Engineering, they are considered in the study subject "Environmental Accounting". Besides micro- and macroeconomical basics, Life Cycle Costing (LCC) approaches play a significant role in the syllabus of "Environmental Accounting". Further, approaches to the monetary assessment of ES, as for instance methods which estimate (a) the cost resulting from lost ES, (b) payments for ecosystem (or environment) services (PES), (c) public private partnership (PPP)-models, as well as (d) environmental resilience grants (ERG) are included. Further, the topic of benefit sharing approaches for resources is considered in order to achieve the maximum benefit for resource providers and users, under consideration of positive and negative externalities.

4.3 Ecosystem Services as Interrelating Factors

ES are services which are produced by ecosystems through natural processes or through the function of the compartments or species which are part of the respective ecosystem that provide benefits to human (Millenium Ecosystem Assessment 2005) and without that mankind would lose prosperity (Mooney et al. 1997). Provisioning ES are for instance water, soil and wood; regulating ES are services like the water cycle, water quality or climate; as well as cultural ES are, for instance, the use for recreational and spiritual purposes. Further, supporting ES are of substantial importance as these are services like soil formation, photosynthesis and the nutrient cycles. The benefits which human derives from ecosystems are health, safety, resources for a prosperous life and social relations, which determine the life quality and allow for a level of personal prosperity.

Even the value of ES generally can be estimated in monetary terms, it is usually not appropriately reflected in the policies. According to Constanza et al. (1998) the

monetary value of the ES is in a certain way is unlimited, because the world's economy would be immediately stopped if the ES would not exist anymore. In the literature exist several approaches to the monetary assessment of ES which are reflected in the curriculum of the study course "Ecological Engineering" in the discipline of "Environmental Accounting". Under the provision that ecosystems ultimately provide tangible monetary value for the society, it should be feasible also to reflect this in the life cycle framework through the general methodology of Life Cycle Costing (LCC). In the study course, it is assumed that the concept should be transferable because ecosystems are particularly subjected to cycles, such as the cycle of natural succession. The final stage of a succession cycle represents an ecological balance of a self-sustaining ecosystem after it has gone through several stages of development and optimisation.

The complex interrelation focuses on the integration between biotic and abiotic cycles through the interrelating ES, summarised under the term Integrated Resource Management (IRM). Practically, this approach aims to integrate the Nexus approach with the concept of the EU Habitats Management Plans and unlike those explicitly focus on ES. Furthermore, it makes use of standard management approaches, based on the Plan–Do–Check–Act (PDCA) cycle. The tools applied worldwide for the quantification of the impact on the environment and its ecosystem services are Strategic Impact Assessment (SEA), Environmental and Social Impact Assessment (ESIA) and the Environmental Footprint Assessment (EFA). In contrast to the LCA, these assessment approaches do not refer to products or services, but to plans (SEA), as well as projects and activities (ESIA) which are foreseen on a certain regional unit. While SEA and ESIA are qualitative methodologies, EFA is a quantitative approach, which is usually part of ESIA.

Biotic and abiotic resources are ES that are provided by nature as natural capital, and in this way form the interrelating factor between the fields of the Ecological Engineering, applicable for the Ecosystem Restoration as well as for the Industrial Ecology. The main difference usually is the time duration of passing a full cycle and the complexity of the circularity. The importance of ES can be expressed through the DPSIR framework (OECD 1993), as presented in Fig. 4. After finding the gaps through the SWOT analysis, the DPSIR approach was used to understand how to close the gaps in appropriate way.

For the Ecological Engineering, the crucial subject for integrating with other disciplines is the design of Green Infrastructure (GI), promoted by the EU as nature-based green infrastructure solution. A network of healthy ecosystems often provides cost-effective alternatives to traditional "grey" infrastructure and offers benefits for both human and biodiversity. The mitigation of the man-made reductions of the ecosystem services is the objective and the subject of the EU Strategy "Green Infrastructure—Enhancing Europe's Natural Capital" (2013). The long-term securing of biodiversity and Ecosystem Services with the aim of sustainable economic reuse of this natural capital by means of engineering solutions is a thematic focus of the Ecological Engineering with a significant future potential. Having in view the opportunities offered by the design of GI, there is a large potential for their use for sustainable regional valorisation, particularly regional value chains (VC).

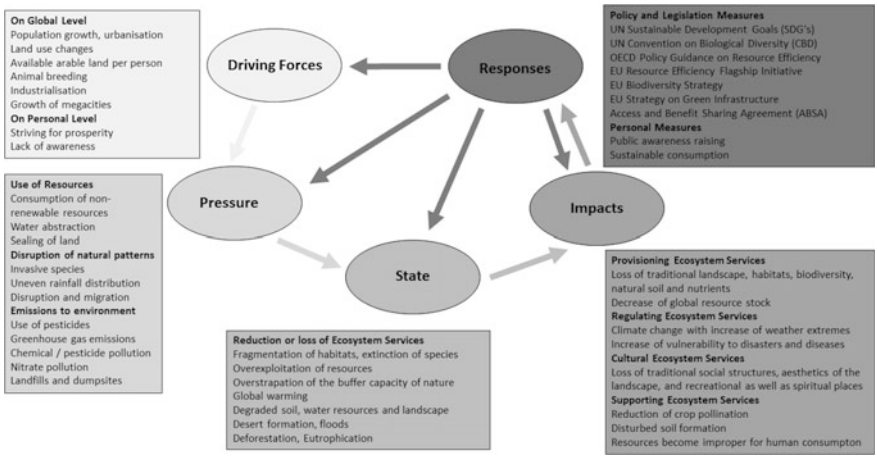

Fig. 4 Stressors to ecosystems and their services expressed through the DPSIR framework

Further, this approach allows the clear definition of improvement potential within structured utilisation and management options. The Ecological Engineering provides the interdisciplinary design tool for GI, and other approaches to design sustainable infrastructure as for instance Sustainable Drainage (SuDS) (Charlesworth et al. 2016). In addition, the concept of IRM concept is an innovative approach, and the consideration of the ecosystems and their ES opens up the possibility to teach interrelated and integrated thinking under the Nexus approach.

4.4 Approach to Teach Interrelated and Integrated Thinking

An interdisciplinary conceptual thinking is important in all natural sciences, but especially in Ecological Engineering. Teaching the capability of interrelated and integrated assessment of interdisciplinary contents is a special challenge in the teaching practice. The Nexus approach to environmental resources' management has been considered by the authors of the study course as appropriate approach to teach interrelated and integrated thinking. The scope of this approach is to raise the awareness for environmental issues as a whole. The guiding principles of the Nexus approach are to promote sustainable and efficient resource use—doing more with less—to ensure access to resources for the most vulnerable, especially the poor, and to maintain healthy and productive ecosystems (Hoff 2011). As the Nexus approach examines the interrelatedness and interdependencies of environmental resources and their transitions and fluxes across spatial scales and between compartments (Huelsmann and Ardakanian 2014), it forms a feasible frame for the "Ecological Engineering" study course due to its integrative environmental concept, even the existing practical implementation examples for the Nexus are only a few by now. Having in view the needs for the implementation of the UN Sustainable

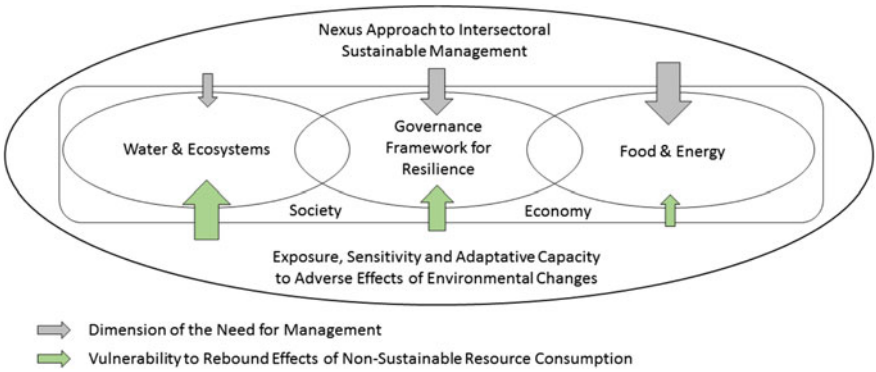

Fig. 5 Framework of the awareness raising for environment as a whole under the Nexus approach

Development Goals, the upgraded curriculum provides methodologies and management options for the practical implementation of Nexus projects. The term Nexus in general means to integrate concepts or disciplines, regardless which disciplines are considered. The authors of the study course considered the Water-Energy-Food-Ecosystems-Nexus (UNECE 2014) a practical framework for the integration of Restoration Ecology and Industrial Ecology in the curriculum.

The approach to teach interrelated and integrated thinking in integrated resources management considers the vulnerability of resources, and inside the LCA the adaptive capacity as function of resilience, see Fig. 5. Adaptive capacity is the capacity of a system to adapt if the environment where the system exists is changing. It applies to e.g. ecological systems as weak as social systems. In the upgraded study course, this concerns especially the Restoration Ecology including the design and management of GI. According to the author's experience, the implementation of sustainability and resilience in industrial and other managed systems requires a governance framework under consideration of the Social Responsibility Guidance Standard (ISO 26000).

The background analysis and literature review prepared for the development of the upgraded curriculum included also a review of Good Practice Examples of teaching curriculums with a focus on the implementation of the sustainability principles, as for instance Johnson and Hayward (2015). Those colleagues provided information about a curriculum on Circular Economy. These and other literature research results have been used as inspiration for the development of the upgraded "Ecological Engineering" curriculum and provided information about feasible structures as well as innovative teaching and learning methodologies.

4.5 Teaching and Learning Methodology

The teaching and learning methodology in the study course "Ecological Engineering" considers the typical range of methodologies to create an interesting

course with a long lasting effect on the students under consideration of constructive alignment according to Biggs and Tang (2007). The teaching methodologies include watching (video), reading (article), reflecting (key question, self-assessment), interpreting (cause-and-effect analysis according to Ishikawa (1990), SWOT analysis) and sharing (with the group). This sequence follows the classic Kolb learning cycle (1984) and reflects one of the key features of a circular economy, the feedback loops, having the function of feedback in sense-making, interpretation, promoting fresh thinking and looking at the world in a different way. With the upgraded structure and study course scope, syllabus and content become clear and highlight a) what students can expect from the study course and b) what is expected from the students.

The scope of the teaching the interrelated and integrated thinking—according to Biggs and Collis (1982) the SOLO 4,5 level is "deep understanding"—summarised below.

(a) to develop students' insights into real-world systems which are typically non-linear, complex and dynamic systems. The application of a systemic thinking aims to:

- provide insight in the character of feedback-rich systems, their effectiveness and scale,
- provide ability for the characterisation of interrelatedness and interdependencies of resources along substances flows,
- provide technical tools for identification of the balancing mechanisms of substances flow in order to create or refine circular systems,
- provide awareness for diversity and its central role in creativity, resilience and adaptive capacity, being applicable for all dimensions of sustainability.

(b) to develop students' insights on how a circularity might be understood, including the role of natural capital as a vulnerable resource, the society as resource user with economic interests and governance as framework to enlarge the resilience of managed systems. The study course aims to enable students to apply the Nexus approach as framework for interrelated and integrated thinking. Applying the Nexus approach to a natural or anthropogenic systems, through using appropriate tools like MFA, LCA and environmental accounting, provides a manageable structure of material flows.

(c) to develop students' insights about (a) and (b), using participatory learning approaches, as an example of feedback-rich learning in order to learn also the concepts for the application of "benefit sharing" approaches for shared resources, as applied for instance in the transboundary water management.

4.6 Examples for the Syllabus Implementation

Characteristic of the study course is the knowledge transfer with a large proportion of practice in an interdisciplinary context. The syllabus implementation of the module "Resource and Flux Management", as example, is presented in Fig. 6. The students get to know the assessment and implementation tools of resource engineering, e.g. MFA (Brunner and Rechberger 2005), LCA according to ISO 14040, and (VC) according to Porter (1986). The next learning step is knowledge on the organisational framework as there are management systems, especially for quality management according to ISO 9001, environmental management according to ISO 14001 and Social Responsibility according to ISO 26000.

Being equipped with these fundamentals, the students receive a home work topic for the application of the learned knowledge, which requires them to select a metal, to conclude a product produced from this metal, to assess the whole VC of the metal being processed to produce the respective product and to prepare the LCA for the respective product. The last step of the homework is the deficiency analysis and the assessment of the resource efficiency improvement potential along the VC. In this way, the students learn to apply resource efficiency optimisation approaches in the context of Cleaner Production (CP) and the necessity of sustainable consumption in order to save natural resources.

A further example, the syllabus of the modules "Ecology and River Development" and "Nature Near River Engineering" contains a common scientific project on ecosystem restoration (for instance a project for a weir demolition) in team work which consists of the following parts:

- Mapping of aquatic biota and characterisation of morphology, hydrology of the respective water body,

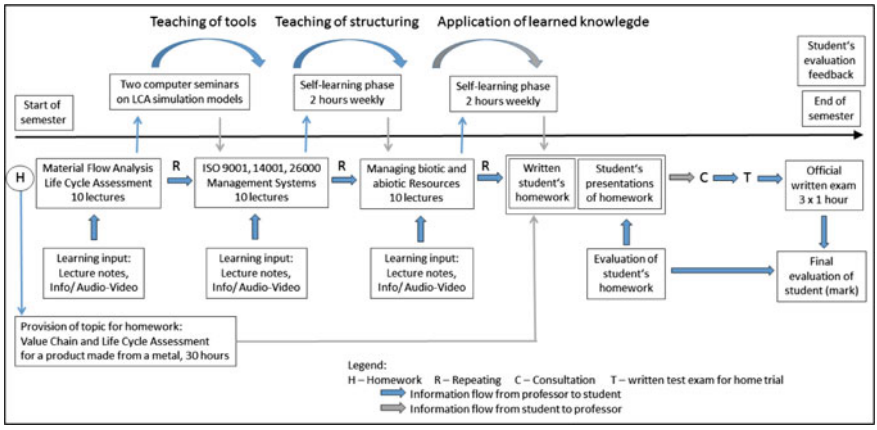

Fig. 6 Example of a syllabus implementation for the module "Resource and Flux Management"

- Variant assessment for the basic implementation design and river engineering for the preferred option on the level of detailed design,
- Environmental impact assessment for the implementation of the preferred design option.

The preparation of this project enables the students to learn the full range of ecological planning for the implementation of GI, which is considered one of the main future planning tasks on the level of the EU. The interrelation with the valorisation of the ecosystem services achieved through the improvement of the existing infrastructure situation is done in the frame of integrated resource management.

4.7 Research Profile

Having the described background, the study course is considered to be "more research orientated" in educational terms. This evaluation assumes also the fact that sustainable environmental solutions usually need to be tailored to the respective environmental problem under an innovative interdisciplinary approach. For that reason, the profile of the study course is orientated to national and international key research topics under the extended Nexus term Water-Energy-Food-Ecosystems (UNECE 2014), as there are:

- Methodologies for the implementation of the EC Water Framework Directive (with focus on biotic resources, saving of the natural capital, ecosystem restoration and resettlement of species as well as IWRM),
- Improvement of resource productivity and optimisation of the resource utilisation (with focus on abiotic resources, circular economy, recycling, urban mining, energy efficiency),
- Integrated resource management (with focus on the Nexus approach, Ecosystem Services, circular economy, industrial symbiosis, integrated management systems and environmental accounting),
- Bio-based economy (with focus on "Agricultural Systems of the Future", renewable raw materials, urban farming, aquaponic and energy generation from recycled biomass).

5 Conclusion

The study course "Ecological Engineering" at the University of Applied Sciences Magdeburg-Stendal aims to provide a master study course for obtaining a degree in applied sustainability implementation. The approach of the upgraded study course "Ecological Engineering" relates to the UN Sustainable Development Goals SDGs

"Transforming our world: the 2030 Agenda for Sustainable Development" (UN 2015) in a national and international context. The study course is closely linked to the sustainability goals SDG 4 on Quality Education, SDG 8 on Decent Work and Economic Growth, SDG 9 on Industry, Innovation and Infrastructure, SDG 11 on Sustainable Cities and Communities, SDG 12 on Responsible Consumption and Production, SDG 13 on Climate Action, as well as SDG 15 on Life on Land. From a global perspective, the study course considers also SDG 2 on Food Security and Sustainable Agriculture, SDG 3 on Good Health and Well-being, SDG 6 on Clean Water and Sanitation, as well as SDG 7 on Affordable and Clean Energy.

The scope of the study course "Ecological Engineering" is to provide knowledge and concepts for integrated resource management, which allow sustainable multi-sectoral planning and management with consideration of the site specific natural capital, the relationship between the resources and their cyclical processes as well as the resulting ES. The integration shall consider both, aquatic and terrestrial ecosystems with biotic and abiotic natural resources that have a manageable size and are exposed to anthropogenic stressors (like agriculture, irrigation, mining, tourism). The scope of the study course is to teach an overview on the interlinkages between various concepts like resource efficiency, cradle-to-cradle as well as industrial symbiosis, and to provide the understanding of the interrelations between different types of natural and anthropogenic resources. With this kind of interdisciplinary knowledge, students shall be enabled for the integrated planning of GI under specific socio-economic conditions, supporting the reduction of environmental impacts already in the design stage and the recovery of disturbed ES through targeted conversion of non-sustainable uses of resources into sustainable uses. Based on a deep understanding of pressures and impacts on SOLO 4,5 level (according to Biggs and Collis 1982), the learners shall be put in the position for the practical implementation of circular approaches as such and in analogy to natural ecosystem cycles.

The course's authors are perfectly aware of the high expectations with regard to the holistic approach of the integrated resource management. In parallel, the authors are also convinced that teaching sustainability can only be done in a holistic way, especially under the Nexus approach. Although in the master course, a specialisation is not foreseen, the students arrive automatically at this point with the master thesis and tend more in the direction of ecosystem restoration or industrial ecology.

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Understanding Waste Flow in Malaysian Cities for Sustainable Waste Management

Ahmad Fariz Mohamed, Muhammad Izzat Rasnan, Norazmin Adibah Othman, Shaharudin Idrus and Mohd Raihan Taha

Abstract

Malaysian cities have undergone rapid growth over the past four decades. Cities such as Kuala Lumpur continues growing and its population have reached 1.67 million in 2015. As its population increases, a city's metabolism process quickens, in turn, producing more waste as a by-product. The increasing rate of waste generation has become a critical issue for Malaysian cities, which generated 16,200 tons of waste per day in 2001 compared to 33,000 tons per day in 2012. Hence, managing the waste requires significantly more technological, financial, and human resources as well as land. There is now a need to understand the waste flow and to determine the key factors of sustainable waste management. This study was conducted to analyze factors such as waste generation patterns, technology, and infrastructure as well as the financial, legal, human resource, and waste management systems currently in place. The analyses conducted illustrate that these factors play an important part in controlling waste generation and flow. The findings from these analyses also provide key strategy for managing the waste flow in Malaysian cities such as Kuala Lumpur towards achieving sustainable waste management.

Keywords

Waste · Recovery · Waste flow · Liveability · City

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1 Introduction

The dynamics of the Malaysian urbanization process has resulted in many positive and negative impacts on the people who live in the urban areas and to the urban environment. One of the main phenomena requiring critical attention from the rapid urbanization process in Malaysia is its waste management. Sustainable waste management is imperative, as its generation increases with population growth and economic activity. As cities grow, the demand for consumption of resources will continue to support its economic, social, and urban processes, thereby increasing demand for more efficient waste management (Schulz 2007; Fernandez 2007). With cities' increasing metabolism rates, waste generation multiplies as a by-product, thereby necessitating more services and support systems that incorporate more land space, infrastructure, technology, and financial and human resources. Cities with limited resources like land will require a strategic management system in which they are able to manage their waste in a sustainable manner. For example, there is a need for a strategy to change the focus of waste management from an end-of-pipe approach towards a cyclic approach to reduce waste disposal and to capture valuable resources from waste. Moreover, emphasis should be placed on reducing waste generation and increasing waste recovery. This means that city managers must focus on how to reduce dependency on waste disposal, which will help reduce waste flow to landfill and also help reduce demand for future land space for new landfills.

There are many approaches that could be implemented to help minimize waste generation and reduce disposal to the landfill. Separation at the source and recycling are the key approaches for waste reduction. However, these two approaches require vital information about the types of waste generated by households, industries, institutions, and businesses in order to assess the best management approach and determine recovery values as well as applicable technology. This study thus examines the importance of waste flow management initiatives and conducts analysis to support the waste separation and waste recovery activities for the reduction of waste flow to landfills.

2 Urban Growth in Malaysia

Malaysia's urbanization process accelerated after its independence in 1957. When it reached stability in the 1960s, the country enjoyed economic growth and enhanced social quality, promoting population growth and urban expansion. Malaysian cities, especially those with quality infrastructure, economic opportunity, and government focus saw an influx of rural populations seeking jobs. Backed by government policies and strategies for economic growth and social enhancement from the 1970s, the rapid change among urban populations became more visible in the 1990s (Fig. 1). The increased movement of the rural population to the urban areas is illustrated in Fig. 1, where the change reached in 1990, after which the urban

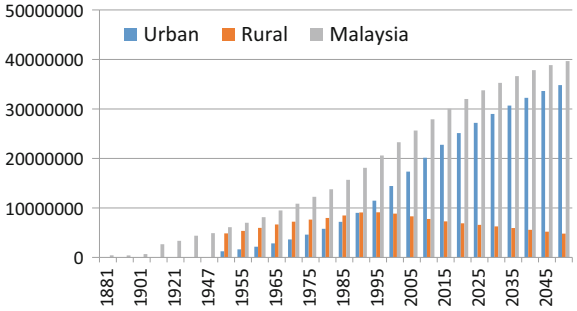

Fig. 1 Total population in Malaysia: urban and rural, 1881–2050. *Source* The United Nations Secretariat (2008) and Department of Statistics Malaysia (1970, 1980, 1991)

population continued to increase by an average increment of 2.0% annually (Department of Statistics Malaysia 2016).

As cities grow, the demand of space for economic and social development increased. Urbanization processes in Malaysia, especially areas in the Klang Valley, North and South of Peninsular Malaysia, have experienced rapid urban growth since the 1990s, and increased the demand for land for development. This leads to uncertainties regarding suitable land for landfills to ensure efficient waste management. There is a need to have a strategy and action plan to handle these critical issues, if urban waste is still managed using an end-of-pipe approach, where landfill is the main option. One effective strategy is to implement waste recovery to reduce dependency on limited space, human resources, and capital. However, this strategy will require a deeper understanding of waste flow from generation to recovery or disposal. Employing this strategy will help to reduce flow of waste to the landfill and increase the lifespan of a landfill, with the potential for not needing landfills in the future.

3 Solid Waste Management in Malaysia

Solid waste management in Malaysia follows the federated governance approach and system. Waste management has undergone many changes and development. The latest development was in establishing policy related to waste management as well as prioritizing waste recovery and minimization in the legal system, demonstrating the government's commitment to the issue. Previously, solid waste management fell under the jurisdiction of the Local Government Act of 1976, the Street, Drainage and Building Act, 1974, and the Town and Country Planning Act. Yet, the legislation was not equipped with the proper requirements for a waste recovery system. Hence, the focus of this legislation was geared more towards cleaning the cities and sending the waste to landfill, thereby prioritizing end-of-pipe approach. During this time, more landfills were built in many cities. When the waste issues

became more critical, and there was a clear problem to find suitable land for landfill, the government reviewed the law and established more comprehensive legislative tools for sustainable waste management in Malaysia.

The review process established policy and legislation for waste management, specifically for solid waste, to ensure that waste would be managed in a sustainable manner. The National Solid Waste Management Policy of 2007 and the Solid Waste and Public Cleansing Management Act (SWPCMA 672) of 2007 were established to prioritize waste minimization and recovery as a resource. SWPCMA 672 was enforced in July 2011 and steered by the National Solid Waste Management Policy and the National Strategic Plan for Solid Waste Management. SWPCMA 672 will implement sustainable waste management based on a waste management hierarchy, which prioritizes waste reduction through reuse, reduce, and recycle (3R), intermediate treatment, and final disposal, as well as placing emphasis on environmental protection and public health (Abdul 2007). These policies will ensure that the ecosystem functions and services of the Malaysian cities will be able to support the increasing volume of the generated waste.

The administration of the SWPCMA 672 was carried out by two agencies, namely, the National Solid Waste Management Department (SWMD) and the Solid Waste Corporation (SWCorp). The SWMD has a responsibility to focus on the policy, strategy, and management of solid waste. The task of SWMD includes:

- Develop policy framework, strategy, and planning.
- Develop planning for management facilities for solid waste in reference to location, type, and scale size.
- Determine the standards, specification, and guidelines of practice.
- Conduct monitoring and management.

While the SWCorp has a mandate to implement and enforce the policy, strategy, and planning, other SWCorp responsibilities include:

- Implement policy, strategy, and planning.
- Monitor compliance of standards, specification, and guidelines.
- Implement and enforce the SWPCMA 672.
- Conduct initiatives to enhance public participation and increase awareness.
- Enhance and ensure service quality for solid waste management and public cleansing.

Only eight Malaysian states agreed to be part of the federated system. As of July 1, 2011, the states of Perlis, Kedah, Kuala Lumpur, Putrajaya, Pahang, Negeri Sembilan, Melaka, and Johor implemented the federated system for MSW management. Thus, the role and responsibility of MSW management were given to SWCorp. The SWCorp appointed three main contractors for MSWM: Alam Flora Sdn Bhd, SWM Environment Sdn Bhd, and E-Idaman Sdn Bhd. Table 1 shows the states in which these contractors were given license to operate.

Table 1 List of states served by the solid waste contractor appointed by SWCorp

Contractor	States
Alam Flora Sdn Bhd	Kuala Lumpur Putrajaya Pahang
SWM Environment Sdn Bhd	Negeri Sembilan Melaka Johor
E-Idaman Sdn Bhd	Perlis Kedah

Source SWCorp (2014)

4 Waste Generation Trends and Flows in Malaysian Cities

Waste generation in Malaysian cities mainly consists of non-hazardous solid waste. However, there is also waste generated that contains hazardous substances, which includes paint cans, aerosol cans, and waste oil from vehicles. Business as usual for waste management in most Malaysian cities is when the waste flows from the generator and is subsequently sent to landfills for disposal. However, there are other initiatives for waste recovery, and some waste has been channeled out of the disposal flow. An estimated 95% of waste generated was sent to landfill in 2005. However, with increasing demand for waste recovery, the amount of waste sent to landfills reduced to 90% in 2012 to achieve a 10% waste recovery rate. The Government of Malaysia has set a target to increase waste recovery to 22% by 2020, which will help to reduce waste disposal to landfills by an additional 12%. (SWCorp 2014).

The current solid waste generation in Malaysian cities shows a worrying trend. The amount of solid waste generated in Malaysian cities increased significantly from 16,200 tons per day in 2001 to 19,100 tons per day in 2005 or an average of 0.8 kg per capita per day (Zeeda and Keng 2012). Waste generation has also increased on a national level, from 19,000 ton/day or 0.8 kg/day/person in 2005 to 33,000 ton/day or 1.17 kg/day/person in 2012 (SWCorp 2014). The Klang Valley, in the middle of Peninsular Malaysia, is the largest waste generator at 9702 tons/day, and its residents generate on average 1.35 kg of waste per capita. Of the total, food waste forms the largest chunk of generated solid waste at 45% (Department of Solid Waste Management 2012). In addition, the study conducted on five cities in Malaysia shows some cities generated higher rate than the national waste generation. In reference to Table 2, Kuala Lumpur and Ipoh populations generated higher waste per person compared to the national average of 1.17 kg/day/person. Ipoh population generated more waste per person than Kuala Lumpur in 2015.

These trends show that with increasing population, the amount of waste generated will also increase. The data also illustrate that city populations such as Ipoh's have a problem in managing their resource consumption and thus have a problem from high waste generation, as many resources were inefficiently managed. Thus, this requires the understanding of waste flow, which is important in determining

Table 2 Status of waste generation for the five cities in Malaysia 2015

City	MSW generation (kg/person/day)	Ton/day	Population (million)	Total 2015 (ton/year)
Kuala Lumpur	1.50	2700.00	1.75	961,322.40
Ipoh	1.90	1394.40	0.73	508,958.80
Johor Bahru	0.91	500.00	0.55	182,500.00
Pulau Pinang	0.79	649.00	0.82	237,013.01
Kajang	0.86	755.00	0.88	275,661.70

action to reduce waste generation at the source, thereby minimizing waste disposal to landfill and recover waste for resources.

5 Management for Waste Flow in Malaysian Cities

Managing waste efficiently will require the city managers and stakeholders to understand the flow of waste and determine which departments will be responsible for each section of the flow. This understanding will help to determine how to handle the waste for certain actions, such as reducing waste generation, recovery of waste, handling of disposal, and reducing environmental and human health impacts.

Figure 2 illustrates the waste flow process and the stakeholders responsible for each process in Malaysian cities. There are two types of waste management for the waste flow. The first type is the federated approach, where the management of waste is conducted and enforced by SWCorp with work done by the concessionaire (Table 1). In this case, the state and local governments have no direct responsibility in managing waste. The second type requires that the state and local governments manage the waste. However, the structure of the waste flow and its stakeholders are similar in Fig. 2. The work is the same, but the difference is the responsibility, in the first type falls on SWCorp, while that of the second type falls on local government. Yet, regarding financial matters of the first type of waste flow management, the state and local governments pay the cost to SWCorp, though an additional financial requirement which includes infrastructures, equipment's, human resources, enforcement, and awareness program, will be borne by SWCorp. In contrast, for the second type, the state and local governments are responsible for all the related financial requirements.

Figure 2 illustrates that for each process, from waste generation to waste recovery and waste disposal, there are stakeholders that have a role in managing it. With the aims to reduce waste generation, increase waste recovery, and reduce waste disposal, these stakeholders are required to conduct their work efficiently in a responsible manner. However, this is easier said than done. There are many factors such as human resources, technology, financial, information system, and industry support criteria, which need to be streamlined. Yet, if these issues are resolved and ready to be implemented, sustainable waste management will be possible.

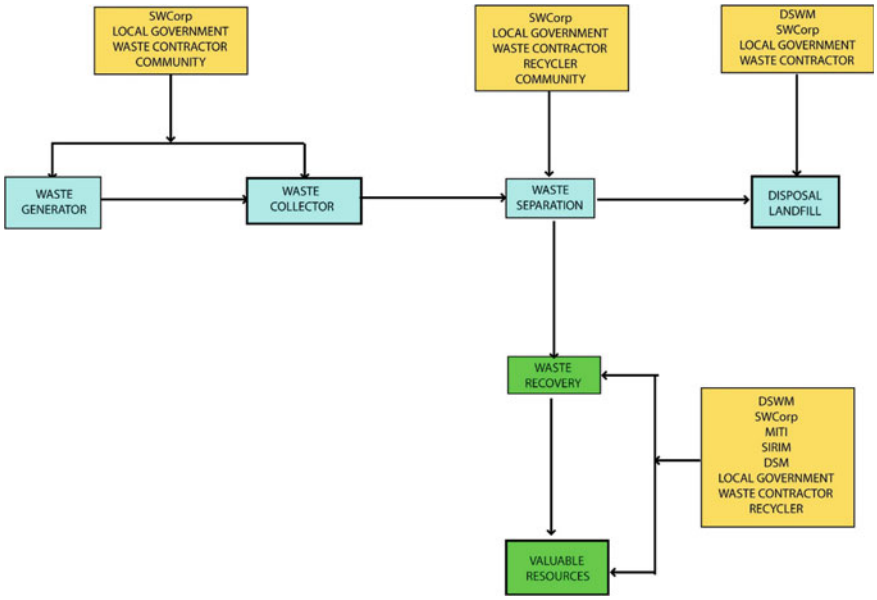

Fig. 2 Role of stakeholders in managing flow of municipal solid waste in Malaysian cities

In Malaysian cities, waste separation at the source only started on June 1, 2015, as part of a plan to increase the recycling rate from 10 to 22% by the year 2020. The support system for waste separation at the source is key for the waste flow, especially for the recoverable waste collectors and the industry responsible for waste recovery. The waste recovery industry is still focused on collection and separation with small number of them producing the real recycled products. Without a good database of waste separated by types, and enforcement of collection for recoverable waste as well as technological, financial, and policy support, the waste recovery industry in Malaysia will not be able to handle the increasing waste generation in its cities. It is, therefore, necessary to enhance the waste recovery industry's capabilities, especially if the Malaysian cities are able to increase its waste separation rate to exceed the 22% recycling rate. These two stakeholders must be well informed, technologically savvy, and equipped with the proper financial support.

Figure 3 shows an example of a possible waste flow management system. Inspired by electronic and electrical waste or E-waste flow in Kuala Lumpur, it illustrates how the waste moves from producer to consumer and includes all the processes involved in the flow. This is a result from the study conducted in 2015. The study monitored the fate of E-waste in the flow. The amount of waste flow could be divided into three processes, as shown in Table 3. The findings show that the recovery for E-waste was good, at 60.28%, while only 16.80% was sent for disposal at landfills. This E-waste recovery achievement shows that Kuala Lumpur's population is aware about waste recovery and many of them practice waste separation and support recycling.

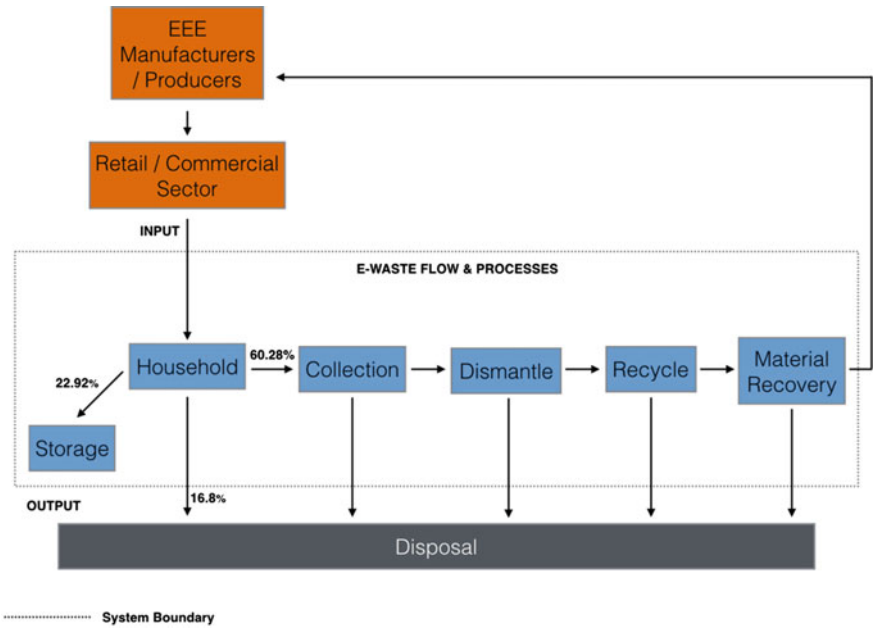

Fig. 3 Flow of E-waste in Kuala Lumpur in 2015

Table 3 Fate of E-waste in Kuala Lumpur 2015

Process	Percentage (%)	
Recovery	60.28	1. Scrap collectors = 44.03% 2. Donated = 5.14% 3. Waste concessionaire = 5% 4. Recycle center/bin = 4.03% 5. Return to retailers = 2.08%
Storage	22.92	
Disposal	16.80	

To make the waste management system more efficient and more sustainable, several issues require attention. For example, data from waste generation and separation at the source are not available in many Malaysian cities. A database for waste flow is an important component to any proper waste management system, as the information about the number and types of waste will determine waste recovery efficiency and sustainability. In addition, there is a need for data collection tools in order to evaluate the waste flow in the city. There are tools that could be used for this purpose, e.g., material flow analyses (MFA) or life cycle assessment (LCA). These two tools allow city managers, the waste recovery industry, and other stakeholders to follow through on the waste flow and gain important insight into the city's current waste generation. This will help the city manager and the stakeholders

to make proper decisions and to ensure the efficiency and sustainability of waste management and waste recovery for resources.

As discussed above, the waste recovery collectors and industry must have skilled human resources, technology knowhow, and proper financial support. The percentage for E-waste disposal to landfills is still high, as the recovery process also contributes to this amount. However, the 2015 Kuala Lumpur study has shown the city has achieved relatively effective E-waste recovery.

6 Waste Flow Management for Sustainable Development

Waste management is a critical aspect to ensure urban liveability. Managing waste flow in Malaysian cities helps to reduce many issues such as illegal disposals, unknown waste type and conditions, inefficient waste separation, and other related issues to waste management. Waste flow management helps to divert waste from being disposed to the environment and increase waste recovery for alternative resources or uses. The impact of reducing waste will help to reduce required land for landfill and reduce ecosystem degradation. More participation among stakeholders in the waste management network will help in understanding the internal mechanism and the complexity of the waste flow of the urban ecosystem (Wanying et al. 2016). Their roles will include fulfilling the needs for governance and monitoring, participation among local communities in waste generation control and collection, business, and industry entities to handle waste recovery and disposals, and other stakeholders for education, awareness, and cultural development for sustainable waste management.

Given the increasing populations in Malaysian cities, waste management incurs a heavier burden (Fig. 1). However, if the proper policy and strategy are in place to manage the waste in a sustainable manner, the annual increment of waste generation could be managed efficiently. For example, effective waste separation at the source with target of at least 60% participation of city population will help city managers and waste recovery industry to process the waste efficiently. Thus, this helps to support the initiative of waste recovery, which will use the understanding of waste flow to ensure its efficiency for sustainable waste management.

The waste recovery industry has become an important industry. It is part of the initiative to achieve sustainable development, especially for cities and industrial areas. In reference to sustainable development goals (SDGs), the waste recovery initiative has been found to support goal no. 11 and no. 12. The waste recovery industries also help support SDGs no. 1 and no. 9. The role of the industry in supporting SDG no. 12 is to ensure sustainable consumption and production patterns. The technology, resources, system, and mechanism setups will make the waste recycling industry one of the main economic activities to achieve this goal. In reference to SDG no.11, which seeks to make cities and human settlements inclusive, safe, resilient, and sustainable, the relevant industries must focus on urban metabolism. The waste recovery will ensure waste is managed in a

sustainable manner, provide sufficient resources for city processes, which include waste to energy, and allocate proper resources for industry and support creation of wealth for cities.

A proper waste management system is also relevant for SDG goal no. 9, which seeks to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. The waste recycling industry helps to ensure efficient use of resources, especially the nonrenewable resources. The industry will provide alternative resources in replacement of natural resources to ensure industry and economic growth. Innovation from the recycling industry to use waste as resources. The industry will also help to achieve goal no. 1, which is to end poverty in all its forms everywhere, as the waste recycling industry is able to provide new job opportunities. This has been done in many countries to generate income directly or indirectly (David et al. 2006; Gutberlert 2008, 2010).

To make waste flow management more effective, there are many factors that need to be in place. Policy, legislation, and guidelines must be in place that mandate monitoring and regulate enforcement processes. In Malaysian cities, there are existing policies and guidelines that could be adapted and tailored for waste flow management, as well as the ability to pass new legislation. The effectiveness of policy, legislation, and guidelines will require efficient institutions with skilled human resources. Therefore, city managers in local governments and other government agencies must be equipped with current knowledge and be technologically savvy, as they must be ready to evaluate and possibly employ the latest developments to manage complex systems. Challenges will undoubtedly arise due to the existing weaknesses in the implementation of policy and legislation for waste management in Malaysian cities. For example, community and industry participation for waste separation at the source is still low, and the participation of Malaysian cities for waste separation and waste recycling is still low, with only 17.39% from 28 million people (Astro 2016). This shows that the policy and the legislation must be reformed and disseminated to the broader population with strategies to enhance education and promote awareness. Focus should be given on how to engender a culture of waste reduction and waste recovery among the community and industry. Hence, amendment of approach for policy and legislation implementation help to increase community participation for waste separation at source and to enhance waste recovery industry as well as to handle future situation.

As mentioned, employing effective tools is key for supporting a more efficient waste management system. The use of tools such as the material flow analyses (MFA) and life cycle assessment (LCA) for assessment will strengthen efficiency and help to focus on the existing weaknesses (Lucio et al. 2015). There is also the need to have waste recovery guidelines and standards that are environmentally focused and business profit oriented. The existing Malaysian waste recycling standards require improvements, as the number of materials produced from waste has increased. Such improvement for the new standards must also include standards for the process of producing the recovery materials, which must prioritize environmental and human health requirement. Proper standards play an important role

not only for valuation and monetary purposes, but also for compliance with legislation and export requirements.

The need to understand the waste flow and to determine the key factors that influence the waste generation and flow is important towards developing a sustainable waste management in the cities. The knowledge of waste flow and the process of managing waste for sustainability will help to make the city liveable. Proper waste flow management will also help Malaysian city managers to achieve several SDGs, especially for SDG no. 1, no. 11, and no. 12.

7 Conclusion

City managers and state governments in Malaysia will continue having problems in managing waste until they take the proper steps to reform their respective systems. Reform is urgent, given the increasing populations and thus increasing waste generation. The proper knowledge about waste flow and the need to manage the waste is critical, as inefficiency of waste management leads to many environmental and human health problems. Proper waste flow management will help to reduce waste generation from being disposed to landfills, and thus help to reduce dependency on land needs, minimize environmental pollution, and reduce human health problems. Moreover, a reduction of waste flow to landfills will help city managers reduce the associated waste management operation costs and even help generate revenue from other activities, particularly from the waste recovery industry.

Proper waste flow management also promotes the waste recovery industry, which utilizes waste for other resources. This industry will help in creating more job opportunity and even enhance economic capability for the city. The waste flow management tools such as MFA and LCA will help identify important indicators for city managers to make proper policy and employ effective strategy for future development and to fulfill the demand for increasing populations and the economic growth of the city. In addition, they will help to achieve Sustainable Development Goals targets.

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Going for Green Cities: The Role of Urban and Peri-Urban Forestry in Creating the Ambiance of the Liveable City in Malaysia

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Abstract

It is well acknowledged that the world's population is expanding and increasing. According to the United Nations, more than seven billion people inhabited the earth in 2011, and the number is expected to increase to 9.3 billion in 2050. Consequently, for the first time since 2008, more than 50% of the world's population resides in towns and cities, which is expected to increase to more than 70% by 2050. Similarly, rapid urbanisation in Asian countries is also expected to expand tremendously, and many of the mega-cities will be located in

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Asia. Malaysia is also experiencing a rapid expansion of urban areas due to economic and business activities. It has been estimated that by 2020, 75% of the total population in Peninsular Malaysia will be residing in urban and city centres. Furthermore, 50% of the Peninsular Malaysian population will be in Kuala Lumpur Extended Mega-Urban Region (EMUR). The rapid pace of expansion and development in urban areas will undoubtedly effect many aspects of sustainable development. Unsustainable consumption of natural resources, water, land and recreational facilities will have detrimental effects on the environment as well as on both economic and social livelihood. Thus, this paper elaborates on the general perspectives of the current status of forests and green areas in the extended mega-urban regions as well as explores the need for future development of urban greening for liveable cities. The development of strategies and solutions are urgently required to assist cities in achieving sustainable development goals (SDGs), particularly goal SDG11, which focuses on making cities inclusive, safe, resilient, liveable and sustainable.

Keywords
Recreational forest · Urban forest · Peri-urban forest · Urban liveability

1 Introduction

The world's population is substantially increasing each year in both developed and developing countries. According to the United Nations, more than seven billion people inhabited the earth in 2011, and the number is expected to increase to 9.3 billion in 2050. Consequently, for the first time since 2008, more than 50% of the world's population resides in towns and cities, and this figure is also expected to increase more than 70% by 2050. The increasing migration to major towns and cities is attributed to several factors, such as better job opportunities, good facilities, efficient transport systems and sound urban finance (Pacione 1990).

Similarly, it has been estimated that 60% of the world's population resides in the Asia Pacific region. In 2014, the population was 4.367 billion, and it is projected to rise to 5.08 billion by 2050 (UNESCAP 2014). Currently, 42% of the region's population lives in urban areas, which is projected to increase to 63% of the total by 2050. Furthermore, out of 28 mega-cities with more than 10 million people in the world, 15 cities are in Asia and the Pacific region, with Tokyo (37.8 million), New Delhi (25 million) and Shanghai (23 million) being the three most populated cities in the world (UNDESA 2014). Malaysia, particularly Peninsular Malaysia, has experienced rapid urbanisation during the past two decades, and the rate of urbanisation increased 54.3% between 1991 and 2000. It has been projected that this figure will increase by 75% by 2020 (JPBD 2006).

The rapid pace of urbanisation and population growth has severely accelerated environmental degradation, including landscape fragmentation and an unsustainable consumption of natural resources, forests, water, land and green spaces. Vulnerability to extreme weather conditions, such as floods, droughts and landslides, is more common. Moreover, the expansion of the Extended Mega-Urban Region (EMUR) has driven the urbanisation process and population growth. As Kuala Lumpur, the capital city of Malaysia, is in the midst of the urban explosion, environmental changes have occurred as consequences of the development. The city suffers from landslides, dust encroachment, floods, soil erosion and water shortages. Therefore, the implementation and conservation of forests and green areas in the EMUR offer numerous potential benefits, such as producing forestry products, mitigating the ecological effects of urban sprawl and improving the living environment of the urban dwellers. The benefits from the forests and green areas enhance the livability of the city and make urbanisation more conducive to the environment.

This paper focuses on the role of peri-urban forests regarding the contributions of recreational forests in providing amenities and a pleasant environment for the city's population. These recreational forests are mainly located at the periphery of the major cities, particularly in the Kuala Lumpur EMUR.

2 Kuala Lumpur EMUR: Bernam–Linggi

Scholars have defined the Mega-Urban Region (MUR) using various terms, such as 'megalopolis' (Gottman 1961), 'extended metropolitan regions' (Ginsburg et al. 1991) and 'interlocking metropolitan regions' (Zhou 1991); however, an MUR is simply defined as the formation of mega-urban regions as a process whereby an increasing proportion of a country's GDP and urban population are concentrated in large mega-urban regions (McGee 2009). Furthermore, it is based on the measurement of functional integration in MURs, such as transport flows, economic linkages (industry, service and agriculture) labour markets and population movements that create the 'transactional space' of the MUR (McGee 2009).

Malaysia has several MURs, which include urban centres, small towns, large municipalities and cities that have grown beyond their boundaries and merged to form a huge conurbation of urban centres (Abdul Samad et al. 2010). There are three primary urban conurbations that continue to grow. The first is the Klang Valley, stretching from Kuala Lumpur to Port Klang (covering 50 km). The second conurbation is Georgetown, which spans from the Seberang Perai industrial town in Penang to Kulim in Kedah. The third conurbation is in Johor Bahru, which is Pasir Gudang. These urban conurbations consist of diverse economic, social, cultural, infrastructure and industrial activities.

The MURs have undergone rapid expansion due to fulfilling the demands of population growth; therefore, it has been predicted that the Kuala Lumpur Extended Mega Urban Region stretching from the Bernam–Linggi area has the potential to

become the largest MUR in Malaysia. The population growth in the Bernam–Linggi area is estimated to be 41.6% of the total Peninsular Malaysia's population. The population growth in urban centres throughout the Bernam–Linggi areas rapidly increased after its independence in 1957, and this year can be considered the tipping point for the urban growth and development there. Most of the urban centres of Bernam–Linggi were founded during the British colonial intervention in Perak state. Three major basins in Bernam, Selangor were founded during this period, whereas the Linggi basin in Negeri Sembilan was founded between 1874 and 1900.

Due to widespread manufacturing industries, social infrastructures and developed transportation networks, the urbanised frontier moved from Kuala Lumpur to Port Klang on the coast and Seremban to the south, replacing the vast agricultural landscape. Moreover, the urban landscape had been dominated by Kuala Lumpur and Petaling Jaya in the 1970s, and leading for the evolution of Bernam–Linggi basins urban landscape. The extent of land use and the land use pattern, particularly for agriculture, forests, bodies of water and urbanised areas of the Kuala Lumpur Extended MUR are shown in Fig. 1.

3 Profiling the Liveable City for Malaysia

The National Urbanisation Policy of Malaysia aims to ensure that urban development creates a liveable environment and a more peaceful community and living environment, which requires a balance in all aspects of development, namely physical, economic, social and environmental development. Hence, it is vital to create a visionary city with a peaceful community and living environment through sustainable urban development (JPBD 2006). The underlying concept of a sustainable city is liveability. According to Lennard and Lennard (1995), liveability is defined by performance in three main areas: environmental quality, neighbourhood amenities and individual well-being.

In Malaysia, a liveable city must embrace and would be characterised by a friendly and pleasant city for all groups. It must be attractive, vibrant, healthy and safe for all races. At the same time, it should offer opportunities and provide a mechanism for people to realise their full potential for a harmonious livelihood.

Thus, a liveable city should include the main components that influence the configuration of a city. These attributes are shown in Fig. 2, which include the physical environment, the economy, social structure and well-being, cultural resiliency, infrastructure and amenities, to illustrate a wide range of multidimensional as well as cross-cultural issues related to liveability. These key issues are as follows:

1. **A better infrastructure and amenities** are essential for mobility and accessibility for a city's population. An efficient public transport system is paramount to reduce the need to travel and to minimise the travel time to work.
2. **A city's vibrant economy** depends on not only foreign direct investments but also on local investments and incentives provided by the government. At the

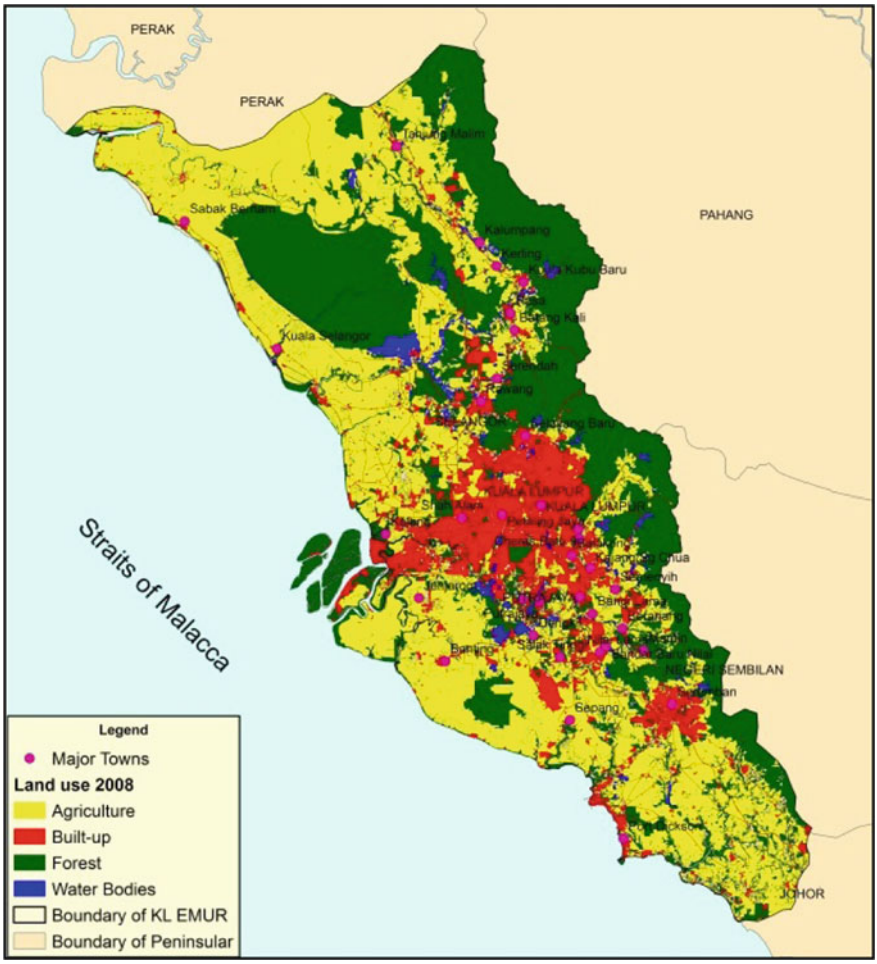


Fig. 1 Land use of Kuala Lumpur extended MUR in 2008. *Source* Abdul Samad et al. (2011)

same time, the services sector, such as electricity and access to materials, must be effective and efficient. Sustainable production and consumption are important for cities.

3. **The social structure and well-being** of a liveable city are heavily influenced by its population structure and growth, which include age groups and fertility rates. The work forces, both foreign and local, also influence liveability.
4. **Cultural resiliency** is an important aspect of a liveable city, particularly for multi-racial and cultural societies, such as in Malaysia. This requires a harmonisation of common values shared by all sectors of the population. Religious understanding and tolerance amongst different communities are also crucial for a united and harmonious nation.

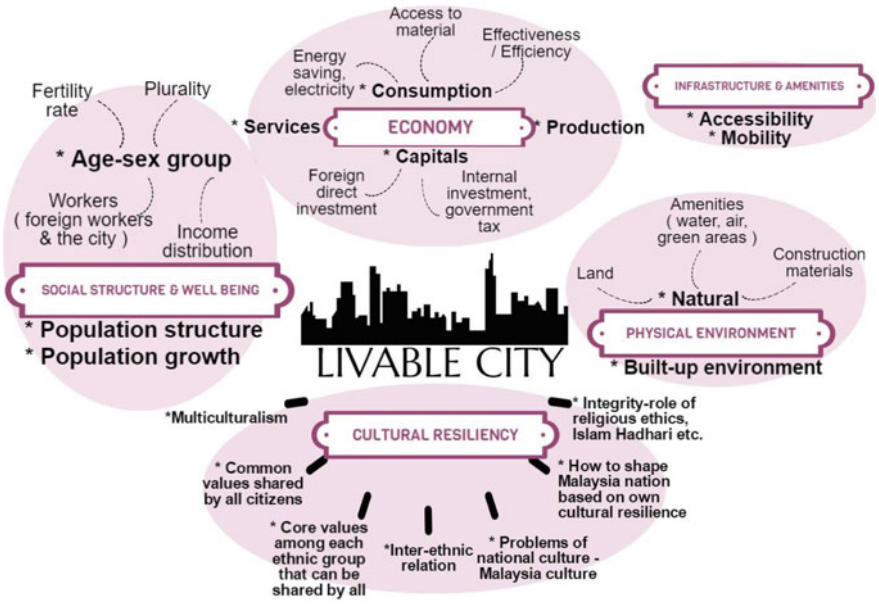


Fig. 2 Components of the liveable city. Adapted from Abdul Samad et al. (2007)

5. The balance between the **natural and built environment** is also crucial to city dwellers. The provision of adequate green areas, such as parks and recreational areas, are important for urban liveability.

4 Urban and Peri-Urban Forests

Urban forests, trees and vegetation are an important component of liveable cities. These natural resources are vital, as they provide a wide range of ecosystem services. With a rapid pace of urbanisation, forests and vegetation within city areas are continuously susceptible to being cleared for various types of urban development, human settlements and economic activities; however, city planners have realised the crucial role of urban forests and trees in providing a habitable environment for a city's population. Hence, the protection and management of forests, vegetation and trees in urban areas have become a new discipline in forestry.

Urban forestry is an emerging and evolving discipline, which was conceptualised in the late 1960s in North America. The subject is now a global concern and an important objective for several international organisations. For the past decade, the Food and Agriculture Organisation (FAO) has been instrumental in a number of conferences and seminars. For example, during the recent 23rd Committee on

Forestry (COFO) on 21 July 2016, the FAO organised a side event on 'Urban Forests for Sustainable Cities', which provided an overview on policies, field projects and research in many different regions around the world to support urban and peri-urban forest implementation on different scales (FAO 2016a). It also serves as a forum for exchanging ideas and sharing best practices for the implementation of urban forest programmes. At the regional level, the First Asia-Pacific Urban Forestry Meeting was held from 6 to 8 April 2016 in Zhuhai, China. The intensity of these meetings at the international level strongly indicated the urgent need to further promote the role of urban and peri-urban forests in addressing many of the environmental issues of urban centres.

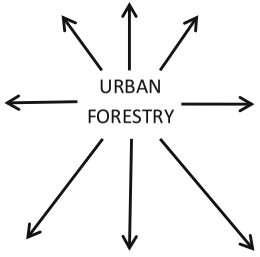
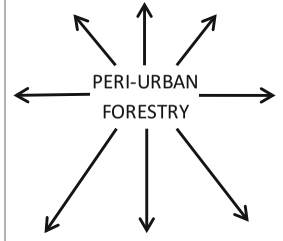
One of the earliest definitions on urban and peri-urban forests was provided by Grey and Deneke (1986) and Miller (1997) (as cited in Konijnendijk et al. 2004a, b). Grey and Deneke defined urban and peri-urban forestry as 'the planned, integrated and systematic approach to the management of trees in urban and peri-urban forest for their contribution to the physiological, sociological and economic well-being of urban society'; however, Miller defined urban and peri-urban forestry as 'an integrated, city-wide approach to the planting, care and management of trees in the city to secure multiple environmental and social benefits for urban dwellers'. A broader definition of urban forestry was provided by Helms (1998): 'the art, science and technology of managing trees and forest resources in and around urban community ecosystem for the physiological, sociological, economic and aesthetic benefits trees provides society'.

Randrup and Nilsson (1998) argued that the concept of an urban forest has been widely acknowledged as being comprised of the planning, design, establishment and management of trees and forests along with amenities located in or near urban areas. Thus, urban forestry is a multidisciplinary approach that utilises horticultural knowledge and landscape concepts and design while incorporating trees and vegetation for recreational and ecological purposes.

The concept and scope of urban forestry and peri-urban forestry is presented as a matrix in Table 1. At the strategic level, urban forestry and peri-urban forestry include determining the form and function of urban and peri-urban forest resources as well as the planning and design policies related to them. Urban and peri-urban forestry involve a range of techniques and approaches in terms of the selection and breeding of the appropriate trees for urban environments and growing conditions as well as tree establishment. The strategic and operational aspects are regulated at the management level.

Both the definitions and the matrix show that urban forestry focuses on urban woodlands as well as all urban and peri-urban tree resources, including single trees and groups of trees along streets, in public and private parks and gardens, and in cemeteries. The distinction between the three types of locations included in the matrix arises from four different levels of planning and management hierarchy, including stress, establishment techniques, average life spans and costs in relation to establishment and management (Nilsson et al. 2001). Street trees, for example, are usually single trees with a low average life span due to a high stress level. Moreover, street trees generally involve the highest management costs. Park trees are also found

Table 1 The urban forestry and peri-urban forestry matrix

	Urban forest			Peri-urban forest		
	Individual trees		Urban forests and woodlands (forests and other wooded land, e.g. natural forests and plantations, small woods, orchards, etc.)			
	Street and roadside trees and associated vegetation	Trees in parks, private yards, cemeteries, fruit trees and associated vegetation		Recreational forest	Fruit orchard	Eco-resorts
Form, function, design, policies and planning						
Technical aspects (e.g. selection of plant material, establishment methods)						
Management aspects						

Source Adapted from Konijnendijk and Randrup (2004)

individually or in small groups, with a medium or high average life span, a medium stress level and medium costs for establishment and management. Urban woodland trees are usually established in stands by seeding or planting small trees, with a high average life span, low establishment costs and relatively low management costs (Nilsson et al. 2009). In the Malaysian context, the matrix for peri-urban forest includes recreational forests, fruit orchards and eco-resorts. Fruit orchards and eco-resorts are mainly owned and operated by individual and private companies; however, recreational forests are mainly managed by Forestry Departments.

5 The Benefits of Urban and Peri-Urban Forests

Forests and trees are crucial components of the environment. They provide a wide range of important benefits to people and their surroundings. Urban and peri-urban forests also contribute to an attractive green townscape and thus enhance the image of a positive, nature-oriented city. In an urban setting, they play an important role by providing several benefits to a society's health and environment. These important benefits of urban and peri-urban forests have been widely discussed and implemented by several scholars and authors (Konijnendijk et al. 2005; Mazifah 2008; Sham 1986; Latiff 1986). Brief descriptions of the various benefits and uses of urban forests for social, health, economic, environmental and ecological purposes are illustrated as below.

Social

Recreation opportunities and improvements of home and work environments enhance physical and mental health. Trees and forests contribute to a better quality of life in cities because they improve the air quality and consequently the health of urban residents. Viewing or visiting the natural scenery of forests also has important positive effects on mental health because it contributes to reducing stress in everyday life (Tyrvainen et al. 2005). Creating green urban centres by planting trees also softens the impact of concrete and the rough images of buildings (Mazifah 2008).

Economic

Economic benefits, such as the value of market-priced benefits (timber, fruits, mushrooms, etc.), increase property values and boost city tourism. The Economic Transformation Programme (ETP) launched in 2010 introduced Greater Kuala Lumpur—Klang Valley as one of the sectors of the National Key Economic Areas (NKEAs). Greener Kuala Lumpur is one of the entry point projects (EPP) in Greater Kuala Lumpur (GKL). The project aims to increase the green density and space within Kuala Lumpur to make it a more liveable city. This EPP is led by Kuala Lumpur City Hall's Department of Landscape and Recreation with an annual target of 30,000 trees to be planted. At the same time, there is an annual target of 5000 trees to be planted and funded by the private sector. During the period from 2011 to 2014, a total of 139,227 trees were planted. A total of 29,651 trees were planted and

funded by the private sector. Thus, the goal to plant 100,000 trees has been successfully achieved (ETP Annual Report 2011, 2012, 2013, 2014). Furthermore, urban forestry activities also contributed to the growth of supporting industries, such as plant suppliers and nurseries, and created new job opportunities.

Environment

The ecological benefits of the green landscape of an urban forest include tree growth and seasonal dynamics that become biotopes for flora and fauna in an urban environment. Small forest parks in an urban setting may help in reducing and moderating the temperature due to shade and evaporation (Sham 2008). For example, shade trees have been shown to reduce high afternoon temperatures by as much 4.5 °C (Sham 1986). Trees remove gaseous air pollution through uptake via leaf stomata, and some gases are removed by plant surfaces. A recent study showed that urban forests are capable of ameliorating the urban atmosphere through the deposition of particulates on the surfaces of leaves and vegetation (Nur Dina et al. 2016).

6 Peri-Urban Forest: Recreational Forests

Forest recreation areas (FRAs), or amenity forests, are identified and developed mainly in forest reserves to provide opportunities for outdoor recreational activities. The development of forest recreation areas began modestly and has increased to a total of 121 areas located strategically throughout the country. The development of recreational forests in forest reserves is in line with the National Forestry Policies 1978 and the National Forestry Act 1984, which aimed to create areas that are adequate and appropriate for recreational, ecotourism and educational purposes for society to be aware of the forests' functions and importance.

In Malaysia, the establishment of recreational forests was introduced under the First Malaysian Plan (1966–1970) with five recreational forests in Peninsular Malaysia. The earliest recreational forests developed in Peninsular Malaysia were the Telok Bahang in Penang and Sekayu in Terengganu, which were established in 1967. Currently, there is a total of 121 forest recreational areas developed throughout Peninsular Malaysia, with the states of Pahang and Kedah having the largest number of 27 and 28 areas, respectively.

The captivating landscape of forests, the diversity of flora and fauna, the unique geological structures and the geomorphological features are the key elements that attract people to participate in recreational activities in forests. Recreational involvement can include either active or passive activities (Shaharuddin and Azman 2009). Such activities include camping, swimming, mountaineering, jungle trekking, picnicking, environmental education and enjoying the scenic beauty of the forests.

Furthermore, the majority of recreational forests in Peninsular Malaysia are located in the hills and mountains, which feature beautiful waterfalls and rapids. Other attractive areas include rocky and sandy beaches, limestone caves, natural

Table 2 Number of visitors to recreational forest of all states in Peninsular Malaysia (million)

Year	Number of visitors (million)
2006	1,125,906
2007	2,314,428
2008	4,514,013
2009	5,190,167
2010	5,697,732
2011	5,042,669
2012	5,332,258
2013	5,311,639
2014	5,379,097
2015	5,115,481

Source Forestry Department of Peninsular Malaysia (2015)

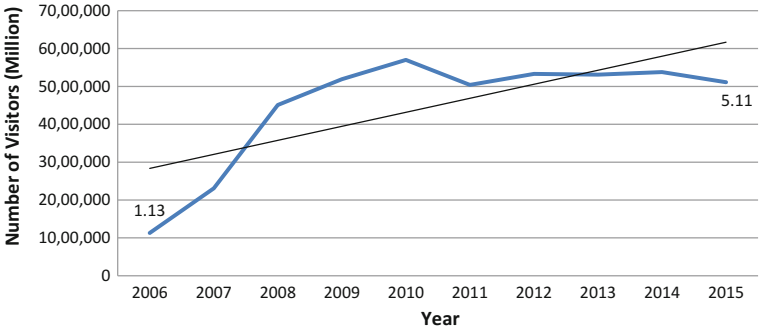


Fig. 3 Number of visitors to recreational forests of all states in Peninsular Malaysia, 2006–2015

and man-made lakes and lowland rivers and mangrove swamps (Leman et al. 2008). A large number of visitors who are attracted to recreational forests prefer water-based activities.

From 2006 to 2015, there was an increasing trend in the total number of visitors to recreational forests for all states in Peninsular Malaysia. In 2015, a total of 5.11 million visitors patronised the recreational forests, which is 18% of the total population of Malaysia (Table 2; Fig. 3).

The increasing trend of the number of visitors to recreational forests is also shown in Figs. 4 and 5. Figure 4 shows the number of visitors to recreational forests in Selangor. The most visited sites were Hutan Lipur Kanching and Hutan Lipur Sungai Congkak, with 158,116 and 95,425 visitors in 2015, respectively. Both recreational forests are located near major town areas, such as Shah Alam, Rawang and Kuala Lumpur, and can be reached within 30 min.

Figure 5 shows the number of visitors to recreational forests in Negeri Sembilan from 2006 to 2015. The most visited recreational forests were Hutan Lipur Ulu Bendol and Hutan Lipur Jeram Toi with a total of 185,857 and 106,353 visitors in

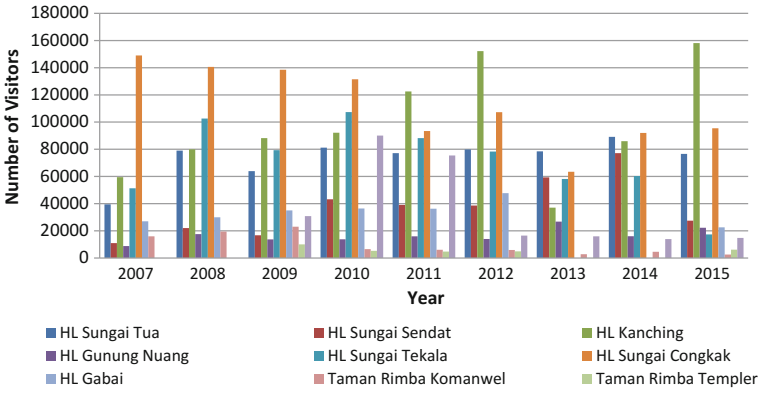


Fig. 4 Number of visitors to Selangor recreational forests, 2007–2015

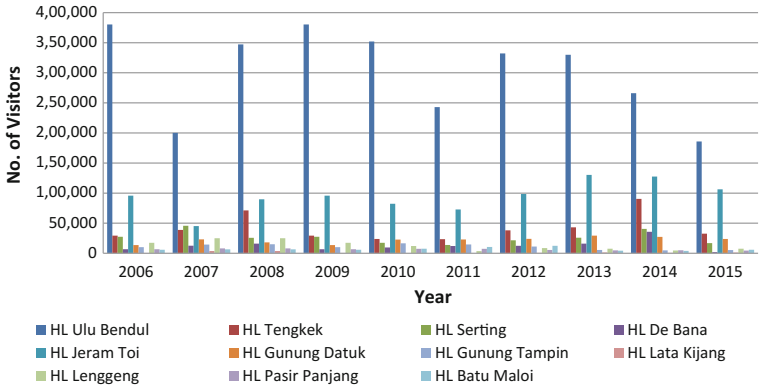


Fig. 5 Number of visitors to Negeri Sembilan recreational forests, 2006–2015

2015, respectively. Both areas are easily accessible by road within 30–40 min from the nearest towns, which are Seremban and Kuala Pilah.

A further analysis in terms of the distance of recreational forests to the nearest city in relation to the frequency of visitors showed a definite trend that recreational forests that are nearer to major urban centres receive a higher number of visitors (Fig. 6). For example, Hutan Lipur Kanching and Hutan Lipur Sungai Chongkak, which are within 20–30 km of Kuala Lumpur, are frequently patronised by visitors. Similarly, in Negeri Sembilan, Hutan Lipur Ulu Bendol and Hutan Lipur Jeram Toi, which are within 20–28 km from Seremban, are also frequently visited by city dwellers. The analysis also indicated that people would like to spend more time in the forest than travelling. Thus, a better management and provision of amenities and services are required to provide a conducive and pleasant environment for various recreational activities for families and the general public.

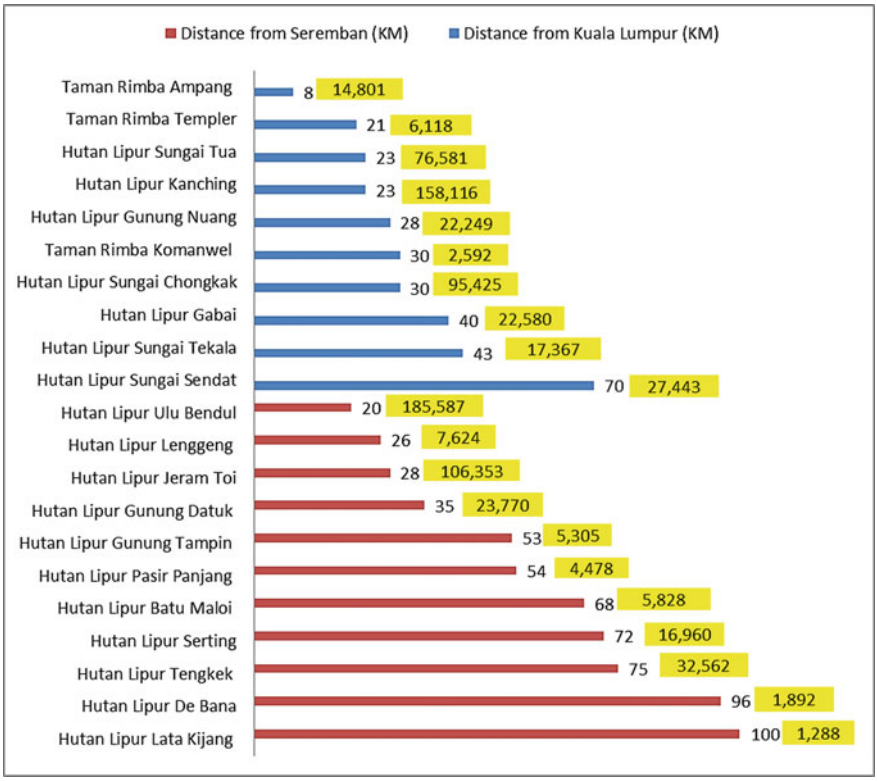


Fig. 6 Frequency of visitors to recreational forests in relation to city centres. *Note Yellow boxes* indicate the number of visitors to the recreational forests

7 Urban and Peri-Urban Forests in the Context of Sustainable Development Goals

Urban and peri-urban forests can significantly contribute to the achievement of sustainable development goals. Nine goals namely No Poverty, Zero Hunger, Good Health and Well-Being, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Sustainable Cities and Communities, Climate Action and Life on Land have been identified. In Malaysia, these goals have been expanded to include strategies identified and outlined in the 11th Malaysia Plan 2016–2020. The selected strategies that correspond to the sustainable development goals are presented in Table 3.

Table 3 Contributions of urban and peri-urban forests dimensions in the context of sustainable development goals

Goals	Description	11th Malaysia plan 2016–2020
	Urban and peri-urban forests create employment, reduce the cost of urban infrastructures and contribute to boosting the local green economy	• Elevating B40 households towards a middle-class society • Empempowering communities for a productive and prosperous society • Improving labour market efficiency to accelerate economic growth
	Urban and peri-urban forests are direct sources of food and contribute to increasing nutrition security by providing affordable woodfuel, high-quality water and improved soil for sustainable agricultural production	• Modernising agriculture • Transforming services • Investing in competitive cities and regional economic corridors
	Forests and green spaces in and around cities provide ideal settings for outdoor recreational and relaxing activities, contributing to the prevention and treatment of non-communicable diseases and to the maintenance of mental health	• Creating safer living environments for thriving communities • Improving the quality of education for better student outcomes and institutional excellence
	Urban and peri-urban forests are efficient regulators of urban hydrological cycles, as they filter drinking water, reduce the risk of floods and erosion and help reduce water loss	• Conserving natural resources for present and future generations • Encouraging sustainable energy use to support growth
	The sustainable management of urban forests and trees can produce renewable energy for use by urban communities, particularly in lower income countries, where woodfuel is often the only available and affordable source of energy	• Enhancing awareness to create shared responsibility • Adopting the sustainable consumption and production concept • Encouraging sustainable energy used to support growth
	Investments in urban forests and green infrastructure contribute to green economic growth by providing an attractive environment for tourism and business, creating job opportunities, providing materials for housing and generating savings in the costs associated with energy and the maintenance of human health	• Strengthening the enabling environment for green growth • Improving the quality of education for better student outcomes and institutional excellence
	Urban forests and trees make significant contributions towards the environmental and socio-economic resilience of cities by helping mitigate climate change and natural disasters; reducing energy costs, poverty and malnutrition; and providing ecosystem services and public benefits	• Providing adequate and quality affordable housing to poor, low- and middle-income households • Improving road safety and emergency services to reduce fatalities

(continued)

Table 3 (continued)

Goals	Description	11th Malaysia plan 2016–2020
	Trees and forests in and around cities contribute to climate change mitigation and adaptations by sequestering carbon, helping saving energy, reducing the urban heat island effect and mitigating extreme climatic events	• Funding green growth through new economic instruments • Strengthening resilience against climate change and natural disasters
	Urban and peri-urban forests help create and enhance habitats, constitute a pool of biodiversity, significantly improve soil quality and contribute to land restoration	• Encouraging the widespread adoption of green buildings criteria • Conserving terrestrial, marine areas, endangered plants and wildlife species

Source Adapted from FAO (2016b) and EPU (2015)

8 Conclusions

To create a liveable city in Kuala Lumpur, there are several initiatives and actions that must be implemented. The proper planning and development of a sustainable and liveable garden city in Kuala Lumpur is a necessity, where the respective authorities and private and public sectors should be responsible for providing the best formulation of guidelines that will ensure the city remains as vibrantly and attractively developed as conceived. Furthermore, the rebranding of recreational areas would be beneficial in promoting the recreational forests of Malaysia at both the local level and the international level. Therefore, it is of utmost importance to improve the accessibility of visitors so that they can engage with nature. This could be achieved through landscape connectivity by utilising the river corridors, reserved parks and plazas. To achieve the goal of becoming a Garden City, proper actions must be taken into account, especially in developing good and user-friendly facilities and services to provide the best benefits to urban dwellers. In turn, visitors will be ensured safety while enjoying the mesmerising panorama of nature. At the same time, environmental education and interpretation should be conducted at every level of educational institutions to emphasise the importance of the conservation and preservation of urban green areas as well as to create awareness among the public. These initiatives will facilitate the creation of greener cities that are environmentally friendly and sustainable. This requires comprehensive planning, management and implementation strategies for energy efficiency, water utilisation and effective waste disposal, including recycling activities, as well as ensuring that forests and green spaces are not compromised.

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In Pursuit of Sustainability: Building Science and Community Development

Monjia Belizaire

Abstract

The local, state, and federal department goals for housing and community development organizations are to create, strengthen, and sustain communities. This contributes to the enhancement of quality of life and helps to meet the need for affordable housing for all. In the United States, approximately 21.3 million people are spending more than 30% of their monthly income to cover rent; this number is documented as a record high. Financial experts recommend budgeting 30% of monthly income to cover housing costs. Incorporating sustainability into these goals through building science can be the path to achieving green building development, which positively further impacts development of affordable communities. The key concepts and relationships among various disciplines (architecture, engineering, and construction) in the building sciences support advancement in how buildings reduce waste and conserve energy and resources. This paper seeks to inform, involve, and support private and public stakeholders in the field of sustainable development by helping to reduce resource consumption, encouraging the development community to advance the practice of sustainable building science, promoting the improvement of policies affecting these practices, inspiring smart growth, and strengthening affordable community development. This paper also describes how sustainable building science can address concepts of affordability that affect community development. These sustainable development practices offer a holistic approach to advancing the real estate development agenda in our built environment and should ultimately bring us closer to transforming our world by 2030.

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Keywords
Sustainability · Sustainable development · Community development · Sustainable building science · Building science · Affordable housing · Creative financing · Partnerships · Sustainable communities · Economic development

1 Introduction

Pursuing Sustainability in building science and community development promotes the United Nation's Sustainable Development Goals contained in the Transforming Our World: The 2030 Agenda for Sustainable Development paper. Building science is a field of knowledge that draws upon physics, chemistry, engineering, architecture, and the life sciences in understanding the physical behavior of the building as a system, and how this impacts energy, efficiency, durability, comfort, and indoor air quality (Kesik 2016). Community Development is a process where the community members work collectively towards economic, social, cultural, and environmental solutions to support the community. There is a relationship between Sustainability Science, Building Science, and Community Development in addressing as well as affecting the United Nation's Sustainable Development Goals. It is important to understand the current and future needs of community development on a local, regional, and national level, as well as existing initiatives in efforts to develop global strategies and partnerships. The information provided on the affordable and community development process is limited to the United States. However, understanding the workings of affordable housing in the U.S. can contribute to the conversation of building resilient infrastructure globally. Similar to the importance of the community's involvement in community development, the global community's involvement is necessary in implementing the Global Partnership.

Sustainability Science, when applied to our built environment, provides a holistic approach in addressing our global housing crisis. The quality of spaces, that we build to house ourselves, directly affect our natural resources (environment), consumption and production of goods and services (economics), and human potential (social). Our environment, a physical system consisting of exchanged mass, energy, or other properties, is changing (i.e., climate change) and demanding that we adapt to the changes we are experiencing. As our global population and energy use increases, there will be a greater demand for sustainable housing; an economic concern. Community involvement in building development has increased due to concerns such as energy dependence, neighborhood improvements, and affordability. Identifying the phases in the building development process such as team structure, finance, contracts, sustainable design, green construction, and building and property management can assist us in developing the framework for public policy, and implementation of sustainable strategies.

2 The Community Development Team Relationship

There is a relationship between community development and private–public partnerships, it includes a mix of public and nonprofit funding, or tax credits and private capital. The work of community development between the public and private entities or key stakeholders plays a significant role in community development building projects. The developer, the visionary, drives the process while spending months refining the plan and assembling all the required resources. For example, the developer hires the architect and general contractor—participating in the project for a fixed amount of compensation (low risk). The architect provides the plans and specifications of the building development project based on the vision of the developer. The designers and engineers (i.e., mechanical, electric, civil, etc.) have an opportunity to design a sustainable building (i.e., pursuing LEED certification, Energy Star Program, or Passive Design) that addresses energy efficiency. The general contractor and hired subcontractors (i.e., wood or steel framing, concrete, drywall, etc.) build the project per the architect and design engineer's plans and specifications. The experience and craftsmanship in building construction impact the implementation of targeted greenhouse gas emission goals, reduction of operating cost, and mitigation of air quality issues. The lender finances the project. A construction lender will finance the construction or building project, and the permanent lender will finance the completed project following certificate of occupancy. The construction loan will disburse funds monthly to pay for construction activities to date, and the permanent loan will receive cash flow from project revenue to repay the loans. The lender will hire a construction manager to monitor the progress and quality of work, as designed by the architect, prior to monthly disbursement of funds. Other key partners in the development project include nonprofit organization (mission focused or social groups), property management, attorneys, underwriters, environmental specialists, and planners. The team and their contributions play a role in the enhancement of green features on the project. For example, the developer provides the vision for an affordable and sustainable multifamily housing development, the nonprofit partner offers social programming, the architect and engineers design a sustainable building, the general contractor constructs an environmentally sensitive building, the lender finances affordable housing, and the building manager implements and maintains sustainable project goals set before construction design. The developer assumes the most risk.

3 Affordable Development Project and Sustainability

Affordable housing development projects seek to prevent the displacement of residents with low and moderate incomes; preserve housing for vulnerable populations such as persons with disabilities, seniors, veterans, and the homeless; and maintain diversity in the community. The availability of affordable housing and investment funds to support affordable housing are limited. Housing costs are rapidly

increasing each year while incomes remain the same. Between 2001 and 2014, real rents increased 7% while household incomes decreased 9%. These trends pushed the number of cost-burdened renters (paying more than 30% of income for housing[1]) up from 14.8 million to a new high of 21.3 million. Additionally, the number of these households with severe burdens (paying more than half of income for housing) jumped from 7.5 million to 11.4 million, setting a record (Fernald 2015). The least expensive housing options are not affordable for most people living in urban areas. Cities are challenged with people living on the streets and are also struggling to provide shelter for the homeless. Affordable housing aims to address the housing cost burden for households less than 80% of the statistical area median income (AMI), which is considered low-income household (McCabe 2016).

Affordable housing development and sustainability offers a holistic approach to advance the sustainable development agenda in our built environment—protecting the balance with our surroundings. An inclusive approach to housing and community development is forming partnerships with local nonprofit groups or public services to offer quality public amenities and social services such as health care, childcare, educational resources, and job training/career placement programs. Onsite community amenities to accommodate these programs may include a computer lab, fitness center, or a community multipurpose space; helping residents to achieve economic and personal goals. An indirect benefit of the inclusive approach is the potential reduction for the need of the homelessness shelter system, which is a considerable public cost. People experiencing homelessness are three to four times more likely to die prematurely than their sheltered counterparts, according to a study released by the National Health Care for the Homeless Council, wherein lower temperatures, higher housing and energy costs, and insufficient shelter contribute to the problem (Thomas 2016).

4 Affordability and Finance

Affordable housing is an economic concern. The questions to be asked are: Can households afford to pay rent or mortgage payments for housing? What investment funds are available to construct or preserve affordable housing to keep up with demand? Research conducted by the Joint Center for Housing Studies of Harvard University and other publications offer data to support the first question. The general consensus is that greater efforts are needed to expand housing options to address affordability. There are investment funds and programs available to preserve affordable housing that can be categorized as: development incentives, development/home purchase loans, housing voucher/capital, community land trust, and federal subsidy. Development incentives such as land offered at a discounted price, density bonus (i.e., Inclusionary Zoning—Affordable Dwelling Units), or waiver of government development requirements (i.e., waive impact fees) are

[1]Affordable housing needs according to the U.S. Department of Housing and Urban Development.

available to developers. Loan programs available to developers or homebuyers include FHA 203(b) program—single-family homebuyer, FHA 21(d)(4) program—multifamily rental development, and energy efficiency state loans (i.e., Maryland's BeSmart Home Loan Program). Federal subsidies that reduce the cost of capital are Low Income Tax Credits (LIHTC), Public Housing Program, and local administration financing.

The federal affordable housing programs are administered by the U.S. Department of Housing and Urban Development's (HUD) Community Planning and Development Office and Housing Office, and are implemented by state governments or public housing agency/authority. Housing policy seeks to address affordable housing needs at different levels of affordability. HUD sets income limits for their housing programs, which include public housing, Housing Choice Voucher Program Section 8, elderly housing—Section 202, and housing for people with disabilities—Section 811. For example, in the Washington, D.C. area, the AMI (household income for the median household in a market area) for a four-person household is $108,600. A family of four at 30% AMI ($32,600 household income) can qualify for housing voucher. A family of four at 60% AMI ($65,160 household income) may qualify for affordable housing at a development with secured tax credits. Since there are no incentives for developers to serve tenants earning less than 50% of AMI, federal or other programs are needed to support affordable housing for lower income households (Ballard 2003). The HUD community development programs include the Community Development Block Grants (CDBG), and the Home Investment Partnerships Program (HOME) program. The housing programs include HOPE VI public housing, which was created to revitalize existing distressed public housing, and Choice Neighborhood Implementation Grants (created to redevelop existing public housing into mixed-income communities). The most robust affordable housing program is the Low Income Housing Tax Credit (LIHTC) program, which provides incentives to developers to create and maintain affordable housing. Investors buy income tax credits in qualified properties that have received state allocation, creating cash equity for owners that reduces project development debt burden while the developer agrees to rent a specific number of units to qualified tenants at specified rents, usually below market.[2] The LIHTC program provides equity to a project at a fixed tax rate of 9% and at 4%, for new construction and rehabilitation projects. There is more demand for 9% tax credits (allowing for a smaller gap in funding in order to execute a deal) due to its more predictable funding, however, it is more competitive compared to the 4%. Its availability is dependent on state allocation and federal funding. Applications for LIHTCs, through the Qualified Allocation Plan (QAP), include incentives for developers to include green building elements in their application for funding (Linstroth 2013). For example, the state of Maryland's QAP awards points for projects that incorporate renewable energy. There are also financial incentives for pursuing green building certifications such as Leadership in Energy and Environmental Design (LEED). Even with these benefits, environmentally sensitive

[2]An overview of LIHTC and its regulation is provided at: https://nhlp.org/lihtcoverview.

design is perceived by developers to have higher initial development cost. In 2016, HUD announced a new funding stream for housing to serve low-income households, called the National Housing Trust Fund (NHTF). This new vehicle can be of advantage, once made available, in meeting our country's housing needs and supporting HUD's mission in creating strong, sustainable, inclusive communities, and quality affordable homes for all.

The allocation of funds made each year by state or region is available but the collection of data in evaluating and comparing the success of the housing programs is not accessible. It is evident the programs have helped alleviate the lack of affordable housing because housing programs such as the Home Investment Partnerships Program (HOME), Housing Choice Voucher Program Section 8, Community Development Block Grant (CDBG), and Community Land Trust have provided capital to increase purchasing power for housing. Even with these allocated resources, there is still a deficit in the housing market for households earning 30% of area median income as well as housing for specific groups such as Gen-Xers, Baby Boomers, and Young and Single Households (Fernald 2015).

5 Contract Negotiations

Proper negotiation of terms can greatly impact the project benefits and better guide it toward the affordability and sustainability goals. Different contracts are signed at multiple phases of the development process among project stakeholders. This includes acquisition of land or property, design and engineering services, construction, lending terms, green building certification, property management, leasing, etc. After terms have been accepted and are legally binding, critical conversations and strategic planning continue to guide the development project. This holds true during the construction phase as the developer, lender, architect, engineer, and general contractor meet regularly to discuss progress in building construction. Maintaining a positive and productive working relationship is key to the success of each phase of development. For example, the ability to communicate coherently when opinions vary and stakes are high, and team members holding each other accountable. The contracts used are industry standards documents, which are edited to meet the objectives of each project. For example, AIA Document B101-2007—Standard Form of Cost Plus Agreement between Owner and Architect, AIA Document A102-2007—Standard Form of Agreement Between Owner and Contractor/Cost Plus, and AIA Document A201-2007—General Conditions of the Contract for Construction. It is good practice to review contractual agreements periodically to assure project compliance and fulfillment of terms. For example, as a project is waiting on an anticipated date for closing on a bank loan, a developer may consider extending an option on the land purchase agreement.

To stimulate the adoption of sustainable goals for affordable building projects, performance-based incentives may be included in the contracts. The U.S. Department of Energy provides a resource guide in procuring these services to ensure energy efficiency and sustainability goals are met (Hotchkiss 2012). The Harvard University Office for Sustainability provides guidance on green building request for proposal (RFP) language and Owner's project requirements (Harvard Business School 2011). Another approach to aligning financial interest with sustainability is green leasing.[3] These are rental agreements in which tenants commit to, or gain incentives by participating in water/energy conservation, waste reduction and recycling, use of nonhazardous cleaning products, or other sustainable actions.

6 Development Plan

The development scope of work identifies the many requirements of the project, other than meeting deadlines and staying within budget items. Visualizing the development process also allows foresight in grouping resources, and compilation of sustainable development goals throughout the development schedule. The phases in the development process include the vision or development concept; analyzing the market (market study); identifying and evaluating a project site (energy audit, building assessment report, and environmental reports); evaluating schematic designs and sustainability programs; estimating construction cost; performing financial analysis (preparing income/expense statements and sources/uses of funding); obtaining construction loan, permanent loan and equity contribution; negotiating partnership agreements and contracts; building construction; and property/asset management. The development schedule allows time for acquisition, land planning and zoning, architectural design and engineering, preconstruction, construction, and stabilization. It is good practice to obtain financing commitments and approvals before closing on a project site. Construction is anticipated to span 12–18 months (for multifamily residential units) provided that the construction team can input value by way of ensuring efficient constructability. The success of the design and construction of the project can be managed in order to keep cost and schedule within project targets. There are several variables that contribute to the development schedule and project sustainable development goals such as scope of work, site conditions, finance options, locality, community involvement, etc. A sample project development schedule is outlined in Fig. 1.

[3]Green Leasing Resources is available at: https://www.go-gba.org/resources/green-building-methods/green-leasing/.

Phase	Activity	Timeline
Due Diligence	Idea Conception	Varies
Design	Design Development	2 months
	Construction Documents	7 months
Permitting	Zoning	1-2 years
	Building Permit	6 months
	Meet with Community Organizations	12 months
Construction	Site work	3 months
	Base Building Construction	12-18 months
	Interior Construction	6 months
	Punch list	1 month
	Final Completion	Milestone
Operation	Property Management	Milestone

Fig. 1 Sample development schedule

7 Sustainable Design

Green building, green design, sustainable building, high-performance building, and low-impact development are among the terms used to denote practices that reduce the environmental impact caused by the built environment (Fisher 2010). Building Science is a broad discipline that is concerned with the full life cycle of building, including policy (codes and standards), planning, design, construction, commissioning, facilities management, forensics and rehabilitation, restoration and retrofit, preservation, and demolition' (Kesik 2016). Sustainable building science is the relationship between these various building disciplines such as architecture, engineering, and construction while being mindful of waste, energy, and natural resources. Sustainable development promotes the practice of sustainable building science and green construction to reduce resource consumption and conserve energy, while inspiring smart growth. Designing a sustainable building requires an understanding of how people interact with the built environment and the natural landscape. The design team that is selected to carry out the sustainable design intent must have experience with high-quality green design and building science as well as have a good working relationship with private and public entities such as local jurisdictions. The team must also stay up to date with local and international building and design codes. The design team will be expected to have a qualified team of building architects, interior designers, mechanical/electrical/plumbing engineers, structural engineers, civil engineers, ADA consultant, and landscape engineers. The architectural design package will consist of drawings (civil, architectural, mechanical, electrical, structural plumbing, and HVAC) specifications and information models. For example, the Advanced Commercial Buildings Research group at the National Renewable Energy Laboratory (NREL) develops and utilizes advanced energy modeling to help architects, engineers, and facility managers understand the energy implications of their designs and maximize the efficiency of

their buildings (NREL 2012). The Leadership in Energy and Environmental Design (LEED) rating system provides a benchmark and quality standard for environmentally responsible buildings and developments. Similarly, the U.S. Department of Energy's Energy Star[4] program, Green Globes,[5] or Passive Home Design[6] program provide criteria to achieve the same goal while taking advantage of building site location, climate, and materials to minimize energy usage. The characteristics of green building consist of (but not limited to) energy efficient mechanical/electrical systems, recycling construction waste, using rapidly renewable or recycled building materials, good indoor air quality, natural lighting, conserving natural resources/vegetation, and reasonable access to public transportation. The sustainable features listed are the criteria to meet the U.S. Green Building Council, LEED standards[7]: Sustainable Site (i.e., abundant green open space; green roof, roof top deck and open green space at ground level), Water Usage (i.e., water efficient fixtures and low flow urinals in restrooms which will reduce water use), Energy Efficiency (i.e., thermal efficient building envelope integrated with mechanical requirements, contract to purchase green power from clean and renewable sources, and ongoing accountability of building electricity performance), Indoor Air Quality (i.e., low-emitting/low-VOC materials, and HVAC system designed to meet Thermal Comfort Conditions for Human Occupancy and Acceptable Indoor Air Quality), and Renewable Materials (i.e., specified and procured new regional materials that contained recycled content, new materials obtained from local/regional manufacturers, central area dedicated to the collection and storage of materials for recycling, and green cleaning). Investing in good quality materials and equipment such as mechanical, electrical, and plumbing systems permits for cost-effective long-term management. To reduce overdesigning and over usage of resources, the development team will need to work closely with other disciplinary groups to create opportunities to exceed sustainability goals.

8 Green Construction

The construction general contractor is expected to have a professional working relationship with project stakeholders, experience constructing affordable and sustainable projects, flexibility in appointing individual subcontractors, experience obtaining building permits, a reputable safety record, understanding of the green building certification process, knowledge about local building codes, availability for value engineering counsel during design phase, and history delivering projects of excellent quality. In constructing a green building, precautions must be taken to

[4]Energy Star programming information is available at: www.energystar.gov/newhomes/.
[5]The Green Globes system is available at: www.greenglobes.com.
[6]Passive Home Design standards and case studies is available at: www.phius.org/.
[7]LEED Rating System and Case Studies are available at: http://www.usgbc.org/sites/default/files/LEED%20v4%20BDC_04.05.16_current_0.pdf.

ensure the design intent is communicated effectively and efficiently to the construction management team.

Depending on the unique requirements for a project, the integrated project delivery (IPD) structure may allow an efficient design–construction relationship in building out the project. Unlike traditional delivery methods, the collaborative process of IPD brings the owner, architect, engineer, and general contractor together at the beginning of the project and promotes participation from all parties at all project stages (AIA 2007). The general contractor would need to be available as early as the design phase to provide input such as cost comparison information or guidance on performance of proposed systems. A few advantages that this structure has over traditional methods (i.e., multiple prime contracts or design-build) of procurement are lower project cost, ability to handle project changes more easily, and it places emphasis on building relationships. This opportunity also affords the project an expedited review of construction documents, green building construction permit applications, and cost incentives. The site plan, mechanical, electrical, plumbing, acoustics, lighting, etc., are all parts of the design phase which require extensive construction coordination as it transitions into the construction phase. Each disciplinary field offers a wealth of knowledge where outlets such as project meetings can provide the opportunity to share expertise and best practices. This also allows a channel for developers, land use attorneys, government agencies, communities, and consultants to interact and make collective decisions, as well as focus team efforts on reduction of consuming material resources and energy throughout the construction phase.

9 Building and Property Management

Sustainable development considers the life cycle cost of maintaining the development project and its environmental impacts. In 2015, about 40% of total U.S. energy consumption was consumed in residential and commercial buildings, or about 39 quadrillion British thermal units (U.S. EIA 2016). Measuring the buildings energy performance and resource consumption can be tracked using platforms such as the Building Management System[8] and the U.S. Department of Energy's Energy Star Portfolio Manager.[9] As efficient appliances and low utility expenses become an increased priority for residents, the developer can capitalize on this demand by highlighting these features within their marketing strategy and green leases.[10] Low maintenance and low energy consuming appliance can reduce operating expenses,

[8]Building Energy Management Systems (or BEMS) are computer-based systems that help to manage, control and monitor building technical services (HVAC, lighting etc.) and the energy consumption of devices used by the building. Source: https://www.trendcontrols.com/en-GB/bmssystem/Pages/default.aspx.

[9]Energy Star Portfolio Manager Online Tool information are available at: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager.

[10]Green Leasing Resources are available at: http://www.greenleaselibrary.com/.

replacement reserves, and maintenance expenses; effectively lowering the buildings net operating expenses. Tracking building performance is an effective strategy in ensuring sustainable goals such as implementation of targeted greenhouse gas emission goals and ensuring that reduced operating cost are being maintained after the project development phase. Local governments are adopting sustainability initiatives. For example, DC Sustainable Energy Utility, a quasi-governmental agency, under contract by the District Department of the Environment (DDOE), offers training sessions for residents, developers, and managers of multifamily buildings to teach skills on effectively managing and reducing energy use and finance needed improvements. In May 2014, the Montgomery County Council adopted Bill 2-14, Environmental Sustainability—Buildings—Benchmarking, requiring the county and building owners to benchmark energy use in certain nonresidential buildings of 50,000 square feet or greater with the Energy Star Portfolio Manager tool (U.S. GBC 2015).

10 Conclusions

The pursuit of sustainability in the field of building science and community development will help bridge the gap in affordability in local communities, and influence global sustainable development plans. This paper has identified the key disciplines and areas in the development process such as finance, team relations, contracts, sustainable design, green construction, and building and property management, in which sustainable development can be the framework for addressing the environmental, economical, and social impacts of community building. The team relationship among the team members, and their commitment to sustainable development goals are key components in implementing the development plan. While for-profit developers are usually focused on building development and finance, partnerships with nonprofit or public social services can assure mission focused community initiatives are implemented such as affordability and economic stability. The idea of building social and economic mobility into community development by integrating social programming can allow residents to connect with the space which impacts people's health and well-being. Resources such as community development corporations assist communities in taking advantage of local assets and dedicated funds, as well as potentially alleviate complex social problems. The developer, in collaboration with local authorities, can incorporate environmental and social concerns in business operations. Funding for affordable housing and sustainable programs require capital to preserve long-term goals, in the form of donations, grants, and government subsidy. Since the private sector cannot profitably supply low-cost units, the government must play a critical role in ensuring that the nation's most disadvantaged families and individuals have good quality, affordable housing (Fernald 2015). Public policy, with a higher level of commitment to lower income households and quality housing, is needed. For example, incorporating building science into sustainable design and property management,

and building to sustainable standards. The sharing of global experiences in sustainable development and the data collection or evaluation of successful programs will support the Global Partnership in building resilient infrastructure globally. These sustainable development practices offer a holistic approach to advancing the real estate development agenda in our built environment and ultimately address the United Nation's Sustainable Development Goals.

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Freedom from Poverty and the Right to Sustainable Development: One Goal but Different Rights and International Commitments

Katarzyna Cichos

Abstract

Over the last decades, the right to development as well as standards of development assistance evolved. Recently, development assistance concentrates its actions on the elimination of poverty. Analysis of the right to development and international regulations of the development cooperation (UN, EU, OECD, WB) proves that on the basis of the development cooperation, the eradication of poverty became an independent purpose of the international community, and it can be treated as a new international legal obligation. Additionally, on the basis of international law, it can be proved that presently we have two different human rights: the right to (sustainable) development and the right to freedom from (extreme) poverty. They cannot be treated in the same way because those rights relate to different subjects and objects. Everyone has the right to development but not everyone lives in extreme poverty. To make development cooperation more effective, global development cooperation agenda should take this distinction into consideration and provide two different groups of development goals—one which will concentrate on areas where the humanity struggles with the elimination of extreme poverty, and second which will concentrate on areas where sustainable development is needed. Such distinction can make development assistance, especially in the developing countries, more coherent, effective, and transparent.

Keywords

Sustainability · Implementation · Development assistance · Poverty

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1 Introduction

Probably nobody can argue that everyone has the right to development but not everyone lives in extreme poverty. The main question that will be raised in this paper is if world's community should treat everyone (those who live in poverty and those who do not) equally. On January 1, 2016, the 17 Sustainable Development Goals (SDG) of the 2030 Agenda for Sustainable Development (Agenda 2030), that were adopted by world leaders in September 2015 at the UN Summit, came into force. SDG were established on the basis of Millennium Development Goals (MDG 2000, 2001) which global community tried to achieve for last 15 years. This paper does not discuss the states' policy and their individual action for sustainable development to implement the Agenda 2030 within their own countries. It will not make any analysis of the freedom from poverty as a human right, which can be found in legal literature (Pogge 2008). The paper concentrates on international commitments and global duties to eradicate poverty. It tries to answer a question whether people have the right to live in freedom from poverty? If the answer is positive, is there an international obligation to support the developing countries to eradicate extreme poverty? And going further—if the right to live in freedom from poverty means something more for international community's obligation than the right of people to sustainable development? On the threshold of implementation of the new Agenda 2030, those questions are more important than ever before.

In the first part, the paper presents the differences between MDG and Agenda 2030 within the creation of international obligations. The second part explains what poverty is, and how different concepts of development tried to eradicate it. The third part shows the level of internationals commitments to implement right to development and eliminate poverty.

In the paper, the author applies two main research methods. First is the theoretical—legal method which consists of examining ways of regulations, application, and enforcement of development cooperation law. Historical method will also be applied by presenting the genesis of concepts of development and the legal background of development cooperation and its evolution.

2 MDG v. Agenda 2030

At the official website of SDG, we can find the very basic explanation what is the difference between MDG and Agenda 2030 for sustainable development. As it is explained in SDG FAQ "the new Goals are universal and apply to all countries, whereas the MDGs were intended for action in developing countries only". It very clearly shows that the MDG was an "action" in "developing countries" and SDG are "universal…" but it is not said what? but probably just goals, without any planned action. The author is not going to discuss if the implementation of this agenda is possible or not. It should be just noticed that international community might lose the action for poorest and developing countries within so many goals

without planned action. It will not be the result of wrong policy, which is rather clear. It will be the result of not taking into consideration former binding commitments and actions in order to implement the MDG.

The Agenda 2030 for Sustainable Development says that it "is a plan of action for people, planet and prosperity" it also recognizes that "eradicating poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and an indispensable requirement for sustainable development" But the Declaration also adds that "we recognize that each country has primary responsibility for its own economic and social development" (p. 41). "Primary responsibility" does not exclude international support and assistance, however, it might be interpreted as "states' business" how they achieve their own development and put priority for "its own" not global development. There is commitment to eradicate extreme poverty by the end of 2030 (Agenda 2030, Goal 1.1) but how it is going to be achieved is not mentioned. Even though there is goal number 17 (Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development), there is only repeated commitment for developed countries to "implement fully their official development assistance commitments, including the commitment by many developed countries to achieve the target of 0.7% of gross national income for official development assistance (ODA/GNI) to developing countries and 0.15–0.20% of ODA/GNI to least developed countries". There is nothing about how developed countries shall cooperate, and what is necessary to make international policy within different aspects more coherent with the development policy. Document very generally mentions the effectiveness of aid. It all makes that the Agenda 2030 seems to be a document of nice ideas, far away from today's global reality, including migrations, wars, religious conflicts, etc. It is also very hard to believe that it can be fully implemented globally. It means that the Agenda 2030 and sustainable development goals might be a great vision of our future world but at the same time, it can be a step back from the global discussion and already signed commitments on effectiveness of development assistance and responsibility for elimination of poverty which are presented below. SDG aim to go further than MDG to end all forms of poverty. However, is it possible to go further and ignore already developed standards like those accepted within development assistance cooperation to eliminate poverty?

3 Global Concept of Poverty and Development

3.1 Poverty

Nowadays, poverty is understood much broader than the dictionary meaning. According to Encyclopedia Britannica, poverty is the state of the one who lacks a usual or socially acceptable amount of money or material possessions. The World Bank defined the international poverty line as $1.25 a day in 2008 (Ravallion et al. 2008)

and in October 2015 reset it to $1.90 a day. According to the World Bank, poverty means deprivation in well-being, and comprises many dimensions. It includes low incomes and the inability to acquire the basic goods and services necessary for survival with dignity. Poverty also encompasses "low levels of health and education, poor access to clean water and sanitation, inadequate physical security, lack of voice, and insufficient capacity and opportunity to better one's life" (World Bank 2001). Economic and Social Council added that in the light of the International Bill of Rights (for example art 11 of ICESCR 1966), poverty may be defined as a "human condition characterized by sustained or chronic deprivation of the resources, capabilities, choices, security and power necessary for the enjoyment of an adequate standard of living and other civil, cultural, economic, political and social rights" (Human Rights Council 2008). But it must be add that "the lack of basic security leads to chronic poverty when it simultaneously affects several aspects of people's lives, when it is prolonged and when it severely compromises people's chances of regaining their rights and of reassuming their responsibilities in the foreseeable future" (Economic and Social Council 1993). This is actually the situation that is discussed in this article, when the poverty is becoming destitution and requires special attention and global treatment.

3.2 The Concepts of Development

Originally, the development was seen in purely economic sense, as making economic growth involving financial support in order to increase the gross domestic product (GDP). The dominant role played the British economist, founder of the Bretton Woods Institution, Keynes (1936). Keyes and his successors rely on the experience of the use of funds allocated under the Marshall Plan pointed out that the development is caused by economic growth, which can be increased through investment. They defined the role of development aid as bridging the gap national economies by increasing foreign capital. Thus, the base of determining the factors causing the development was the need to increase the rate of investment, which was made possible in developing countries only through substantial cash injection (Rostow 1960). The creators of the concept of the so-called growth model were Harrod and Domar. Chennery and Strout (1966) developed this concept as so-called "Two Gap Model" (Easterly 1999). The first period of development aid is called the period of development by increasing GDP and covers the years 1950–1965. In the preamble to the Declaration on Social Progress and Development in 1969 r. (UN 1969), it was observed that economic development depends on social development and they influence each other. The new concept which included the importance of basic needs for development played an important role since the mid-60s to early 80s. In the 80s the concept of sustainable development began to dominate, which summarizes the idea of the first sentence of the World Commission on Environment and Development's report "Our Common Future" (UN 1987) from 1987 r., which says that "humanity has the ability to make development sustainable to ensure that

it meets the needs of the present without compromising the ability of future generations to meet their own needs" (p. 27). Contained in the report, development vision takes into account both the human population, flora and fauna, ecosystems and natural resources of the Earth, as well as in an integrated way treats the most important challenges facing the world, such as the fight against poverty, gender equality, human rights and security, education for all, health, intercultural dialogue. It was stressed that the creation of a fully sustainable model of life requires a variety of activities in the regions of the world within the framework of the so-called three pillars: economic growth and equitable distribution of benefits, conservation of natural resources and the environment and social development (Stoddar 2011).

In addition to the concept of sustainable development, the concept of human development appeared. The main authors of the theory of human development are the Nobel Prize winner—Amartya Sen and Pakistani economist, the author of the Human Development Index (HDI)—Mahbub ul Haq (Sen 2010). The concept of human development was introduced in the early 90s and it is presented, starting from 1990 in reports on human development (HDR). It defines development as the "process of enlarging human choices" (HDR 1991). This concept, as highlighted in the 1996 HDR, goes far beyond measuring income and economic growth in order to cover the full flourishing of all human capabilities (HDR 1996). The report stresses the importance of putting people—their needs, aspirations, and choices—in the center of development work (Alkire 2010). Thus, human development is to ensure a long life to individuals with access to health care, education, the possibility to participate in social and political life of the country, and the co-decisions which impact and influence on their lives. Each of these concepts was reflected in international regulations presented below.

4 International Commitments on Right to Development and Elimination of Poverty

4.1 Right to Development

The base of the right to development, which justifies the actions of the international community for the development, was described by Keba M'Baye during his lecture at the International Institute of Human Rights. According to M'Baye (1972), the right to development belongs primarily to the community and through them to every human being. Objectively, it recognizes all development issues at the national and international levels. The basis of the concept of the right to development can be found in articles 55 and 56 of the Charter of the United Nations (UN 1945). Formally, international community recognized right to development in 1979. Resolution 5 (XXXV) of the Commission on Human Rights (UN 1979a) confirmed that the right to development is a human right and that equality of development opportunities is both nations as well as individuals' prerogative. The confirmation of the adopted resolution was a resolution of the General Assembly from November

1979 (UN 1979b), which recognized the right to development as a human right (Drzewicki 1988). But only in 1986, right to development has been formulated and adopted at international level as United Nation Declaration on the Right to Development (UN 1986) and in 1993 it was confirmed in Vienna Declaration (Vienna 1993) which reaffirms that "the right to development, as established in the Declaration on the Right to Development, as a universal and inalienable right and an integral part of fundamental human rights" and provided commitments that "states should cooperate with each other in ensuring development and eliminating obstacles to development" (p. 10) Adoption of the right to development, especially in the sense of "right to a process towards development" for the international community, seems to be a breakthrough for the functioning and justification of development aid.

Although this theory was created in the 70s of the twentieth century, comments on the complementarities of human rights, as well as the need to engage in their implementation, not only countries but whole societies, have become very important due to the deepening of poverty and violations of human dignity worldwide. The problem that remains is the implementation of the right to development, including identification of the institutions liable for its implementation. For this reason, more and more developed countries show that the right to development is a synthesis of the rights already included in numerous human rights conventions, and postulate that without complementary treatment of human rights there is no possibility of real development (Sen 2007). This affects the development cooperation policy, in which more and more activities are focused on the direct or indirect promotion of human rights (Uvin 2007) as Human Rights Based Approach to Development (Hamm 2001). All this makes that since 70s, international community has not found a way how to implement "right to development". Although there is the "development", and individual countries are developing, the existing solutions do not seem to be fully sufficient for people who live in extreme poverty, whose situation actually have not changed since 1970s. Therefore, maybe, we should put more far-reaching question—if the right to live in freedom from poverty might be a special area in the whole understanding of the right to development. The subject and object of right to live in freedom from poverty could be much easier to specify than for the right to development. It can facilitate the creation of international commitments and provide special mechanisms within the international law and especially within development cooperation. It seems to be also an already existing international commitment.

4.2 Commitments to Poverty Eradication

Since the 1970s, there were two independent concepts that have their legal development. The first was sustainable development. The concept of sustainable development has affected the content of international instruments, as exemplified by the Declaration of Vienna of 1993, the Stockholm Declaration (UN 1972), The Rio (1992a) Declaration and Agenda 21 (Rio 1992b), the Declaration of Johannesburg

(2002a, b) and adopted the Plan of implementation (2000b), and the Declaration of the Rio + 20 of (2012). It was also included in a number of EU documents, including for example the Europe 2020 Strategy (EU 2020). All of these documents are not binding and over the years they have failed within the implementation process.

The second theory was the concept of human development in order to eliminate poverty. The new perspective on human development, focuses on the improvements of human's live condition cause that since the 90s, not "development" any more, but the "eradication of the poverty", has became the main object of development cooperation. At the World Summit for Children in 1990 (UN 1990), a declaration against poverty was signed for the first time. According to article 28, "achievement of child related goals in the areas of health, nutrition, education, etc., will contribute much to alleviating the worst manifestations of poverty" (Pebley 1993). In the Vienna Declaration (1993), which is concentrated on human rights and right to development it has been noticed that the "existence of widespread extreme poverty inhibits the full and effective enjoyment of human rights; its immediate alleviation and eventual elimination must remain a high priority for the international community". The World Conference on Human Rights affirms also that "extreme poverty and social exclusion constitute a violation of human dignity and that urgent steps are necessary to achieve better knowledge of extreme poverty and its causes, including those related to the problem of development, in order to promote the human rights of the poorest, and to put an end to extreme poverty and social exclusion and to promote the enjoyment of the fruits of social progress" (p. 25). Copenhagen Declaration on Social Development (where the concept of poverty occurs in the context of unemployment, social exclusion, equal treatment of women, the environment, armed conflicts, etc.) signed during the World Social Summit in 1995 r., is widely regarded as a milestone in an integrated perception of various aspects in the context of poverty (Fukuda-Parr 2011).

The OECD in the document "*Shaping the 21st Century*" (OECD 1996), identified poverty reduction as a common goal of all members of Development Assistance Committee and established six International Development Goals. The first goal was the eradication of poverty. The most important document appears to be the Millennium Declaration adopted in 2000 by 189 countries (MDG 2000), which is the general framework of the activities of the United Nations at the beginning of XXI century and the presented by the UN Secretary General, detailed and measurable targets and indicators, so-called the Millennium Development Goals. The implementation was expected by 2015 (MDG 2001). The United Nation committed to "spare no effort to free our fellow men, women and children from the abject and dehumanizing conditions of extreme poverty, to which more than a billion of them are currently subjected (p. 11) and to create "an environment – at the national and global levels alike – which is conducive to development and to the elimination of poverty" (p. 12).

Today, all organizations indicate poverty eradication as the goal of development policy and development cooperation. Until 2015 within the UN, the MDG have been implemented. The World Bank in 2013 (WB 2013) established two basic

objectives of its activities, which include the eradication of poverty by 2030 and promotion of common prosperity. OECD's countries, in the document "Shaping the 21st Century", identified poverty eradication as the main objective of Official Development Assistance. European Union in art 3 of the Treaty on European Union (EU 2009a) notified that in its relations with the wider world, the Union shall contribute to peace, security, the sustainable development of the Earth, solidarity and mutual respect among peoples, free and fair trade, eradication of poverty (…). In art 21 it is stated that the "Union shall define and pursue common policies and actions, and shall work for a high degree of cooperation in all fields of international relations, in order to (…) foster the sustainable economic, social and environmental development of developing countries, with the primary aim of eradicating poverty". In Title III, article 208 of the Treaty on Functioning of European Union (EU 2009b) it is stated that "Union development cooperation policy shall have as its primary objective the reduction and, in the long term, the eradication of poverty". Eradication of poverty was mentioned also in 2006 in European consensus on development (EU 2006), which confirmed that the "primary and overarching objective of EU development cooperation is the eradication of poverty in the context of sustainable development, including pursuit of the Millennium Development Goals" (art. 1.5). Elimination of poverty also appears in the Cotonou Agreement signed between the EU and 79 African, Caribbean and Pacific States (EU 2000). In article 1, it is stated that "the partnership shall be centred on the objective of reducing and eventually eradicating poverty". The biggest individual donor of development aid is the United States. Within its strategy "Celebrate, Innovate and Sustain: Towards 2015 and Beyond" (US 2010) the USA sees the MDG as a declaration "of the world's commitment to eradicating extreme poverty and hunger".

Within last 15 years, MDG (as an action towards elimination of poverty) have been recognized by almost all developed and developing countries in its national development strategies (Stein 2012). It all shows that the entire international community accepted the MDG as an action to eradicate poverty and made some binding commitment to implement that at national and international level. It means that we also can consider development aid or any action to provide development as practice (usus) which is the primary, necessary element to establish international customary law (Rieu-Clarke 2005). We can argue if this "practice" is "constant and uniform" (ICJ 1950) or "settled" (ICJ 1969) as it is demanded by International Court of Justice (ICJ). However, even though the development assistance policy and practices were very different for last decades and it was hard to see the cohesion within the certain donor countries within last 50 years it was changed in 2000. By adopting MGD, international community has concentrated on common goal and very specific action. We can also argue that "few" years is not enough, however, the duration is not a primary concern as long as it could be proven that the practice was "extensive and virtually uniform" (Rieu-Clarke 2005). It means that we have more than 50 years of global practice within development aid and 15 years of uniform development cooperation action in order to eradicate poverty. It seems to prove that we can accept that there was a common international practice in order to eliminate poverty for last 15 years. Additionally by signing all agreements mentioned above

and taking binding international commitments, states seem to prove that they have belief that these actions were carried out as a legal obligation. This belief (opinio iuris) is a second necessary element to establish a legally binding custom. That means that two necessary elements (usus and opinio iuris) of customary international law can be confirmed and development aid is not only a good practice any more. It has become a practice in order to fulfill legal commitment to eliminate poverty. It means that indirectly the international community accepted the new law —freedom from poverty—and it has already taken initial steps to make this right common and universal. Elimination of poverty seems to be globally accepted and includes the acceptance of regular transfer of funds by developed countries for this (specific) purpose.

5 Conclusions

People have the right to live free from poverty. Freedom from poverty and the right to sustainable development definitely have one goal—creating a better world and make human life better. The problem is that the Agenda (2030), just like SDG put them into one big basket and treat them equally. It is not necessarily the right approach. Moreover, it is also against already accepted international commitments that seem to treat right to freedom from poverty differently than rights to (sustainable) development. MDG in 2000 were not binding proposal but after 15 years, its goals, especially the eradication of poverty, became part of many binding instruments and agreements. It means that they became binding. In this contest adoption of new, not binding but more general and much less targeted declaration, in the contest of elimination poverty, cannot be named differently as a step back. Agenda 2030 treated as a global agenda which shows the new main global goals can be acceptable. However, if SDG shall fulfill all concepts and "actions" in this area, it is not enough. There are no binding international commitments for sustainable development but it will not help making any action to implement them more effective if we just add some goals from previous global action to eradicate poverty. SDG can be the most incredible vision for our world but it needs some very specific goals, as it has been done for MDG. It is hard to say if SDG can be more effective than previous declarations which were concentrated on ecology, but for sure they are not as detailed as MDG and they seem to left behind what international community already accepted.

International community needs to sign a new declaration or even a binding convention on freedom from poverty which shall concentrate on specific actions to eliminate poverty. Even though nowadays, states are very reluctant to join in the painstaking process of adopting binding commitments, the situation of people who live in extreme poverty seems to be justifying this effort. This convention shall not only be an international "promise", but very specific document where developed countries commit funding and international cooperation, where it will be presented which and how international institutions will be responsible for transferred funds,

with the spending and control mechanisms. This convention shall be also signed by developing countries which need to accept the way of cooperation to help deliver these funds to their people effectively without fear of unaccepted intervention in their internal affairs. There shall be also very limited areas where those funds can be used, like education (at different levels) and health to make the cooperation the least politicized. There should not be any extra condition like democracy or human rights. People have the right to live in dignity even when their government breaks the basic rights and freedoms. Leaving them without any help condemns them to extreme poverty and deprives the chance for better future not only adults but also their children, which should contribute to the improvement of governance and development of their countries in future.

Fifteen years was not enough to overcome poverty but international community has still a real chance to eliminate extreme poverty and indigence. MDG were just the first step, and international community needs to take the next step. Only by adoption of an agreement on freedom from poverty and international action and assistance, the first goal of SDG can be achieved. In any other cases, it will be forgotten within so many others broad goals and 15 years of work on building international sensitivity on the situation of the poorest will be lost. At the same time, it is not possible to achieve global development without supporting the most vulnerable. If the world does not hear their voices from the places they live, someday they will come as immigrants or soldiers. There will be no global peace as long as extreme poverty exists. It is also impossible to achieve SDG without achieving the first goal. It means that international community shall pay special attention to it. The easiest way to achieve it is to organize international conference and adopt the convention on freedom from poverty and accept commitments on development assistance to focus on aid for the poorest. Considering that all countries accept this goal, and it is not expressed only in oral declarations but in binding legal documents and agreements, this convention should be adopted with worldwide acceptance.

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Sustainable Development and Climate Change

K.S. Getvoldsen, T.E. Butt, C. House and F. Ferreira

Abstract

The sustainable development philosophy can be regarded as the most multi- and interdisciplinary field. On the other hand, climate change, which is relatively a new field, has yet been evolving as another significantly multi- and interdisciplinary field. Both, the sustainable development and climate change have many factors in common ranging from socio-economic to the environment. However, commonality between the two has so far been studied insufficiently. This paper is to advance knowledge in this direction, specifically considering the Climate Change Act 2008 of the UK that legally binds the country to reduce emissions of greenhouse gases (GHG). By employing the UK housing sector as a case study, it is demonstrated via numerical calculations that even partly insulating the existing UK housing stock, legal targets of the Act can almost be met for that sector. Links are also drawn between climate change and sustainable development and that how addressing climate change can directly and indirectly help meeting the national sustainability agenda.

Keywords

Sustainability · Sustainable development · Greenhouse gases (GHG) · Carbon emissions · Energy efficiency · Energy management · And Climate Change Act 2008 · And climate change

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1 Introduction

1.1 Background

Greenhouse gases (GHG) emissions, which is deemed as the most influential anthropogenic activity associated with the climate change, are one of the 12 sustainable development indicators in the United Kingdom (UK) (DEFRA 2013). Carbon dioxide (CO_2) is one of the GHG, which is produced as a chemical product when combustion of fossil fuels (i.e. coal–solid, oil–liquid and natural gas)—an exothermic chemical process—takes place (Butt et al. 2012). Carbon dioxide is the most abundant GHG (Total 2009) and has been continuously on the increase since the industrial revolution (CDP 2009; Butt et al. 2012). Carbon dioxide can accumulate in the atmosphere and trap heat near the Earth surface to cause warming. This is called 'the greenhouse effect' and strongly related with climate change. This is how the relationship between the sustainability (or sustainable development) and the climate change phenomenon exists via carbon emissions. For more details, the case of the national sustainability strategy or agenda of the UK is described below.

The sustainable development Indicators (SDIs) provide an overview of progress towards a sustainable economy, society and environment. The UK sustainability agenda comprises 12 headline and 23 supplementary indicators, supported by 25 and 41 measures, respectively. Among the 12 headline indicators, one is GHG emissions that are supported by these two corresponding measures: the UK GHG emissions and the GHG emissions associated with UK consumption. However, carbon dioxide (CO_2) is one of GHG. So, narrowing it down to CO_2 only, 'UK CO_2 emissions by sector' is one of the 23 supplementary indicators. This supplementary indicator is supported by the residential sector as one specific measure (out of the 41). Furthermore, the housing energy efficiency is another relevant supplementary indicator which covers both the existing and the new housing. (DEFRA 2013; ONS 2015). This signifies the relationship between climate change and sustainable development strategy of the UK.

The Climate Change Act (CCA) was introduced in November 2008 as a legislative instrument to reduce GHG emissions by setting legal carbon cut targets and encourage activities that would reduce such emissions from the atmosphere (Legislation.gov.uk 2008). There are three binding targets for the UK emissions reduction as follows: Kyoto protocol which is an agreed target of 12.5% cut by 2012; an 'interim target' of a cut of 34% by 2020; and the third target of 80% carbon cut by 2050. These targets are set with respect to 1990 as the baseline when UK carbon emissions were 778 million tonnes (Beales 2014). The CCA derived these targets based on Kyoto protocol as well as to be in line with actions required across the world to preserve a 50% likelihood of staying below the global 2 °C threshold. (CCC 2015; Giddens et al. 2009). These targets are now deemed as benchmarks to gauge the progress of the UK in terms of the reduction of its carbon emissions (DECC 2015). These targets are set in the law and must be addressed with all energy efficiency improvements project to any property (Curtis 2012).

Sustainable development philosophy is generally considered along its three principal dimensions which are: the social/ethical, economic and environmental. There is limited literature on the relationship between the sustainable development and climate change along the three dimensions. However, there has been found no specific literature to date which focuses on mapping sustainability implications on the legal targets of the Climate Change Act, along each of the three aforesaid dimensions and yet in one document. The purpose of this paper is to explore this specific knowledge gap and find aspects, which could lead to bridge this gap while identifying some innovative and new areas for further research.

1.2 Aim and Objectives

Draw links between the sustainability philosophy and climate change at social/ethical, economic and environmental fronts, thereby specifically employing the UK housing sector as a case study, and using the legal carbon cut targets of the UK Climate Change Act (2008) as benchmarks. This aim is managed via the following objectives:

1.2.1 Objectives

1. Establish group types and the size of each group type of dwellings in the UK, as well as energy consumption/losses in them;
2. For a typical insulation technology if applied to each of the group types of the housing stock, calculate the corresponding potential savings in energy and cost;
3. Map the calculated potential savings of energy on to the legal carbon cut targets of the Act, and estimate how far these legal targets can be achieved in the residential/housing sector; and
4. Overlay the findings from Objectives 2 and 3 on the three individual principal dimensions of the sustainability philosophy to establish mutual implications between sustainable development and climate change.

2 The UK Housing Sector

The housing stock in the UK is responsible for 29% of the total UK carbon dioxide emissions (DECC 2013) of which space heating accounts for 53% (Green 2014). New homes will have improved emissions as building regulations have improved but majority of the UK population still live in older, less efficient homes. It is estimated that over 70% of the housing stock will still exist in 2050 (Baeli 2013) whereas according to another estimate, it is 86% of the total current housing stock (Gillott 2008; Milner 2008). Irrespective of some degree of discrepancy between

such estimates, it is obvious that the onus of carbon emissions control lies substantially more on the existing building rather than the new built.

Majority of homes in the UK are over hundred years old and their energy efficiency varies. This includes 13 million dwellings built before 1960 and 4.7 million built before 1919. Also, almost 40% of the existing stock were built before 1945 (EHCS 2009). The houses built before 1919 are least energy efficient of all dwellings (Baeli 2013). In the UK, there are approximately 25 million houses, this would mean that over 5,00,000 homes would need to be refurbished every year for the next 40 years to improve their energy efficiency—to whatever degree it may be (Hewitt 2010).

Table 1 gives an account of different areas where energy is consumed in a typical domestic setting. Among these, space heating is the biggest energy consumer taking up over a half of the total energy use in a typical house. Controlling this biggest energy wastage will have a direct positive impact not only on energy and cost saving but also significantly contribute to achieving legal targets set by the Climate Change Act. This paper, therefore, focuses on heat losses in the residential sector only in connection to space heating (Table 5).

3 Calculations

3.1 Background Data

Table 3 shows five group types of dwellings in the UK. Corresponding number of dwellings in each group type is also indicated. Whereas Table 4 shows an average energy saving and carbon cut for each group type per dwelling, when a typical external (or internal) wall insulation is applied. These figures could change depending on the size of the home. These are, however, an average based account for homes that are gas heated and completely un-insulated (EST 2016).

3.2 Carbon Cuts and Fuel Bill Savings

Based on Tables 3 and 4, potentials of carbon cut and fuel saving per year are calculated below for each of the five group types of the UK housing stock, and yet for both 2020 and 2050 scenarios of the Climate Change Act.

Table 1 Energy waste breakdown of a typical house (Green 2014)

Energy consumers	Energy wasters (%)
Lighting	6
Cooking	5
Appliances	16
Water heating	20
Space heating	53

Table 2 Energy wasters of space heating (Anderson and Kahya 2011)

House envelope components	Energy wasters (%)
Windows	18
Roof	26
Walls	33
Floors	8
Doors	3
General draughts	12

Table 3 Housing group types in the UK residential sector (DECC 2012)

Dwelling group type	Number of dwellings (millions)
Bungalow	2.38
Semi-detached	7.09
Terraced	7.56
Flat	4.98
Detached	4.58

Table 4 Estimated figures based on insulating a gas-heated home (EST 2016)

Solid wall insulation	Detached	Semi-detached	Mid terrace	Bungalow	Flat
Carbon cuts ($kgCO_2$/year/dwelling)	1,900	1,100	720	740	610
Fuel bill savings (£/year/dwelling)	455	260	175	180	145
Typical insulation cost	External wall insulation: £5,000 to £18,000 Internal wall insulation: £3,000 to £14,000				

$$\textbf{Carbon cut} = \textbf{Number of dwellings} \times \textbf{savings}\,(\textbf{kg/year})$$
$$\textbf{Fuel bill saving} = \textbf{Number of dwellings} \times \textbf{fuel saving}\,(\textbf{£/year})$$

Detached

$$\text{Carbon cut} = 4{,}580{,}000 \times 1{,}900 = 8{,}702 \times 10^9\ \text{KgCO}_2/\text{year} \qquad 8.702\ \text{MtCO}_2/\text{year}$$
$$\text{Fuel bill saving} = 4{,}580{,}000 \times 455 = £2{,}083{,}900{,}000\ /\text{year} \qquad £2{,}083.9\ \text{million/year}$$

Semi-detached

Carbon cut $= 7{,}090{,}000 \times 1{,}100 = 7{,}799 \times 10^9\ \mathrm{KgCO_2/year}$ $7.799\ \mathrm{MtCO_2/year}$
Fuel bill saving $= 7{,}090{,}000 \times 260 = £1{,}843{,}400{,}000\ /\ \mathrm{year}$ £1,843.4 million/year

Mid-terrace

Carbon cut $= 7{,}560{,}000 \times 720 = 5{,}443 \times 10^9\ \mathrm{KgCO_2/year}$ $5.443\ \mathrm{MtCO_2/year}$
Fuel bill saving $= 7{,}560{,}000 \times 175 = £1{,}323{,}000{,}000\ /\ \mathrm{year}$ £1,323 million/year

Bungalow

Carbon cut $= 2{,}380{,}000 \times 740 = 1{,}761 \times 10^9\ \mathrm{KgCO_2/year}$ $1.761\ \mathrm{MtCO_2/year}$
Fuel bill saving $= 2{,}380{,}000 \times 180 = £428{,}400{,}000\ /\ \mathrm{year}$ £428.4 million/year

Flat

Carbon cut $= 4{,}980{,}000 \times 610 = 3{,}037 \times 10^9\ \mathrm{KgCO_2/year}$ $3.037\ \mathrm{MtCO_2/year}$
Fuel bill saving $= 4{,}980{,}000 \times 145 = £722{,}100{,}000\ /\ \mathrm{year}$ £722.1 million/year

Total carbon cut of the residential sector = 26.742 $\mathrm{MtCO_2}$

3.3 Climate Change Targets

3.3.1 Scenario 1–2020 Targets

External/internal insulation

Without insulation:

$$(2015-2020)\ \text{Residential emissions}\ 74\ \times\ 5\,(\text{years}) = 370\ \text{MtCO}_2 \quad (\text{A1})$$

With insulation:

$$26.742 \times 5\ \text{years} = 133.71\ \text{MtCO}_2 \quad (\text{A2})$$

Presuming it dates from 01/01/2015 to 31/12/2020

Eq A1 − Eq A2 = (residential proposed emissions difference) over 5 years

$$370 - 133.71 = 236.29\ \text{MtCO}_2$$

Eq A1 – Eq A2/Eq A1 × 100 = %

$$370 - 133.71/370 \times 100 = 63\%\ \text{saving by 2020}$$

This figure is nearly the double of the carbon cut target of 34% by 2020 and yet just applying the wall insulation technology alone.

3.3.2 Scenario 2–2050 Targets

External/internal insulation

Without insulation

$$(2015-2050) \text{ residential emissions } 74 \times 35 = 2590 \text{ MtCO}_2 \quad \text{(B1)}$$

With insulation

$$26.742 \times 35(\text{years}) = 935.97 \text{ MtCO}_2 \quad \text{(B2)}$$

Presuming it dates from 01/01/2015 to 31/12/2050
Eq B1 – Eq B2 = (residential proposed emissions difference) over 35 years

$$2590-935.97 = 1654.03 \text{ MtCO}_2$$

Eq B2 − Eq B1/Eq B2 × 100 = %

$$2590-935.97/2590 \times 100 = 64\% \text{ saving by } 2050$$

The 64% saving is 16% short of the target that is set for 2050, i.e. 80% CO_2 reduction to the 1990 base level. Still, 64% alone is a significant amount to contribute to the target. It is noteworthy that only wall insulation is considered in these calculations. If, in conjunction with wall insulation, other energy saving technologies and techniques are applied to the other energy wasters including ceiling/roof, windows, doors, floors, etc.; it can be safely said that the target can not only be well met, rather exceeded. However, further research is needed to substantiate this hypothesis.

4 The Climate Change Targets Versus Sustainability

Based on the mathematically derived results above, this section of the paper maps the legal climate change targets on various aspects of the sustainability philosophy along each of its three principal dimensions.

4.1 Social/Ethical Aspects

The legislation of a country is a social or ethical matter, for it is derived by the public via the parliament in a democratic manner. Therefore, abiding by the law of the land is equally socially and ethically important. It is numerically demonstrated in the calculations section that via insulation of only walls of the residential sector of the UK, there is substantial potential to meet requirements of the Climate Change Act 2008 in the sector, especially when the legal targets deadlines are approaching fast.

As explained in the Introduction section of the paper that GHG emissions, carbon cut and housing energy efficiency are specifically clearly covered in the national sustainability strategy/agenda of the UK. Thus, merely via the wall insulation of the residential sector of the UK, it is possible to further progress along the aforesaid three indicators and measures of sustainability. Similarly, the fuel poverty is another measure or indicator included in the national sustainability agenda. The mathematically presented concept above can also be useful to support this specific sustainability measure of the UK via saving energy and relying less on the fuel.

Human comfortability (as per their desire and need) in the context of room or ambience temperature in a dwelling is a social aspect of sustainability. The wall insulation of the housing sector can effectively contribute to this not only during extreme cold weather but also extreme hot weather (e.g. heat wave). This is because insulation works by slowing down the rate at which heat transfers through the material, as heat by virtue of its nature always transfers to a colder area or surface from a hotter place (KdB Insulation Ireland Ltd 2013). In a cold weather, the insulation slows the heat transfer rate from the house, whereas in a warm weather, the insulation resists the heat entering the cool inside of the house from the outside. Thus, in a cooler weather, less energy is required to heat the house and in a warmer weather, less energy is needed to use air conditioning (WEC 2013).

Similarly, a house insulation can also be particularly useful, when due to climate change extreme cold and extreme hot spells are increasingly becoming a more common phenomenon. Annual temperature is expected to increase from 1 to 3.5 °C in the forthcoming decades, and also due to concentration of industrial infrastructure, buildings and transportation often urban heat islands are formed (Hulme et al. 2002; Crawley 2003, 2008). Thus, insulation can help to maintain human comfortability temperature in the house in both extremes without having to use much energy either in space heating or air conditioning/cooling.

4.2 Economic Aspects

Affordability for the maintenance or running of a house can be regarded as an economic aspect of the sustainable development philosophy. This particularly includes bills for gas and power. In the last few decades, bills have been on the increase, mainly due to fuel prices have been increasing overall. Thus, while helping meet the legal carbon cut targets, the insulation can additionally help reduce

on gas and electricity bills. In addition to fuel poverty, to a point, this can also help to reduce (financial) poverty which is one of the economy headline measures of the national sustainability agenda (DEFRA 2013).

Poor people are more likely to live in less energy efficient houses. Thus, insulation of their houses with government subsidy schemes can help. For instance, there is a total of £540 million available for eligible homeowners in England and Wales over the next 3 years (Straus 2014). Some households can be granted up to £7600 to improve their energy efficiency. Also, an extra £500 if the homeowner has moved in the last 12 months (Straus 2014).

If insulations technologies and techniques are applied on larger scale (e.g. the whole of the housing sector of the UK), this can create new economic opportunities in the country contributing to the GDP (Gross Domestic Product) which directly relates to the sustainability headline measure of Economic Prosperity (DEFRA 2013). Other energy-related technologies such as solar, wind, tidal are mostly imported in the UK from other countries. By developing insulation technologies and materials locally, the import of other complicated technologies can potentially be reduced.

Economic prosperity is one of the 12 sustainability headline measures whereas the environmental goods and services sector is one of the 23 supplementary measures of sustainability (DEFRA 2013). 'Moving towards a green economy includes developing opportunities and markets for environmentally oriented goods, services and jobs. The low carbon and environmental goods and services sector could be a key part of future social and economic prosperity' (ONS 2015, p. 19). Thus, enhancement of insulation technologies to tackle climate change as a mitigation measure can potentially play an effective role in improving on these two headlines and supplementary measures of sustainable development. This way, insulation technologies can also support low-carbon economy which is regarded as the efficient energy consumption.

4.3 Environmental Aspects

Fossil fuels provide a number of valued products and services, specially the generation of energy as the largest contributing energy source. However, as explained in the introduction section, combustion of fossil fuels for energy yields large amounts of unwanted CO_2 emissions, thereby significantly contributing to global warming phenomenon. This phenomenon has its own ripple effects such as extreme weathers, increase in rainfall frequency and intensity, droughts, glaciers melting, acid rains, ocean becoming more acidic and sea levels rising (Butt et al. 2012; CCC 2015). This necessitates an urgent requirement of CO_2 emissions be reduced from anthropogenic activities. That is why, controlling of GHG and carbon emissions, and specifically in connection to the housing sector for it being one of the substantial contributing sector, have been considered as headline and supplementary indicators in the national sustainability strategy.

In 2011, fossil fuels constituted around 83% of the world's energy. The global emissions of carbon dioxide reached a new record in 2012 of 34.5 billion tonnes (McGrath 2013). The UK energy emissions rose in 2012 compared to 2011 records, in contrast to majority of other EU countries reducing their emissions. The UK government is concerned that how the country will secure a low carbon future (CB 2013). This study suggests that the insulation of the residential sector has a substantial potential to reduce energy consumption, consequently reducing carbon emissions while also helping to meet the legal carbon cut targets of the Climate Change Act.

Air quality and human health are not only the ones of the main parameters of sustainability, but also interrelated. In the context of air quality, carbon emissions—irrespective of the source type—are one of the main pollutant sources that compromise air quality. Poor air quality adversely affects human health, safety, life and well-being as well as associated ecological systems, habitat and biodiversity (2013; CCC 2015). Reducing the amount of carbon emissions from the residential sector can considerably contribute to the overall reduction of GHG in general and carbon emissions in particular in the atmosphere. This, in turn, will slow down the rate of global warming of the earth and also, human populations will be living in a cleaner and healthier environment. In addition, this can effectively contribute in reducing other hazards such as acid rain, glaciers melting, sea levels rising, oceans becoming acidic, flooding frequency and intensity.

5 Concluding Remarks

This paper has presented a mathematical model of external/internal insulation of the residential sector. It has been demonstrated via numerical calculations that applying the insulation merely to walls, the residential sector of the UK could potentially yield the carbon cut that is nearly the double of the target by 2020. As for the 2050 scenario, still the calculated potential carbon cut can substantially contribute to meeting the corresponding target, and may even exceed the target if walls insulation is applied in conjunction with roof or ceiling insulation, and preventing other energy wasters of the house. However, this is an area for further research.

The paper has categorically identified a number of headline and supplementary indicators and measures in the national sustainability agenda, which are directly relatable to the legal carbon cut targets of the Climate Change Act. The paper has briefly presented a few innovative insights and implications on how these sustainability measures can be mapped on to the climate change aspects specifically in the context of carbon emissions. Furthermore, the paper has carried out this mapping along each of the three principal dimensions of the sustainable development philosophy.

Meeting legal obligation means satisfying the social dimension of sustainable development. Creating comfortability against extreme weathers via insulation is another social gain—which is also a climate change adaptation. Using less energy

will render the UK society less dependent/reliant on energy, thereby assisting in combating energy demand, insecurity and scarcity.

Saving on energy bill is simply an economic gain for every member of the public of the UK society, particularly when energy prices have been substantially escalating for the past two decades. Energy saving (via insulation as is the case under consideration in this study) also means less import of oil which will have a positive impact on the UK economy. As for environmental aspects using less energy means less carbon emissions, which will result in a correspondingly healthier atmosphere for all humans and other species to breathe in. This will also reduce GHG and consequently greenhouse effect. This can be regarded as an approach of climate change mitigation. In addition, controlling global warming (via energy saving through insulation as proposed in this study) can help control a number of negative ripple effects on the environment such as preserving habitat, ecological systems and biodiversity.

The paper has presented a mathematical model only for the housing sector. Similar research can be reproduced for the commercial and industrial sectors, and later for the whole UK built environment (including not only buildings but also infrastructures). This study has not covered likely changes in thermodynamics by the application of walls insulations, which is another area for further investigation. Currently, the study has presented a conceptual model with some simple calculations based on simple assumptions. Also, implications of external insulations in terms of payback time, planning permission, heritage issues and the like are yet to be further investigated. It is anticipated that the knowledge that this paper has brought out in terms of mapping climate change targets onto sustainability implications can generate avenues for further debate, research and development in the academic as well as industrial, consultancy, government and commercial sectors.

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Lean Production and ISO Standards as Instrument for Achieving 2030 Agenda Goals

Siarhei Zenchanka and Siarhei Malchenka

Abstract

The philosophy of lean production is widely used around the world. It is based on the creation of a production system for client satisfaction, minimization of losses, and energy efficiency. It is in consent with the objectives, defined by the Goal 12 of the Agenda (Transforming our world: The 2030 agenda for sustainable development, 2015) for Sustainable Development: achieve the sustainable management and efficient use of natural resources, achieve the environmentally sound management of chemicals and all wastes throughout their life cycles, and significantly reduce their release to air, water, and soil in order to minimize their adverse impacts on human health and the environment, and substantially reduce waste generation through prevention, reduction, recycling, and reuse. The present paper analyzes the relationship between the lean production concept and the demands of ISO 9001—Quality management, ISO 14001—Environmental management Systems, ISO 50001—Energy management, ISO 45001—Occupational health and safety, etc., standards of management, as well as their impact on the realization of the Agenda 2030 objectives. The results of analyses show that the implementation of the ISO standards in enterprises practice helps them to introduce lean production systems and move towards sustainability.

Keywords

Sustainable development · Lean production · Quality management · ISO standards · Environmental management

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1 Introduction

The new goals of sustainable development are defined in Agenda (2015). To achieve these goals, it is necessary to define several instruments. Lean Production (or Toyota Production System, TPS), Total Quality Management (TQM), ISO standards, and UN Global Compact program may be considered as such instruments.

Lean production or lean manufacturing is a management concept which transforms a business into one characterized with a rising level of output and decrease in any waste that occurs in the production process. The term "waste" refers to any losses (resources, materials, time) which should be removed from the process to make it more efficient. Lean production was developed in Toyota Motor Corporation and is also known as Toyota Production System (TPS n.d.).

The years after World War II were the years of rapid growth of the Japanese economy and the implementation of new approaches to enterprise management, such as Total Quality Control (TQC) and Total Quality Management (TQM).

Considering the history of automotive industry Womack, Jones and Roos (1990) pointed out that, "*after World War II Eiji Toyoda and Taiichi Ohno at the Toyota Motor Company in Japan pioneered the concept of lean production. The rise of Japan to its current economic preeminence quickly followed as other Japanese companies and industries copied this remarkable system*".

The concept of the Total Quality Management (TQM) has been developed at the same time by W. Edwards Deming, Armand V. Feigenbaum, Kaoru Ishikawa, Joseph M. Juran, and others to improve the quality of goods and services production. First, the concept was widely used in Japan, where it was adopted in 1950 to resurrect the postwar business and industry. The implementation of this concept helped the Japanese industry to dominate world markets by 1980.

There are different definitions of TQM suggested by some authors and organizations. Most of them consider TQM as a holistic management approach to long-term success through continuous improvement of all aspects of organization activity for customer's satisfaction.

ISO standards for Quality Management have near a 30-year history. The first version of ISO 9000 family of standards was published in 1987. In 2015, fifth version of these standards was adopted.

The ISO 14000 family of standards includes standards in different areas such as the Environmental management systems, the environmental auditing and related environmental investigation, the environmental performance evaluation, the environmental labeling, the Life cycle assessment, etc. (Environmental Management 2009). The development of these standards is the result of decisions taken at the United Nations Conference on Environment and Development (Agenda 1992) and they aim to improve the environmental performance of enterprises and organizations.

Starting from the end of the twentieth century, ISO developed new standards considering the social aspects of sustainability as well, e.g., ISO 26000—Guidance on Social Responsibility (ISO 2010), ISO 22000—Food Safety Management Systems—Requirements for Any Organization in the Food Chain (ISO 2005), ISO/DIS 45001—Occupational health and safety management systems—Requirements with guidance for use ISO (2014), ISO 31000—Risk Management (ISO 2009), ISO 50001—Energy Management (ISO 2013).

UN Global Compact (2010) initiative was officially launched in 2000. It contains 10 principles combined in four main areas—Human Rights, Labor, Environment, and Anti-Corruption.

Look at these approaches briefly.

2 Agenda 2030 for Sustainable Development

In accordance with the main areas of sustainable development, Agenda (2015) defines 17 Goals, which are presented in Fig. 1.

It is clear that this division is rather simplified—it is often impossible to refer goals to separate areas of sustainable development, as they are interconnected and interdependent.

The Agenda (2015) defines 169 targets which show the scale and ambition of this new universal Agenda.

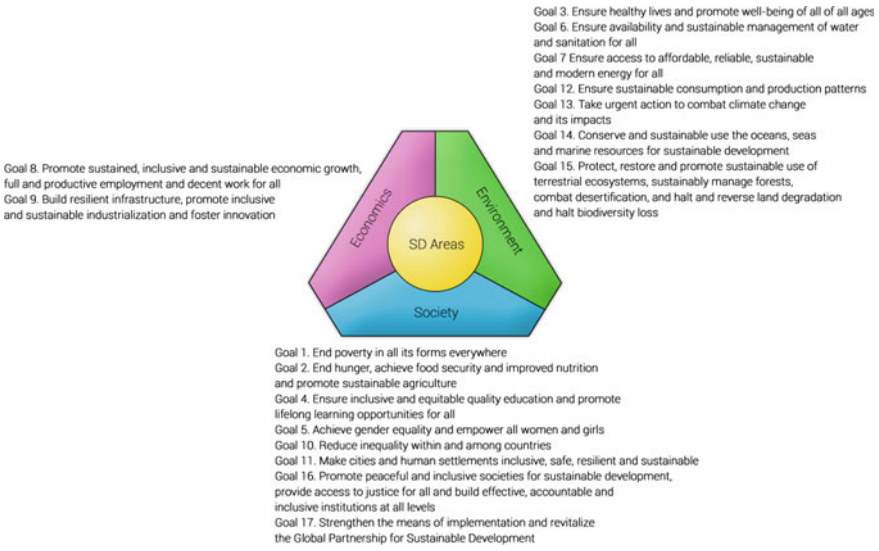

Fig. 1 Correspondences between the SD areas and the goals of sustainable development

3 Principles of Lean Production

TPS Handbook (http://www.artoflean.com/) considers two main pillars of its system:

- **Just-in-time** that means to make only what is needed, only when it is needed, and only in the amount that is needed;
- **Jidoka** that means to build a quality into the process of production.

This system helps to overcome both untimely and over production The approach just-in-time (JIT) demands a new mechanism of logistic. Process approach helps companies to identify violations of the early level.

Toyota Production System (TPS) is the precursor to the Toyota Way, which considers two other pillars (Larman and Vodde 2009; HRD 2002):

- **Continuous improvement** defines a Toyota's basic approach to doing business. It includes challenge, Kaizen (improvement), Genchi Genbutsu (go and see);
- **Respect for people** includes respect, and working in a team.

Concepts of "Lean thinking" and "Lean production" develop TPS and Toyota Way ideas even further.

Lean production demands lean thinking that can be summarized in five principles: (1) precise specification of the value of specific products, (2) identification of the value stream for each product, (3) making value flow without interruptions, (4) let the customer pull value from the producer, and (5) pursue perfection. Womack and Jones (2003) defined these principles as:

1. Value: Specify what creates value from the customer's perspective.
2. The Value Stream: Identify all steps across the whole value stream.
3. Flow: Make those actions that create value flow. Eliminating this waste ensures that your product or service flows to the customer without any interruption, detour or waiting.
4. Pull: To achieve this requires great flexibility and very short cycle times of design, production, and delivery of the products and services.
5. Perfection: Strive for perfection by continually removing successive layers of waste.

As was mentioned above, lean production is directed at eliminating any waste and thus achieve cost reduction. Continuous improvement focuses on the elimination of next major types of waste: (1) Overproduction, (2) Waiting (time on hand), (3) Unnecessary transport or conveyance, (4) Over-processing or incorrect processing, (5) Excess inventory, (6) Unnecessary movement, (7) Defects, (8) Unused employee creativity (TPS n.d.; Womack and Jones 2003; Liker 1997).

Eliminating waste requires constant effort at cost reduction to maintain continuous profit rise in manufacturing. The major way to reduce costs is to produce in a timely fashion, only those products which are out of stock and to eliminate all waste in manufacturing them.

4 Principles of Total Quality Management (TQM) and ISO Standards

Total quality management is a management system of organization that involves all employees in continual improvement of production and is customer-focused. This approach was developed by such quality leaders as Philip B. Crosby, W. Edwards Deming, Armand V. Feigenbaum, Kaoru Ishikawa, and Joseph M. Juran. TQM uses the following principles (Westcott 2013):

- Customer-focused;
- Total employee involvement;
- Process-centered;
- Integrated system;
- Strategic and systematic approach;
- Continual improvement;
- Fact-based decision making;
- Communications.

In 2015, the newest edition of standards ISO 9000 "Quality management systems - Fundamentals and vocabulary" (ISO 2015a) and ISO 9001 "Quality management systems – Requirements" (ISO 2015b) were published. This version contains seven principles that basically coincide with TQM principles:

- Customer-focused;
- Leadership;
- Engagement of People;
- Process Approach;
- Improvement;
- Evidence-based Decision-Making;
- Relationship Management.

On the basis of literature analysis, Jaeger and Adair (2015) defined five basic obstacles for successful TQM implementation: (1) Lack of Customer focus; (2) Lack of planning; (3) Lack of Employee involvement; (4) Lack of Management commitment; (5) Lack of resources.

All ISO standards on management system are directed towards the achievement of SD goals. There is no doubt that industries benefit from the implementation of these standards. Research has shown increased performance, improved

organizational reputation and, ultimately, more business for those organizations that use the management standards effectively. During 2004–2014 decade, the number of ISO 9001 certificates has increased by 72% from 660,132 to 1,138,155 (ISO Focus 2015a); the number of ISO 14001 certificates has increased by 258% from 90,544 in 2004 to 324,148 in 2014 (ISO Focus 2015b).

More and more countries and companies join the UN Global Compact (2010). In 2015, over 9000 companies and 3000 nonbusinesses from 170 countries participated in this global initiative (https://www.unglobalcompact.org/what-is-gc/participants/search?utf8=%E2%9C%93&search[keywords]=&search[sort_field]=&search[sort_direction]=asc). To reach sustainability goals, UN Global Compact published "SDG Compass—The guide for business action on the SDGs" (Compass 2015) which shows companies how they can align their strategies as well as measure and manage their contribution to the realization of the SDGs.

Correspondences of the ISO standards and UN Global Compact principles to SD areas are shown in Fig. 2.

Table 1 presents some links between 2030 Goals, ISO standard, Lean Production, and Global Compact principles.

It appears that the use of ISO standards, lean production principles and UN Global Compact approach helps companies to achieve the 2030 Goals of Sustainability. If the lean production principles are more in line with the economic area of sustainable development, the ISO standards and UN Global Compact principles meet all the goals of sustainable development.

5 Transition of the Republic of Belarus to Sustainable Development

The Republic of Belarus develops its own Strategies of Sustainable Development. The first was adopted in 1996 (Concept 1996) and the latest in 2015 (Strategy 2015). Certification of different management systems in accordance with ISO

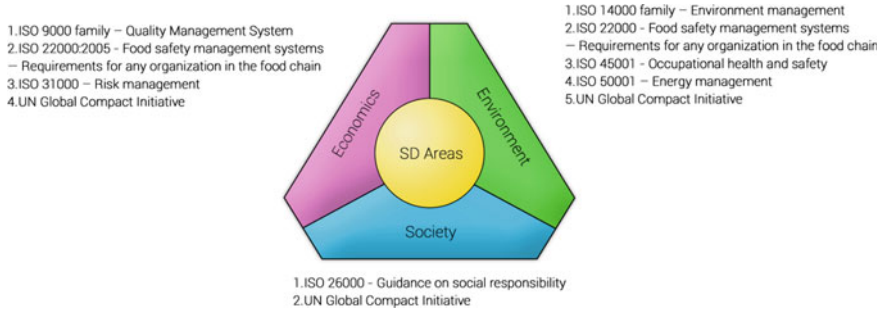

Fig. 2 Correspondences of the ISO standards and UN global compact principles to SD areas

Table 1 Common features of 2030 goals, ISO standard, lean production, and global compact principles

2030 agenda goals	ISO standards, TQM principles	Lean production principles	Global compact principles
G1—end poverty in all its forms everywhere	ISO 26000—guidance on social responsibility		Labor
			Human rights
G2—end hunger, achieve food security and improved nutrition and promote sustainable agriculture	ISO 22000 family—food safety management		Environment
G3—ensure healthy lives and promote well-being of all of all ages	ISO/DIS 45001—occupational health and safety management systems—requirements with guidance for use		Environment
G4—ensure inclusive and equitable quality education and promote lifelong learning opportunities for all		Unused employee creativity	Human rights
G5—achieve gender equality and empower all women and girls	ISO 26000—guidance on social responsibility		Human rights
G6—ensure availability and sustainable management of water and sanitation for all	ISO 14000 family—environment management systems		Environment
G7—ensure access to affordable, reliable, sustainable and modern energy for all	ISO 50000 family—energy management systems		Environment
G8—promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	ISO 9000 family—quality management System	Value	Human rights
		Value stream	Environment
		Perfection	
G9—build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	ISO 9000 family—quality management system	Flow	Labor
		Pull	
		Perfection	Environment
G10—reduce inequality within and among countries	ISO 26000—guidance on social responsibility		Human rights
G11—make cities and human settlements inclusive, safe, resilient and sustainable	ISO 14000 family—environmental management	Perfection	Environment

(continued)

Table 1 (continued)

2030 agenda goals	ISO standards, TQM principles	Lean production principles	Global compact principles
G12—ensure sustainable consumption and production patterns	ISO 14000 family—environmental management	Pull	Labor Environment
G13—take urgent action to combat climate change and its impacts	ISO 14000 family—environmental management		Environment
G14—conserve and sustainable use the oceans, seas and marine resources for sustainable development	ISO 14000 family—environmental management		
G15—protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat decertification, and halt and reverse land degradation and halt biodiversity loss	ISO 14000 family—environmental management		Environment
G16—promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	ISO 26000—guidance on social responsibility		Human rights Anti-corruption
G17—strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	ISO 14000 family—environmental management		UN global compact

standards is developing in Belarus. The data about some management systems certification in Belarus and over the world are presented in Table 2.

There are some discrepancies between the information presented in this table, and the number of certificates, as shown in Sect. 4. ISO organization (ISO Survey 2015) explains such inconsistencies from year to year as due to:

- The variability in numbers of certificates reported each year by individual certification bodies;
- The inconsistent participation of some certification bodies that contribute to the survey one year but not the next;
- The participation of new certification bodies.

Table 2 Quantity of ISO certificates (ISO Survey 2015)

	2008	2009	2010	2011	2012	2013	2014	2015
In Belarus								
ISO 9001	1749	2014	151	171	170	130	2905	3657
ISO 14001	181	219	27	59	29	69	356	415
Over the world								
ISO 9001	9,80,332	1,063,751	1,118,510	1,079,228	1,096,987	1,022,877	1,036,321	1,033,936
ISO 14001	1,88,574	2,22,974	2,51,548	2,61,926	2,84,654	2,73,861	2,96,736	3,19,324

The first conclusion from this table is that there was a remarkable decrease of certification in Belarus in 2010–2013 (red) in comparison with 2009. Possibly, it was the result of two reasons, i.e., the influence of the world crisis on the financial situation of enterprises, and the transfer to a new version of quality management standards—ISO 9001:2008. In 2014, the overall quantity of certificates exceeded the precrisis level. It should be noted that a small reduction in the number of certificates was also observed worldwide (red).

The second conclusion is that very few companies in Belarus have implemented standards of ISO 14000 family, aimed at the implementation of sustainable development goals 2030.

A few enterprises in Belarus use the advantages of lean production. Consulting company "Key decision" is the leader in the implementation of lean production systems in Belarus. Here are some results of the implementation of lean production systems implementation (http://www.krconsult.org/service/berejlivoe):

- Production of windows—productivity increase 70%, labor costs reduced 1.5 times;
- Production of trolleybuses—productivity increase 33%, the production cycle reduction 40%;
- Customized production of door blocks—production volume increased 30% without increasing the size of the enterprise and the number of employees;
- Food industry: implementation of 5S technology has led to monthly savings of more than $ 35,000 in one department with productivity increasing by 25%;

The National Strategy of the Republic of Belarus for Sustainable Socioeconomic Development for the period until 2030 (Strategy 2015) has determined that the main fields of industrial development are:

- The reduction of material consumption in 2030 to 6–7% compared with 2015;
- The development of complete technology of integrated use of all types of waste on the basis of modern technological reequipment; and
- The introduction of advanced international standards of quality and quality management.

The departments of public authorities should use widespread tools based on the principles of the "lean production".

Some elements of Toyota Production Systems have been implemented by JSC "BATE"—managing company of the «Automotive components» holding (http://www.starter.by/press-center/news/93.html). JSC "BATE" is certificated in accordance with ISO/TS 16949: 2009 and EN ISO 9001: 2008 standards. Implementation of these standards and TPS helped to significantly reduce production costs without any damage to quality, as well as to reduce the quantity of working capital and to expand into new markets.

The implementation of lean production principles in the construction of the Belarusian Nuclear Station is its most remarkable application. This project started in 2014 and is aimed at the reduction of the structure of expenditure, reduction of design time, increased productivity and reduction of the number of changes during the project implementation stage both during construction and installation works. Results of implementation of lean production technologies will be evaluated after each stage of project realization (http://www.atom.belta.by/ru/news_ru/view/proekt-po-vnedreniju-texnologij-berezhlivogo-proizvodstva-nachal-realizovyvatsja-v-ao-niaep-zao-ase-4564).

6 Conclusions

The world practice shows that the lean production, the ISO standards and the UN Global Compact initiative are effective instruments for the achievement of Sustainable Development Goals 2030. The analysis showed that the ISO standards and the UN Global Compact most fully meet these goals, while lean production is more in line with the economic area of sustainability.

The third strategy of sustainable development was adopted in the Republic of Belarus in 2015 (Strategy 2015). This strategy aims at the implementation of Sustainable Development Goals 2030 and takes into account the national interests and specific features of the Belarusian economy. The strategy suggests a gradual transition of organizations on the use of modern state standards, adapted to international standards, including the environmental ones.

Belarusian companies make positive steps to reach sustainable development goals, implementing ISO standards, principles of TQM and lean production.

In accordance with Lean Enterprise Institute data (http://www.lean.org/), the implementation of lean production allows to reduce the production cycle up to 90%, to reduce the number of defects to 90%, to reduce production costs up to 75%, to accelerate the time to market by 50–75%, to reduce inventory by 90%, and to optimize the use of production space 10–25%.

As for the Belarusian enterprises, nowadays only a few enterprises use the advantages of technology and techniques of lean production. The rest is still losing money due to inefficient organization and basic disorder. Very few enterprises were able to build their management systems in accordance with process and product approaches and move from mass production to order production.

It should be noted that the implementation of lean production system does not guarantee product quality. The Toyota Motor Corp. recalled more than 6 million vehicles because of various problems in 2015 only (http://www.afp.com/fr/search/site/toyota/).

Competitive advantage of Belarusian enterprises can be achieved by high product quality and low-cost production. Therefore, it is necessary to review the whole organization of production in order to avoid all kinds of wastes. At the same time, the need for an integrated approach, including the quality and the concepts,

methods and tools of lean production should be emphasized once again. High quality can be achieved through the introduction and continuous improvement of management systems

The insufficient activity of Belarusian companies to introduce international management standards should be noted. According to the National Statistics Committee (Handbook 2016), there were over 140 thousand business entities in Belarus in 2016, including 4904 companies in agriculture, 17,026 companies in the industry, and 10,776 companies in construction. However, only under 5000 entities have been certified in accordance with various ISO standards. In order to enhance the competitiveness of Belarus in the global market, it is necessary to develop this activity especially in environmental management.

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Sustainable Transport Futures: Analysis of the Selected Methodologies Supporting the Planning Process Towards Achieving Goal 11 Sustainable Cities and Communities

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Abstract

A quarter of energy-related greenhouse gas emissions (GHG) originate from the transportation sector. Continuously increasing demand for transportation services worldwide is one of the main urban challenges addressed by Sustainable Development Goal 11, target 2. One way to address this issue is to develop an integrated transportation system that can ensure confidence and comfort for the passengers. This will contribute not only to the customers' experience but also to operators and authorities through sustainable, cost-effective, and profitable services. Conversely, the lack of such a system or a poorly managed system prevents the economy and society from realizing its potential. In the transition towards sustainability, the planning process of complex systems such as transportation often requires supportive tools and methods, such as futures methodologies that assist decision-making by providing information about possible futures. In today's rapidly changing environment, forecasting tools do not always provide the expected outcomes since it is difficult to predict all the

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unexpected events. Therefore, there is a demand for alternative methods that not only grasp the constant changes but also create additional value (for example, meeting the needs of multisectoral collaboration and creation of common vision). The present article investigates the usefulness of three such methodologies, namely backcasting, foresighting, and SymbioCity, for the planning process of the bus park and railway station in Kisumu, Kenya, and Centralen in Gothenburg, Sweden. The paper's contribution is a description of the Kenyan transportation system (which has not been studied in detail before), planning process, and pertinent issues related to the stations both in Kisumu and Gothenburg, located in the sharply contrasting contexts of global South and global North, respectively. On the basis of field research, interviews, and feasibility study of futures methodologies, the paper concludes that backcasting is the most suitable of the methodologies for both places, since it can be applied at a small scale, and provides creative solutions and has a high level of integration of stakeholders. Furthermore, the paper examines the application of the futures methodologies in multisectoral urban transitions apart from transportation and draws conclusion on what can be learnt from it.

Keywords
Sustainability · Development · Transition · Transportation · Planning process · Multisectoral collaboration · Current state · Backcasting · Forecasting · Bus park · Railway station · Kisumu · Kenya · Centralen · Gothenburg · Sweden

1 Introduction

Transportation has not always been featured on development priority lists. It was not part of the UN Millennium Goals, but it is included in Agenda 2030's Sustainable Development Goal (SDG) 11: "make cities inclusive, safe, resilient and sustainable". Its Target 11.2 requires all states "by 2030, [to] provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notable by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (UN n.d.). The transportation sector has several leverage points that can be influenced. They are closely connected to demographic changes. Factors such as aging population, growth of the middle classes, and increasing integration of women within the labor market increase demand mobility. It is both a challenge and an opportunity for development.

One of the main challenges facing cities worldwide is to meet constantly increasing demand for transportation services. A well-planned public transportation system provides passengers confidence in their daily mobility. Conversely, when the system does not function adequately, neither a city nor its inhabitants can realize their

true economic potential. This is often the case in rapidly growing urban cities such as Nairobi (Daganzo et al. 2007; Becker 2011; Graeff 2013) and Kisumu. At the same time, Gothenburg—which was awarded a Climate City 2015 prize in the Earth Hour City Challenge from Worldwide Fund for Nature (WWF 2015)—faces several transport challenges related to carrying capacity, air pollution, and transition towards a sustainable system (Cullberg et al. 2014). These require an understanding of how the system works, its strengths, weaknesses, and possibilities for improvement.

Aim and Scope

This paper investigates the usefulness of backcasting methodology in the planning process of the bus park and railway station in Kisumu, Kenya, and Centralen in Gothenburg, Sweden, compared to standard forecasting methodologies. Moreover, it examines applications of the futures methodologies in multisectoral urban transitions other than transportation and draws conclusion on what can be learnt from it. Both cities face challenges for transitioning towards sustainability, within which the respective study sites have strategic importance. The paper does not provide full descriptions of the futures methodologies (backcasting, foresighting, SymbioCity approach), which are readily available elsewhere, but concentrates on the main aspects related to their applicability in diverse contexts. Since Gothenburg's planning process and current situation have been studied to a greater extent than Kisumu, special attention is devoted to Kisumu, for which only limited documented data exist.

2 Methodology

Two main themes are investigated: the respective planning processes and current state of the stations in Kisumu and Gothenburg. In order to understand the planning process in Kisumu, learning about Kenya and its transportation, document studies and 13 interviews were conducted. For the Swedish context, a literature study and two interviews were conducted.

To better understand the suitability of the particular futures methodologies (backcasting, foresighting, SymbioCity approach) in the planning process, these were analyzed based on the framework proposed by Baumann and Cowell (1999). Backcasting can be used as a supportive tool in the decision-making process, which with time developed a strong focus on sustainability. Contrary to the other selected methodologies, a backcasting exercise produces a strategy towards achieving the locally defined goal (Holmberg 1998). Moreover, it is recommended as a planning tool by the UN (UN n.d.).

The research process includes the field studies, which require appropriate preparation, implementation, and analysis methods and techniques. Prior to the field studies, the following issues were taken into account: the research ethics (ESRC 2015), field study (Mikkelsen 2005) and positionality (Simmel 1908; Godbole 2014). While in Kenya and Sweden, methods of sociological primary research (Driscoll 2011) were applied: observation (Agar 1980; Scheyvens and Storey 2003;

Kawulich 2005), semistructured interviews (Arksey and Knight 1999; Burton 2000; Flowerdew and Martin 2005), the "snowball" technique (Arksey and Knight 1999; Scheyvens and Storey 2003), and survey (Burton 2000; De Vaus 2013). This was followed by analysis using SWOT (Maylor 2010), stakeholder management (Thompson 2015) and futures methodologies in the planning process (Amara 1991; Dreborg 1996; Baumann and Cowell 1999; Holmberg and Robèrt 2000; Vergragt and Quist 2011; Ranhagen and Groth 2012; Kuosa 2014).

3 Results and Analysis

3.1 Planning Processes in Kisumu and Gothenburg

The planning processes of Kisumu and Gothenburg differ substantially. Due to the small capacity in Kisumu's City Planning Department, most planning services are outsourced to private actors. The standardized procedure defined by the national government is followed (Otieno 2015a, b). Currently, there is one large plan—the *Integrated Strategic Urban Development* (ISUD) plan—that is in the process of being enacted into law in order to ensure the legality of the document and its legal enforceability (KAM 2016). Its main purpose is to guide new investment rather than being a mandatory master plan. Bureaucratic procedures and the reactive approach of the local planners constantly delay the planning process. Lack of long-term vision is another challenge that has to be addressed urgently (Eising 2015; Otieno 2015a).

At the time of the empirical study, work at the railway station was frozen. Nevertheless, on the international level, Kenya Railways has a big developmental project, which also involves Uganda, Burundi, and Rwanda (Mumo 2014). The main aim of the project is to build a standard gauge regional system (since the current one is old, partly destroyed and does not correspond to international standards). The project has two consecutive phases. The first phase involves the Mombasa–Nairobi line (by July 2016, 75% of work was complete), while in the second phase, the railway will continue from Nairobi to Malaba (the border town) through Kisumu. The second phase has been confirmed by the government in 2016, with up to 85% financed by the China Exim Bank and 15% by the Kenyan Government (Mutambo 2016; Mwende 2016).

For the next 15 years, the Kenyan government has picked five priority SDGs for primary development. Goal 11 is not one of them, which means that the transportation sector will remain as a secondary area of interest (Muchangi 2015). In Sweden, every municipality/city decides for itself whether to include the SDGs in their planning or not and which ones are the most appropriate. Gothenburg's Climate City 2015 award, for example, shows local authorities' willingness to work and report on the progress towards achievement of the SDGs (WWF 2015).

As for Sweden, the planning process there is structured and well defined. Considerable attention is devoted to the preparatory stage. Consultations with the

regional state authorities and municipalities are implemented on the early stages; consultations with the citizens on initial proposals are a norm (Larsson 2006). One example of such inclusion is the "Älvstaden" project, which includes big installation displaying the future Gothenburg city center, with the screens on the walls show the past, present, and future development projects (Göteborgs Stad 2015). Gothenburg also has a defined procedure for the planning process (Kain 2015).

One of the largest current projects in Gothenburg is the Västlänken project by Trafikverket (the national traffic and transport authority) (Trafikverket n.d.). It is meant to create a new commuter and regional train connection with three new stops and reduce the number of modal changes required to reach several parts of the city. Further exploration of the projects in Gothenburg is beyond the scope of the current paper.

Development of the transportation sector in Gothenburg forms part of the Transport Strategy for 2035. The plan incorporates a sustainability perspective in its vision. The strategy was developed "in an integrated process with the Development Planning Strategy and the green strategy" (Hellberg and Jonsson 2014). Based on the policies that influence the transport strategy, several small-scale plans are being developed or in progress, i.e., road safety programme (City of Gothenburg 2010b) and bicycle programme, which is in the development stage (July 2016) (Hellberg and Jonsson 2014). In Gothenburg, the planning process faces challenges in terms of collaboration among the large number of stakeholders involved.

Both Gothenburg and Kisumu have a strategic advantage in long-term planning based on their waterside locations. At the same time, the main difference is the perception of time: while Sweden has visions and development plans for 2030, 2050, etc. (City of Gothenburg 2010a, Hellberg and Jonsson 2014, Göteborgs Stad 2015), "in Kenya tomorrow is already (the) future" (Eising 2015).

3.2 Current Situation: Organization of the System, Key Stakeholders, and Pertinent Issues

3.2.1 Kisumu

Kisumu is a national and regional center for trade, commerce, industry, administration, and communication. It was developed as a port and railway terminus due to its strategic location. Kisumu was the connection point for passengers and freight via Lake Victoria and overland to Tanzania, Uganda, Rwanda, and Burundi as well as to the other big Kenyan cities, such as Nairobi and Mombasa. The transportation system in Kisumu is represented by water transport (the lake port and the dry port managed by Kenya Ports Authority), air transport (Kisumu international airport), road transport with a variety of means (boda-boda,[1] piki-piki,[2] tuk-tuk,[3]

[1] *Boda-boda*—usually motorbike taxi, but can be bicycle taxi.
[2] *Piki-piki*—motorbike taxi.
[3] *Tuk-tuk*—motorized scooter taxi with a canopy.

taxi, matatu,[4] long-distance bus), and railway transport (as mentioned before under the large developmental project).

The bus park is a self-evolved unit in Kisumu. It provides mainly short-distance services within and between neighboring counties, but is also served by several long-distance operators. The bus park has no statistical data documented. To grasp the size of the park, based on the assumptions of the city planner and bus park superintendent, and assuming that every *matatu* leaving the park is full in the mid-season (summer), an educated guess would be that about 11,000 people per day travel through the bus park (Otieno 2015a; Rawinji 2015).

At the initiation stage, there was limited planning by the state—mainly provision of designated space. The structure of the bus park involves many actors that have different levels of power to influence the current situation and future development. Figure 1 depicts the system of the bus park that was identified during the field studies. The most decision-making power and ability to influence the current state in the bus park belongs to the government, although transportation is not a governmental service. There is top-down control over the government-owned land. Regulations connected to the services provided by the park are dictated by the National Transport and Safety Authority (NTSA). The service providers are Savings and Credit Co-operatives (SACCOs).[5] In Kisumu, three groups of SACCOs operate within the bus park: the ones that are registered in Kisumu (24 cooperatives), SACCOs of the western region (19 cooperatives) and SACCOs registered in the neighboring county—Kisii. One can see that the number of Kisumu SACCOs represents 1/3 of total SACCOs that are involved in the provision of services at the bus park. It means it is more difficult to influence the situation at the bus park due to the involvement of external stakeholders.

Current demand for services is met, although at first sight, it might not seem so. The SACCOs act reactively and ensure their performance, sometimes with a certain delay. Since there is no future development plan, there are no projections towards future demand and further study is needed.

The main challenges observed at the bus park are sanitation, solid waste, and maintenance of the park (especially drainage system), which often leads to damages of the vehicles. Based on our survey of the SACCOs' representatives, 11 main challenges were identified within the bus park, with the top three being harassment of passengers and vehicles by *touts*[6]*/manambas*,[7] inadequate space (too many vehicles for very limited area), competition with other vehicles (*probox*,[8] *tuk-tuk*, private cars). Overcoming these challenges would be a stepping stone towards achieving SDG 11 Target 2. However, further research on the state of the art of

[4]*Matatu*—minibus with 14 seats on average.
[5]SACCOs can exist in any industry, not only for transportation. In order to become a legal SACCO, a group of individuals has to register at the Ministry of Co-operative Development and Marketing. Usually one SACCO in the transportation sector operates on one route (Graeff 2013).
[6]*Tout*—a person who provides route and stop information to passengers.
[7]*Manamba*—tout who is possibly involved with criminal groups/activities.
[8]*Probox*—model of the car with five seats.

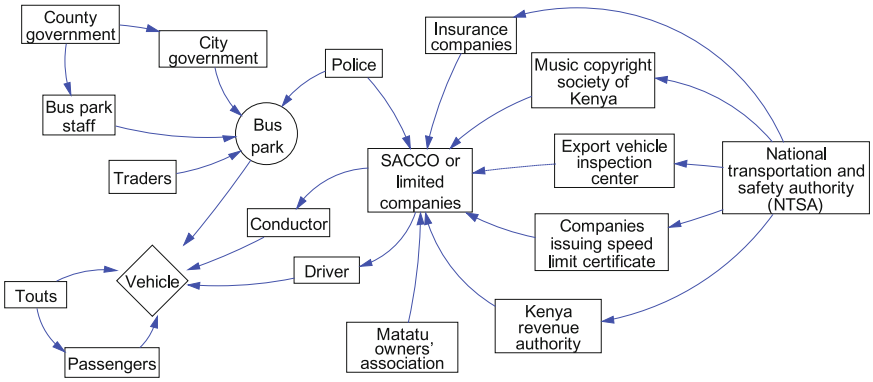

Fig. 1 Bus park system

private services and more detailed investigation on how to meet future needs would be necessary to develop the transition pathway.

The controversial role of *touts* was flagged as a sensitive or important issue by all survey respondents. The *touts* are vital to the operation of SACCOs, providing route and stop information to passengers. The controversy exists partly because many of the *touts* are or were homeless street children and possibly are involved with criminal groups/activities. The methods of coercion used by the *touts* can go beyond what would be considered respectful or appropriate in Europe. This is in part due to the intense competition between SACCOs and the importance of convincing customers to travel with their vehicles. There is thus a negative perception of these *touts*, as customers may feel unsafe due to the threat of physical or other types of harassment. It is controversial to suggest removal of these *touts*, not least due to the difficulty of enforcement, but also due to the important and useful role that they play (information messengers) and the fact that it is a valuable means of employment for people with fewer opportunities.

Several challenges outside the bus park (from the transportation system perspective) were also identified based on the SACCOs' survey. The main three were high taxes, bad roads, and bribery to traffic police ("Corruption from traffic officers is a big problem. Please act immediately!!").

Pertinent issues identified above are not directly related to SDG 11 except for the issue of touts, maintenance and challenges outside of the bus park. That supports the decision of Kenyan's government to give priority to the other SDGs, namely Goal 3 (good health and well-being), Goal 4 (quality education), Goal 5 (gender equality), Goal 8 (decent work and economic growth), Goal 12 (responsible consumption and production), and Goal 13 (climate action) (Muchangi 2015; UN n.d.).

3.2.2 Gothenburg

Centralen Gothenburg is an interchange that combines bus station (the Nils Ericssonterminalen), central railway station and the surrounding territory: city buses, trams, taxis, stores, and a major indoor shopping center. It is a hub that provides

urban, national, regional, and international services. The three main challenges identified at Centralen that make the planning process difficult are large number of actors, lack of cooperation among actors, and the physical state of individual elements of the station.

The number of actors involved within Centralen Gothenburg is very high, which makes the system difficult for the researcher to understand. The "*Market model*" has been applied to the central station in Gothenburg: different parts of the technical system were outsourced and built separately to mimic a market. Each element of the station belongs to different actors: "The tracks are managed separately, as well as traffic management and traffic information; to run the trains themselves constitute another business, broken down by a growing number of different actors; command and information in the wagons handled by yet other companies; ongoing equipment maintenance of yet other actors; Station buildings, commercial space located in a separate company, while waiting rooms operated by another, with the exception of the platforms that are subject to the return of another player. There are some examples of how the system has been fragmented. There are also several different operators running the same traffic route" (Meijling 2014).

Jernhusen is a key player in the system and planning process in Gothenburg with considerable perceived power. This state-owned company "owns, develops and manages properties along the Swedish railway" (Jernhusen AB 2011). Its activities embrace both passenger transportation and freight.

Centralen meets today's travel demand and the future forecasts are taken into account in its development plans. The challenge remains the same—communication and collaboration among the stakeholders. From the brief exploration of Gothenburg's situation, improvement of the physical appearance of the station as well as the management system would help to contribute to SDG 11.2 to make it more safe, accessible, and sustainable.

3.3 Futures Methodologies in the Given Context

3.3.1 Futures Methodologies in the Planning Process

Futures methodologies are not obligatory elements of planning processes; however, they could be of great help. They allow stakeholders to see how the future could/should/would look, thus making the future more concrete. When conducting such studies, it is very important to figure out who your target stakeholders are (planners, companies involved, etc.), because it will affect how the results will be presented. The analyzed approaches of backcasting, foresighting, and SymbioCity are used for the same purpose of assisting the planning process, but they require different information and sometimes different procedures. They may also outline new perspectives.

The outcome of backcasting is a step-by-step strategy for sustainable development towards the vision shared by the stakeholders. At the same time, it is difficult to know the future possibilities and the process requires thorough selection of the experts for qualitative data collection. The forecasting methodologies (foresighting

and SymbioCity approaches) provide scenarios of how the future will look based on the current trends and historical data. In this case, it is difficult to avoid "locked-in" solutions and there might be a need for more expert contributions. Therefore, all three methodologies can be equally recommended to apply in the developmental process in general.

In the given context, the following points arose. Several authorities (Eising 2015; Nzomo 2015; Otieno 2015a) working with city development in Kenya mentioned during the interviews that it would be helpful to use foresighting or similar methodologies in their planning work. No universal approach would work for any environment. **It always depends on the local context.** That is why the three selected approaches are discussed below taking into account current state of the stations in Kenya and Sweden.

3.3.2 Kisumu

Based on the assessment of futures methodologies described above, only *foresighting* would be difficult to apply in Kisumu since it requires historical data, which are rarely documented. Thorough research on the previous performance would be necessary as the basis of the approach. The other two compared approaches (backcasting and SymbioCity) would be possible to apply in such environment. Their respective challenges and advantages are discussed below.

In case of *backcasting*, different level of education and different spoken languages (*Luo*,[9] *KiSwahili*[10] and English) could be a challenge in creating common ground among the stakeholders involved in the early stages of the process. The high number of key stakeholders that are important for the participatory workshop would make it even more complex. During the assessment of the current state, environmental, economic, social and spatial elements should be investigated, described, documented, and illustrated. The land issue would top the challenge list. Kisumu is a rapidly growing city and its transportation system is developing and evolving without official control. Various different means of transport create bigger demand for their services. The bus park is growing informally too, which makes the users (passengers as well as drivers) think that the only solution is bigger space for the bus park (based on the interviews and the survey). This topic would be one of the most sensitive among the stakeholders. To make the process inclusive, one would need to run several participatory workshops (on vision creation and discussion of the results). Nevertheless, using backcasting would ensure participation in the development process, creation of the shared vision among the stakeholders, and a concrete strategy towards the formulated goal. At the time of the study, backcasting had not been applied in Kenya, so using it would be a trial and might require adjustments due to the different culture.

Using the *SymbioCity* approach is also possible given the conditions in Kisumu. It is mainly used for city development; however, elements of the approach can be used on a smaller scale, such as the bus park. In fact, SymbioCity suggests using

[9] *Luo*—local language in the Lake Victoria region in Kenya and Tanzania.
[10] *KiSwahili*—first Kenyan national language, followed by English.

backcasting in the final stages: developing alternative solutions, evaluating their impacts, and integrating them further into the strategies.

Related to that, further challenges could be specification of the objectives, indicators, and targets. As mentioned before, for Kenya tomorrow is the future and actions of the government are reactive. If one is looking for solutions for the short term, SymbioCity could be a better option, although definition of "short term" has to be justified.

Depending on the main reason for using futures methodologies, the result could be a single solution or several solutions. If one desires a single answer—one way to go—SymbioCity would be a good option. However, if several alternative solutions are required in order to better understand what are the possibilities and opportunities, backcasting would be a better option.

When talking about development of the bus park, the scale is small in comparison to the city level (and deals mostly with one social problem despite the complexity); therefore, it would be easier and more "user-friendly" to apply the backcasting approach.

3.3.3 Gothenburg

For Centralen in Gothenburg, the SymbioCity approach would not be useful to apply. It has several dimensions which would not contribute to development, for example, building design and architecture. The station already has all the necessary constructions and building something additional would be use of materials, while sustainability often implies (depending on the local conditions) trying to avoid building new and using what already exists.

Backcasting and foresighting would be applicable in the given conditions of Centralen. Advantages and disadvantages are described below.

The challenge for using backcasting would be involvement of stakeholders. Their number is very high and even organizing a joint meeting could prove challenging. Nevertheless, backcasting provides creative solutions to existing problems and helps to avoid lock-ins. With the rapid development in the Nordic countries, backcasting would allow new ideas to develop based on possible trends, instead of relying on existing technologies. At the time of the study, backcasting had been applied in different sectors of Gothenburg city and municipality, which led to dialogue creation among the stakeholders and some innovative solutions.

Foresighting could also work in Gothenburg. However, since the results are based on historical data and the current situation, it might lead to unimaginative solutions.

Depending on what expectations from the futures methodologies are, foresighting could be helpful in order to see what the possible future of Centralen could look like, while backcasting would show what steps be undertaken to reach the envisioned future.

3.3.4 Futures Methodologies in Multisectoral Transitions Other Than Transportation

Three examples were investigated related to household nutrition, cities, and systemic change for sustainability and climate adaptation in coastal regions, where the main methodology used was participatory backcasting.

The Sustainable Household Nutrition (SHN) project as part of "Strategies towards the Sustainable Household (SusHouse)" took place between 1998 and 2000 in the Netherlands. It was followed up throughout the process, as well as its impact after 10 years. The project had a limited budget, which has been identified as one of the main reasons for low levels of active stakeholder participation and the project did not have follow-up activities when the application for future funding was rejected (Quist 2007).

Wolfram and Frantzeskaki (2016) examine the necessity of radical systemic changes in urban development in order to have sustainable development without crossing planetary boundaries. No matter what direction one would take and which indicators they choose to assess the results, the current planning processes require additional support of futures methodologies.

Another project combining backcasting and adaptive management was implemented in South Africa (van der Voorn et al. 2012). The authors underline the constraints of the current methodologies that are being applied for adaptation strategy creation. Therefore, the two above-mentioned methodologies have been combined. The proposed framework is suitable for application in the strategy and policy creation and has been tested in the Breede-Overberg coastal region.

The investigated cases show the need for alternative methodologies to support the planning process. The complexity of current challenges requires an interdisciplinary and multisectoral approach that would contribute to sustainable development transitions. Such an approach should also contribute to the policy-making process. Futures methodologies can be complementary to existing ones and the combinations with the other emerging disciplines can have a great positive impact on the sustainable transitions.

Funding is one key challenge in the follow-up after the implementation of futures methodologies. In case of Kenya, it is crucial. As was investigated during one of the interviews, depending on what the funding would become available for, the government would react correspondingly adjusting all the plans and current activities (Otieno 2015a). Similar attitude can be seen in the Netherlands with the SNH project, where stakeholders' activity was low due to the limited budget (Quist 2007).

4 Conclusion

The sharply different planning processes in Kenya and Sweden both have defined procedures; however, reality does not always correspond to the norms or rules.

As described before, Kisumu railway station has a revival plan, which is at the end of the first phase of implementation. The bus park, on the other hand, is not managed by any level of government—hence it is unique in terms of self-development. There is no plan for its development yet, hence there is a chance of incorporation of the appropriate SDG target. Several interviewees working with development planning mentioned the need for futures methodologies in their work (Eising 2015; Nzomo 2015; Otieno 2015a).

The transportation sector in Gothenburg has several approaches to sustainability integration at different levels. Nevertheless, our literature review and interviews show that planners are facing several challenges (Hellberg and Jonsson 2014; Isitt 2015; Kain 2015). That is why supportive methodologies could be useful for further development.

Futures methodologies can be applied to support the planning process. Depending on the local context, both backcasting and forecasting methodologies can be used. Backcasting would actually work in both the Kisumu and Gothenburg cases, since it can be applied at a small scale, it provides creative solutions and has a high level of integration of stakeholders. The modest study reported here has demonstrated its value, receiving a positive response from key interviewees in both cities.

Learning from the other fields, one can say that futures methodologies make a great contribution to the complex challenges that the world is facing and contribute to addressing several SDGs at the same time. Future development and adaptation to the local conditions would be the next steps in the research.

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Green Human Resource Management —Delivering High-Performance Human Resource Systems at Divine Word University Papua New Guinea

Zainab Olabisi Tairu

Abstract

Human resource department has been challenged to shift their role to include environmental management. This paper highlights the importance and benefits of practicing green human resource management in universities through the investigation of green human resource at a case site Divine Word University Papua New Guinea. The study of green human resource management has been limited to corporate organizations and not educational institutions. The study addresses Green HRM from an institutional perspective. This study engaged mixed methods using case study as the strategy. A vast majority of DWU staff and students have expressed the need for their institution to do more on sustainability education. The findings from the study on Green Human Resource Management (GHRM) at Divine Word University revealed that departments are not fully integrated like the Egg of sustainability and well-being. This paper has added a new insight to the body of knowledge that greening in a university and green human resource management in organizations and application of green human resource management at an institution are necessary and important to environmental sustainability.

Keywords

Sustainability · Environmental management · Higher education institutions · Education for sustainable development · Green human resource management

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1 Introduction

The expectations about HR roles and functions are changing to develop and articulate the values of the organization (CIPD 2002). Human resource department has been challenged to shift their role to include environmental management. The department of human resource management at higher education institution is considered to have a great role to play in influencing and addressing the issue of environmental sustainability through various means of training, education, and awareness. Jackson et al. (2011) state that the part in human resource management division's program devoted to green HRM was essentially zero. "Human Resource practitioners are positioned to play an instrumental role in helping their organization achieves its goals of becoming a socially and environmentally responsible organization" (Shranberg 2009, p. 5). There has been instance of having the wrong idea about what sustainability represents even to the higher learning institutions (Leal Filho 2000). The United Nation Decade of Education for Sustainability Development (DESD 2005–2014) highlights that universities must advance in responding to global environmental issues through various means of conducting research and educating for sustainable development.

This paper highlights the importance of practicing green human resource management at higher education institutions. This paper explores the concept of green human resource management at a case site Divine Word University (DWU). Human resource department is the discipline in charge of managing people at work. The practice of Green HRM is applicable to all organizations no matter how small or big an organization is and this is the case for DWU.

The combination of both greening on campuses and green HRM in Universities forms the basis for green human resource management in universities, a gap that was addressed through the investigation of green HRM at case site Divine Word University. The study addresses Green HRM from an institutional perspective. The study of green human resource management has been limited to corporate organizations and not educational institutions. Divine Word University (DWU) has started to put in place measures to help preserve and save the environment through the introduction of policies such as the "Printing & paper use policy", also commonly referred to as the "paperless policy", the use of solar as an alternative source of energy, water conservation, and improvement in internet technology (IT) with the aim of becoming a green institution. Despite these policies, student and staff are not fully aware of the need to be sustainable. OECD (2007) maintains that sustainable development goes beyond just recycling and construction of buildings with solar panels but to include community behavior towards nature and the surroundings. Leal Filho (2011) adds that the implementation of sustainability at higher education institutions must not be limited to policy development alone but also be backed by solid actions.

A higher education institution like DWU through its human resource department must play a major part in educating the people of Papua New Guinea for a better environment and economic development and also to fulfill PNG's vision 2050 goals

of sustainable development. In order to explore the concept of green human resource management at DWU, the following questions were raised for the study: *How can Green HRM practices at DWU influence employees to become involved in environmental sustainability activities? How can DWU further develop and provide employees with opportunities to be involved in environmental management organizational efforts? What level of awareness do HRM practitioners at DWU have of Green HRM practices? What level of awareness do DWU staff have of green HRM practices? What level of awareness do DWU students have of green practices?*

To address the above questions, this study engaged mixed methods using case study as the strategy. The data collections instruments for the study were focus group, interviews, survey questionnaire for staff and survey questionnaire for students and in addition, the study consulted policy documents of Divine Word University. This study investigated whether or not the human resource management division at DWU is consciously developing and implementing Green HRM practices in managing people so that employees of DWU can also apply these greening practices in their personal lives and extend beyond to educate others on sustainability.

This paper has added a new insight to the body of knowledge that greening in a university and green human resource management in organizations and application of green human resource management at an institution are necessary and important to environmental sustainability. In the Chartered Institute of Personnel and Development (CIPD) article of 2002, which explored the changing roles of HRM as they are perceived by different stakeholder groups within the HR profession, it was suggested that human resource management should move from the traditional way of being a change agent, administrative expert to a strategic position, and to add value to organizations, be customer advantage, cost conscious, and do things in a better and faster way. Schroeder (2012) writes that sustainability requires a transformative approach involving extensive changes in business operation and strategy that allow the people to have a change in mindset and improve corporate culture. The practice of Green HRM is applicable to all organizations including higher education institutions.

2 The Concept of Green Human Resource Management

There are people who have never heard about the concept of Green human resource management and some people who have heard about the concept are not clear about what it is. Active study dictionary (2010) defines “green” as relating to protecting environment. While green in the context of organization is considered to be any “activity or service that is performed by organizations or institution by generating or storing renewable energy, recycling existing materials, education and awareness of natural resources” (Mathapati 2013, p. 2). Sustainable efforts involve not only technology-oriented innovation but also need focus on sustainable product, service

as well as processes (Mishra et al. 2014). Therefore, green living is about protecting the environment and behaving ethically.

Dutta (2012) defines green human resource management as the use of human resource policies to increase efficiency within the human resource functions and roles of an organization. Gill (2012) argues that green human resource management is the process of "using employee touch point/interface to promote sustainable practices and increase employee awareness and commitments on the issue of sustainability" (p. 244). Prasad (2013) has highlighted that green human resource management comprises all activities and aimed at helping an organization carry out its agenda for environmental management to enable it to reduce its carbon footprint. Opatha and Arulrahah (2014) note that green human resource management is all the activities involved in the development, implementation, and ongoing maintenance of a system that aims at making employees of an organization green.

Green human resource management, therefore, refers to training, education, motivation, and development of people (stakeholder; partners, suppliers, employees and customers) in an environmentally friendly way to achieve high-performance human resource systems. The concept of Green human resource management in Universities rests with the idea that universities must bear profound responsibilities to manage their stakeholders in an environmental friendly way. Universities should serve as advocate knowledge centers and participate in leading and managing stakeholders–partners, suppliers, employees, and students, in a way that is sustainable.

3 Benefits of Green Human Resource Management in Universities

It is important that higher education institutions like universities practice green human resource management for the following reasons:

- Students learn using their five senses of sight, hearing, smell, taste, and touch, from lecturers and their peers, which shape their lives if their lecturers and peers serve as role models.
- Communities, parents, and governments expect student to impart what they have learnt from their institutions to extend these outside of the formal learning environment.
- The kinds of skills the university employs, determines the level of awareness and exposure on sustainability to students.
- To make positive changes to the environment and educate others on how to live a sustainable life as teachers, role models, and employed citizens.
- To balance work life and private life of members of community.

4 Sustainability in Higher Education

The United Nations Universities (2014) identify that sustainability does not need to be associated with only a particular management discipline but must embrace the acting at all levels of organizations for effective change to happen. The Higher Education Sustainability Education Initiatives (HESI) was created as a partnership of United Nations entities, with a membership of almost 300 universities around the world to teach sustainability, encourage research on sustainability development, engage and share information with international networks and green campuses to support local sustainability efforts. Osmond et al. (2013) point out that the most "successful green campus initiatives are those which acknowledge the shifting priorities of becoming a green university and welcoming the emerging opportunities which growth and development can generate" (p. 8).

The United Nations Global Compact is the world's largest corporate voluntary organization, its principles are widely adopted by businesses. A practical guide to the United Nations Global Compact for Higher Education Institutions (2012, p. 6) states that "HEIs are encouraged to participate in the global compact as deeply and meaningful as the thousands of traditional corporate and organizational participants, that have adopted for decades". This means that higher education institutions should also join as the leading advocate and participate as the front runner in environmental sustainability and educating for sustainable development. Cole (2002, p. 6) confirms that "Education is not just to pass [an] examination, take a degree and a job, get married and settle down, but also to be able to listen to the birds, to see the sky, to see the extraordinary beauty of a tree and the shape of the hills and to fall with them, to be directly in touch with them". Micheal (2014) adds that the beauty of nature can have a profound effect upon our senses, those gateways from the outer world to the inner. The beauty in nature is to be able to live in a peaceful environment where all relate well with one another.

5 Education for Sustainable Development

The human species is facing some of the most challenging issues encountered as the development of civilizations is underway. Many living species play an important role in local, national, and global economies either as resources (e.g., in fishing, timber industries, etc.) or as potential contributors of diseases (e.g., parasites, mosquito vectors to name a few). Lowe (2005, p. 5) says "the world's scientists are issuing increasingly urgent warnings about the impact of human activities on natural systems". The Commission on Sustainable Development (2001) maintains that the human environment and development has been largely ignore within the process of globalization, local communities participation and nature conservation are threatened and often overlooked.

Education has been considered as the way forward to response to the issue of sustainability (Huyuan and Jay 2012; Tilbury 2010; UNESCO 2006, 2012). The United Nations Compact in collaboration with several educational organizations has developed the Principles for Responsible Management Education (PRME) to encourage scholars and managers to jointly work on developing new knowledge to promote environmental responsibility (PRME 2010). It is becoming clear that the search for sustainability cannot be limited to classroom teaching but requires multiple participations of relevant stakeholders (UNESCO 2012). Tilbury listed four approaches to resolving environmental disputes among educators to include the "education about the environment; education in the environment, education for the environment and a threefold approach" (2010, p. 208). Education is also considered the fundamental strategy for achieving sustainability (OECD 2007). Higher education must be challenged to build competencies for sustainable development among students as well as among universities educators to empower them to become leaders for sustainable development (Mader et al. 2013). Many institutions only investigated sustainability from the technology improvement and waste management aspect and in a way, the practice of Green HRM is only being practiced at organizations, not educational institutions. A discipline like human resource management has so many ways in which it can contribute to achieving the goals of sustainable development. In all disciplines, it is important that educators at every level help shape the behavior and decision-making skills of its student for the present and the future.

6 Research Approaches

The concept of sustainability is a world issue facing us as inhabitants of the planet citizens of a nation, members of a community, and organization and as individuals. Due to these challenging sustainability issues at DWU, a case study design was chosen to explore the concept of green human resource management at DWU. Yin (2003) defines case study as an empirical inquiry that investigates a contemporary phenomenon within its real-life context. The case study in this research focuses on a specific institution: Divine Word University, in Madang, Papua New Guinea. As discussed earlier, the research focuses on exploring Green HRM at Divine Word University. Thus, the interest in Divine word University as a contested site for Green HRM is an example of intrinsic case study.

7 Methods

This study is concerned only with five areas on sustainability at DWU, which are paper use policy, water conservation, energy consumption and reduction in energy usage, waste management and fuel consumption, and exploring the concept of

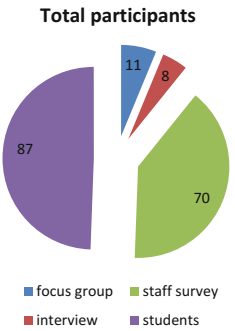

Fig. 1 Methods and total numbers of participants

green human resource management. Figure 1 presents the methods and numbers of participates for each of the methods for the study on green human resource management at Divine Word University.

Total participant for the study was 176; 11 focus group interviews, 8 semistructure interviews, 70 staff participants, and 87 student participants.

The focus group interview was conducted with three different departments: Human Resource Management (HRM), Information and Communication Technology (ICT), and the Student Services Department (SS), the total participants for the focus group were Eleven (11): four (4) from HRM, three (3) ICT, and Four (4) from the student services department. Focus group interviews were conducted to gain insight on sustainability issues in the various departments and how they manage, educate, and dispose their waste including e-waste.

The semistructured interview comprised of (3) Vice Presidents (VP), one (1) director and, four (4) Deans of different faculties at DWU. Semistructured interviews consist of several questions that help to define the areas to be explored, but also allows the interviewer or interviewee to diverge in order to pursue an idea or response in more details.

A closed-ended survey questionnaire was administered electronically to staff and students using the DWU local network (Intranet) and e-mails. Two groups of participants were selected for the survey questionnaire, staff and students, to cover a diverse range of topics and to compare the level of awareness from both sides. For some participants, hard copies of the questionnaires were issued and collected, especially, for those who were unable to complete the questionnaires online or electronically.

The DWU public documents were requested from the human resource management department and confidentiality was assured before it was given to the investigator. Some of the information on the documents was included in the survey questionnaire in order to support other instrument findings. The section below presents some of the finding of green human resource management at Divine Word University.

8 Findings

The study combines greening and green human resource management at DWU. The students answered only questions about greening, which is related to the issue of sustainability at DWU while staff answered questions about greening and Green Human Resource Management (GHRM) at DWU. Data collected was analyzed under each research question. Qualitative data was organized into themes. Quantitative data was summarized on tables in the excel spread sheet and then sorted from the most strongly agreed to the most strongly disagreed and neutral which was then converted into stacked graphs. The section that follows summarizes the findings from the study on green human resource management at DWU.

9 The Printing and Paper Use Policy at DWU

The paperless policy started in 2005 with guidelines to introduce ICT by creating email accounts, and the internal electronic media. The DWU intranet, the internal communication means was adopted as a process of implementing the DWU vision. The university vision under the "DWU Strategic Plan: the Second Decade 2006–2016" states that the university's first strategic objective is enhancing the student experience, second is promoting quality of distinct academic programs, third is supporting high-quality research and knowledge exchange, fourth is capitalizing on opportunities for partnerships, fifth is optimizing the contributions of the staff, sixth is maximizing organizational effectiveness, and the last is making the most of their asset (DWU Learning and Teaching Plan 2012). This forms the basis for the introduction of "The Printing and paper use policy". Therefore, members of the community, staff, and students were issued with laptops to improve upon their information technology knowledge and skills but also to support the paperless policy

The Printing and paper use policy was introduced at DWU for the following reasons (FGI, Interview 2015):

- To facilitate eLearning.
- To issue staff and student computer/laptops.
- To reduce the cost of purchasing paper.
- To meet with international education standards.
- To minimize the use of paper on campus.
- Global concern to reduce forest destruction, climate change, and environment.
- To allow forest to provide us with oxygen.
- It serves as advocacy for sustainability at DWU.
- Development of human resource plan for the future.
- To help PNG with environmental sustainability goal of 2050.
- To support staff and students on resource needs on Moodle and introduce online learning.

10 Technology Improvement at DWU

Technology (science) at DWU has really improved in the last 5 years since the introduction of "The Printing and paper use policy", with the introduction of the Learning Management System (LMS) called Moodle, email communication, use of internet, accessing library resources through various online databases, and the use of laptops by staff and students. One of the Vice Presidents stated, "Technology is appropriate for the modern world in the twenty first century. It is time and energy efficient, which enables efficient communications. It allows access to diversity of information on the internet, it is challenging but flexible, staff and students are advancing in technology at DWU" (Interview, 17/08/15). Technology allows communication to be easier and faster. In the past, members of the community did not know much about information communication technology and the use of computers. Prior to the implementation of "The Printing and paper use policy" staff were trained on the use of computers and how to teach using Moodle. The use of computers as part of the big plan to make the paperless policy work was expressed in a focus group interview, whereby technology allows "End users to contribute to the idea of energy reduction and paper reduction at DWU and beyond" (FGI, 21/08/15). It helps in communication and makes research easy due to access to information on Internet. This view is supported by a participant interviewed who said, technology helps to "effectively manage time but it makes one to be lazy and dependent" (interview, 10/09/15).

11 Energy Consumption

Solar energy at DWU was introduced in the last 5 years to help save the environment, to reduce the consumption of PNG power, and payment of huge bills. Having solar panels on roofs of buildings is appropriate because there is a lot of sunshine here in Madang, helping to drive solar energy. Solar energy was introduced because it is cheaper than paying for diesel but supports the idea for sustainable environment practices. Solar only requires having a reliable battery. Staff are advised to turn off lights when not in use and to report maintenance issues to the building and maintenance department (Interview, 17/08/15). The solar light helps save a lot of money and does not produce air pollution. According to a participant interviewed (participant A), computers; desktops and laptop generate more power which affects the consumption of energy at DWU. Solar energy helps contribute to the preservation of the ozone layer and is a clear way of using energy so solar energy was introduced at the university to be sustainable (Interview, 19/08/15). Also, in enforcing the need to practice energy reduction, there are posters around and inside buildings to tell people to turn off lights when not in use in order to save the environment.

12 Waste Management at DWU

The United Nation Environmental Program (UNEP 2005) states that waste management is intended to reduce adverse effect of waste on health, the environment, or aesthetics. Waste at DWU is buried or burnt, so there is no recycling of waste (FGI, 14/08/15). There is allocated space for waste disposal. Waste management at DWU includes disposing of paper, plastic, and e-waste. Since the introduction of computers and laptop, old computers (older version) are sent to secondary schools in order to support and enhance student learning there. Also "there is no workable plan for disposing, no proper disposal of e-waste" (FGI 21/08/15). Figure 2 summarized the findings from the survey questionnaire administered to staff and students under four main headings, which are sustainability education, the paperless policy, sustainability awareness, and access to sustainability information on campus.

The focus Green human resource management at Divine Word University revealed that an overwhelming majority staff and students want DWU to do more on sustainability education. The policy that is well known by DWU members of the community is "The Printing and paper use policy" which is not 100% in practice. One of the study participants in the staff questionnaire mentioned the President's speech on the paper use policy that DWU was on a mission to achieve its goal and target set for 2013 in response to climate change, sustainable living, and alternatives construction of its physical infrastructures to make all campuses of the university a better place to do research, teaching, and studies. While on the other hand, sustainability awareness is limited on DWU campus.

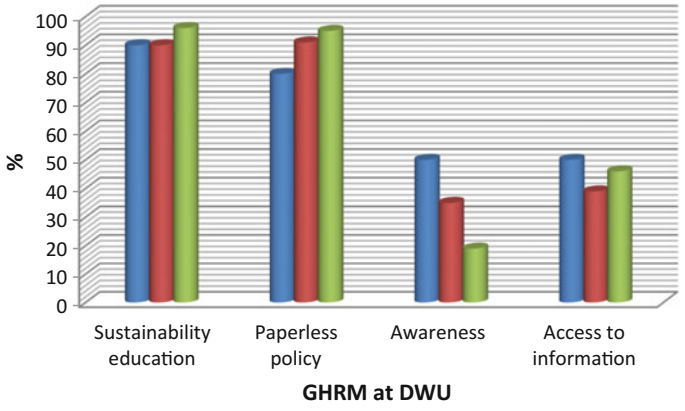

Fig. 2 Summary of findings on green human resource management at Divine Word University, Madang

13 Discussion

This study was interpreted and analyzed using the theory of "Egg of Sustainability and Well-Being" by the International Union for Conservation of Nature (2001). The Egg of Sustainability and well-being suggests that people and the ecosystem need to be treated together as coexisting. While focusing on people for development, it is, however, important to balance the treatment of people with the ecosystem. Pidlisnyuk (2010) adds that the impact of economic activities has also caused contamination by toxic elements and has also increased depletion of nonrenewable resources such as gas, oil, and coal.

The findings from the study on Green Human Resource Management (GHRM) at Divine Word University revealed that departments are not fully integrated like the Egg of sustainability and well-being. There is shifting blame from one department to the other. For example, the Student Services Department responded that the environmental health should promote World Environmental Day. According to Goldman and Salemen (2015), faculty participation is a core component of university operation. True change will require support from the faculty commitment in implementing the strategic plan of the university. In order to achieve sustainability development goal, all departments must work together.

It is revealed that science, policy, and practice influence higher education and capacity building for sustainable development (Walter et al. 2007). Researching about green HRM at a case site DWU identifies that the science which is technology improvement (computers/laptops) is present at DWU. There is also policy on sustainability through these mediums: Paper use policy, posters on energy reduction, and electronic broadcast notice boards for staff and students where discussion on sustainability is shared. In order to contribute to PNG environmental sustainability goal for 2050, a paper use policy was developed to minimize on the cutting down of trees. Theoretically speaking, information is shared, however in practice, there is more that needs to be done. In practice, members of the community at DWU want DWU to do more on sustainability education and to promote and celebrate internationally recognized days like World Water Day and World Environment Day.

14 Paper Reduction

Reducing paper is the most effective way to reduce environmental impacts like forest loss, production pollution, and resource use and disposal pollution (Sarantis 2002). At DWU, every day staff and students are mindful of the need to reduce any printing of paper, although some students are still found printing assignments (FGI, 21/09/15) also, DWU encourages reuse of paper and materials like printing and writing on both sides of the paper.

14.1 Awareness of Sustainability

The United Nation Environmental Program (2005) says that public communication has a key role to play on emerging trend and to make sustainable development approaches and understandable. Collective awareness of environmental and social situation can also be used to drive policies and create new model for economy, society and democracy and therefore citizens will increasingly rely on collective systems for everyday decision-making processes and transaction (Sestini 2012). Schroeder (2012) adds that the awareness and understanding of sustainability are essential for organizational growth. Informed, motivated, and committed people can help us to achieve our sustainable goals. Awareness on sustainability at DWU is limited, more needs to be done to inform and commit members of the community on sustainability awareness.

14.2 Education/Training on Sustainability

The United Nation Global Compact (2011) identified that it is important that academics and institutions keep experimenting with and sharing efforts to embody sustainability, especially in making it a focus of their disciplines and profession in the process of curriculum, design, development, and research. The United Nations Educational, Scientific and Cultural organization (UNESCO) (1997, p. 15) highlights that educators may include, "teachers, lecturers, curriculum developer, administrators, support staff, industrial trainers, country side ranger and staff, environmental health and planning officers, youth leader, parent association members, media people and all representatives of learner in all context". DWU members of the community surveyed responded that DWU does not educate staff and students on lighting, heating, cooling, ventilation, and window opening. There are notices posted everywhere but little by way of education. The Human Resource department needs to do more in educating members of the community.

15 High-Performance Human Resource Systems

High-performance management aims to impact on the performance of the organization in such areas as production, quality, levels of customer service, growth, and profit (Armstrong 2009). At DWU, staff surveyed responded that they are motivated to do their work. Employee participation and empowerment is about the contributions of employees in administration and decision-making regarding policies, objectives, and participation to achieve sustainable development goal.

Delivering high-performance human resource systems at DWU involves considering the environment in managing people to reduce cost and improve effective delivery. The human resource management department has a huge role to play in implementing green HR practices, they have to motivate, train employees to work for green decisions, obligate their staff on sustainability, educate, and reward

members that introduce sustainability. The Chartered Institute of Personnel Development (CIPD 2011) concluded that an ideal HR practitioner is the one that is able to add value to the organization by thinking strategically and performing in a way that will reduce cost and improve performance.

16 Conclusion

This study was a case study on green human resource management at Divine Word University Papua New Guinea-Delivering high-performance human resource systems. Divine Word University is a customer-centric institution that focuses on the student according to the strategic objective which is enhancing the student, this strategy brought about the paper use policy and the introduction of computers and laptops for eLearning also DWU last strategic for 2006–2016 is making the most of their assets which agree with the humanistic philosophy of human resource management.

The study on green human resource management at DWU shows that the institution focus is on people development by introducing technology in order to enhance and improve the experience of the people, attract world class students and staff, and increase their market competition. This is a very positive finding for this study on green HRM performance. The policies, practices, procedures, HR strategy, HRIS, CSR HR, and HR processes must align with the environmental management and also with the management of ecosystems in order to deliver high-performance human resource systems. Scientist gives us encouragement that there is much that can be done to limit further environmental degradation, changes in human activities can mitigate or limit further changes, reducing carbon emissions, and expanding recycling efforts are examples of mitigation effort.

The following are the recommendation for DWU.

- DWU should do more on green energy (Solar), energy saving, and waste disposal.
- More awareness and training on environmental issues like global warming, recycling, energy saving, limitation of the use of plastic (especially plastic bags).
- DWU should be at the fore front of local and national awareness on those environmental issues and incite its staff to conduct research in these areas.
- Sustainability education should be included in curriculum for every department.
- Technology on waste management (Recycling).
- DWU staff/student should in the future think about conducting research into something like eco-friendly servers' rooms and what is sustainable in the long run.
- Obligations of staff on sustainability at workplace and private life and improvement of staff structure.

The research on green human resource management at Divine Word University revealed that the first concept of green human resource management is still evolving. Therefore, the departments of human resource management at DWU are yet to practice green human resource management. Hence, the department of human resource must strategize in order to enhance and involve the people in environmental management activities. Also the kinds of skills the university employs and train determines the kind of graduates they produce of green skills which in latter future determines the graduate income and availability for potential employers and the prosperity of the communities and the well-being of the ecosystem.

This study is concerned with these three areas of sustainability: the social, environmental, and ecological. The study did not go into details of sustainability for economic purposes because this view focuses first on profit. It was realized at the final phase of the research that building and maintenance department should be included for investigations on energy efficiency building (Green buildings) and also how they tend to manage their e-waste which is the electrical appliances. The appliances we have within a building also determine the rate of energy to be consumed. Also future research should look into disposal of solar panels at the end of their useful life because the most significant environmental, health and safety hazards are associated with the use of hazardous chemicals in the manufacturing phase of the solar cell, improper disposal of solar panels at the end of their useful life also present an environmental, health and safety concern.

Appendix

The Study Topic:

Green Human Resource Management-Delivering High Performance Human Resource Systems at Divine Word University Papua New Guinea

The purpose of this study is to explore the concept of Green HR at DWU. Therefore the study is interested in investigating whether or not the HRM division at DWU is consciously developing and implementing Green HRM practices in managing people so that employees and students of DWU can also apply these greening practices in their personal lives and extend beyond to educate others on sustainability.

Participation in this questionnaire is strictly voluntary.

Your name is not to be indicated on this form.

All contributed information will remain anonymous.

I thank you for your cooperation and participation

Ms Zainab Olabisi Tairu
Student in Master of Research Methodology
Divine Word University

Please tick the appropriate answer that applies and please do not include your name on the questionnaire, you can comment on the space available at the end of the questionnaire

Green living means making sustainable choices about what we eat, how we travel, what we buy, how we use and dispose of the product. Sustainability is talking about how to make the earth a better place for all. And also how we care about the environment in which we live.

Thank you for taking your time to fill in this questionnaire

1: Strongly Agree; **2**: Agree; **3**: Neutral; **4**: Disagree; **5**: Strongly Disagree **(R: Reset)**

Activities	1	2	3	4	5	R
I am aware of the concept sustainability at DWU	○	○	○	○	○	◉
I am aware of the paper less policy at DWU	○	○	○	○	○	○
There is sustainability awareness on campus	○	○	○	○	○	◉
I have knowledge on energy consumption as to how it affects the environment	○	○	○	○	○	◉
I have access to information on sustainability on campus	○	○	○	○	○	◉
I have a personal responsibility to make a difference on economic issues like unemployment, local business	○	○	○	○	○	◉
I have a personal responsibility to make on social issues like safety, security, education, health and wellness	○	○	○	○	○	◉
I have a personal responsibility to make a difference on environmental issues (waste, resource consumption & water use)	○	○	○	○	○	◉
Using computer has improved my skills at DWU and beyond	○	○	○	○	○	◉
DWU provides a variety of training opportunities for its staff and student on sustainability	○	○	○	○	○	◉
I put off lights when not in use	○	○	○	○	○	◉
I photocopy using both sides of the paper	○	○	○	○	○	◉
I turn off my computer when not in use	○	○	○	○	○	◉
I want DWU to do more on sustainability education	○	○	○	○	○	◉
I have knowledge on waste as it relates to how it affects the environment.	○	○	○	○	○	◉

Gender: Male ○ Female ○

Status: Undergraduate ○ Postgraduate ◉

Comments (use the text box below)**:**

This questionnaire is "green' so please do not print. Fill up and send back electronically.

Thank you once more for filling this questionnaire. Stay Blessed!!

The Study Topic:

Green Human Resource Management-Delivering High Performance Human Resource Systems at Divine Word University Papua New Guinea

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Participation in this questionnaire is strictly voluntary.

Your name is not to be indicated on this form.

All contributed information will remain anonymous.

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Ms Zainab Olabisi Tairu
Student in Master of Research Methodology
Divine Word University

Please tick the appropriate answer that applies and please do not include your name on the questionnaire, you can comment on the space available at the end of the questionnaire.

Green living means making sustainable choices about what we eat, how we travel, what we buy, how we use and dispose of the product. Sustainability is talking about how to make the earth a better place for all. And also how we care about the environment in which we live to avoid future disaster like landslide, pollution and diseases.

Thank you for taking your time to fill these questionnaires

1: Strongly Agree; **2**: Agree; **3**: Neutral; **4**: Disagree; **5**: Strongly Disagree **(R: Reset)**

Activities	1	2	3	4	5	R
I am aware of the concept sustainability at DWU	○	○	○	○	○	○
I am aware of the paper less policy at DWU	○	○	○	○	○	○
There is sustainability awareness on campus	○	○	○	○	○	○
I have knowledge on energy consumption as to how it affects the environment	○	○	○	○	○	○
I have access to information on sustainability on campus	○	○	○	○	○	○
I have a personal responsibility to make a difference on economic issues like unemployment, local business	○	○	○	○	○	○
I have a personal responsibility to make on social issues like safety, security, education, health and wellness	○	○	○	○	○	○
I have a personal responsibility to make a difference on environmental issues (waste, resource consumption & water use)	○	○	○	○	○	○
Using computer has improved my skills at DWU and beyond	○	○	○	○	○	○
DWU provides a variety of training opportunities for its staff and student on sustainability	○	○	○	○	○	○
I put off lights when not in use	○	○	○	○	○	○
I photocopy using both sides of the paper	○	○	○	○	○	○
I turn off my computer when not in use	○	○	○	○	○	○
I want DWU to do more on sustainability education	○	○	○	○	○	○
I have knowledge on waste as it relates to how it affects the environment.	○	○	○	○	○	○

Human resource information system (HRIS) is an information system for managing the administration of HR processes and procedures. The HRIS is software that helps an organization to acquire, store, manipulate, analyze, retrieve and distribute information about an organization human resource.

Activities	1	2	3	4	5	R
There is recycling of solid waste including paper, plastic and e waste at DWU	○	○	○	○	○	○
DWU educate staff and student on lighting, heating, cooling, ventilation and window opening.	○	○	○	○	○	○
DWU is committed to equity, social justice and diversity and maintains the highest standards of integrity relationship with others	○	○	○	○	○	●
DWU is an institution serving as resource for and stimulus to social, economic, educational, cultural, environmental & community development in PNG and the South pacific	○	○	○	○	○	●
HR has training on sustainability for staff	○	○	○	○	○	●
HR uses information systems like HRIS to perform its functions	○	○	○	○	○	●
HR encourages staff that initiate sustainability	○	○	○	○	○	●
HR communicates with staff on a weekly basis	○	○	○	○	○	●
HR uses computer base test to conduct recruitment test	○	○	○	○	○	●
DWU has a social issue policy on respect for human rights	○	○	○	○	○	●
DWU has a social issue policy on no forced or compulsory labor	○	○	○	○	○	●
DWU have a social issue policy on no child labor	○	○	○	○	○	●
I receive recognition when I do a good job	○	○	○	○	○	●
I am motivated to do my work	○	○	○	○	○	●
I can work from home	○	○	○	○	○	●
DWU functions in the ecosystem very well (sources of food, water, energy as well as the end product of waste and garbage)	○	○	○	○	○	●
I can submit feedback and supported improvement to the Human resource information system(HRIS)	○	○	○	○	○	●
There is a manual or handbook on HRIS	○	○	○	○	○	●
I receive and enter HRIS information problem on a database like oracle, MySQL	○	○	○	○	○	●

Comments (use the text box below):

Gender: Male Female

Status: Academic staff Administrative staff HRM Employee

How long have you been with DWU?

1-2 years 3-5 years 6-8 years 9- 11 years

12 years and above please specify years

This questionnaire is "green' so please do not print. Fill up and send back electronically.

Thank you once more for filling this questionnaire. Stay Blessed!!

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A Case Study on Lifestyles in the Southeast Asian Region from a Sustainable Consumption Point of View

Midori Aoyagi and Aya Yoshida

Abstract

Developing countries continue to struggle to achieve sustainable lifestyles, poverty alleviation, and economic development. Increasing the quantity and quality of consumption generally also means increasing emissions of greenhouse gases and other environmental impacts. The world has recognized the need to decouple economic development (i.e., elevation of the standard of living in developing countries) and resource consumption, but the way to do so remains unclear. The relationship between economic growth and environmental impacts is often discussed in the context of the Kuznets curve, which expresses the development path as an inverted U. One of the ways to decouple that has been discussed in this context is "leap-frogging," in which developing countries skip (or "compress") the period of higher environmental impacts in their developmental paths. Structural changes in a country's industrial sectors are important in this context, including investment in infrastructure, investment in technological innovation, and investment in human resource development (education). The aim of this study was to explore ways to skip the so-called "dirty stages" of development and examine issues related to the "compressed development" concept in the Southeast Asian region, with a particular emphasis on the role of education. To this end, a case study was conducted in Thailand, a relatively newly developed country, in August 2016. A total of 15 individuals were interviewed in Bangkok and Chiang Mai about their current standards of living, social networks, views on education, and future aspirations. The interviewees were from urban and rural areas from five social and economic classes (SECs). Across regional and income categories, (1) people expressed the importance of education in pursuing better lives in the future; (2) people (especially those in the

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lower SECs) owned more household equipment than we expected, including smart phones, which allowed them access to social networking services and online news; and (3) family was reported as an important safety net, especially for people in lower SECs. In addition, current Thai social, political, and economic conditions influenced people's perceptions of their "hopes for the future."

Keywords
Sustainable development · Compressed development theory · Human development · Thailand · Interview survey

1 Introduction

Developing countries continue to struggle to achieve sustainable lifestyles, poverty alleviation, and economic development, which are among the stated United Nations Sustainable Development Goals. To achieve greater economic development under current conditions, developing countries cannot avoid increases in resource consumption, greater emissions of greenhouse gases, and other environmental impacts, which will not be sustainable in the long term. At the same time, all people living on this planet should have a certain standard of living, which means decent jobs, no poverty, good housing, and good education. To achieve this goal, economic development and resource consumption need to be decoupled, but the way to do so remains unclear.

The relationship between economic growth and environmental impacts is often discussed in the context of the Kuznets curve. The Kuznets curve shows the relationship between environmental impacts and economic development (often denoted by GDP) over time. The curve is shaped like an inverted U, which means that in the early (low GDP) periods, a society's environmental impact is low, but as the nation develops economically the environmental burden increases. Then, at a certain point of time, the environmental impact peaks and begins to decrease.

Decoupling means detaching economic growth and environmental impacts. For developing countries to avoid adverse environmental impacts as they move along their developmental paths, they need to consider structural changes in the industrial sector, which is often the source of industrial pollution. Governments need to invest in infrastructure, technological innovation, and human resource development (education) as well. Many recent development studies have focused on the impact of globalization—especially the development of global value chains (GVCs) and economic development in terms of human resource management and education. Human resource development policies and education may have a huge impact on people's lifestyles and consumption patterns, but they may be difficult to implement if the public is not aware of their importance or if there are competing influences from the national culture, lifestyles, or the political system.

UNEP has published a report on decoupling economic growth and resource use (UNEP 2011), stating that, "Decoupling of resources or impacts means that the growth rate of the environmentally relevant parameter (resources used or some measure of environmental impact) is lower than the growth rate of a relevant economic indicator (for example GDP)." In addition, the report noted that, "Decoupling will lead to absolute reductions in resource use only when the growth rate of resource productivity exceeds the growth rate of the economy." Therefore, economic development and the drivers of development must be considered.

One of the key ideas in decoupling is the concept of "leap-frogging." UNEP (2011) stated that "this usually means either shortening the transition from the first to the second mode considerably, or skipping the first phase altogether (Sachs 2002). Leapfrogging, however, will depend entirely on whether the capacity for innovation exists within a particular developing country and whether, in turn, an appropriate set of institutional arrangements are in place to provide incentives and harness innovations that demonstrate economically viable 'leapfrog' technologies" (p. 35). The UNEP report also states that, when discussing decoupling, we should rethink the concepts of "development" and "de-materialization" of an economy, possibly by using the Human Development Index by UNDP (2015). The UNEP report also highlights the importance of innovation, by stating, "An important question from a decoupling point of view is how technological leapfrogging can enable developing countries to skip some of the dirty stages of development experienced by industrialized countries."

The conventional development studies debate assumes five stages of development, originally proposed by Rostow (1960) and since used by other scholars as well. Whittaker et al. (2007) said that "Rostow (1960) saw economic growth as progressing through five stages: traditional, transitional, take-off, drive to maturity, and high mass consumption" (p. 6).

Akamatsu (1937, 1962) developed the "flying geese" model in the 1930s to explain Japan's economic development. The model explains Japan's "catch-up" policies of the time (1910s–1930s) and has been applied to other East Asian governments.

A combination of the flying geese model and Rostow's five-stage model can be used to explain the current status of Southeast Asian countries as well. Japan is the most developed, followed by other East Asian countries, and then by some Southeast Asian countries. The least developed countries are known as "late developers."

A problem with both development models is that late developers would need to experience negative trajectories, such as the health and environmental problems caused by pollution in Japan in the 1950s after its "take-off" stage. Obviously, this outcome is not desirable, and other paths for development need to be explored. Indeed, UNEP (2011, p. 40) stated that late-developing countries or regions should "skip some of the dirty stages of development experienced by industrialized countries." In Rostow's five-stage model, economic development begins when the country reaches the take-off stage, so the take-off, and drive to maturity stages

need to be skipped or compressed to avoid some of these "dirty stages" of development.

Whittaker et al. (2007) expressed some of Rostow's five stages in different ways—for example, as labor intensive, capital intensive, and high-tech periods—but these stages still deal with the drivers of economic development. For example, Japanese economic development after the Meiji Revolution in 1867 began with the labor-intensive silk industry. Exports of silk products led to increased capital accumulation. Using that accumulated capital, Japan's government was able to invest in capital-intensive industries, such as steel production and ship-building. At first, experts from Europe were invited as technological advisers for these industries, but as the higher research and development institutions were established in Japan, these technological innovations were internalized, leading to more high-tech development in Japan.

Currently, globalization has made these developmental paths change. Whittaker et al. (2007, p. 6) wrote that, "sharp separation among the three developmental stages [labor intensive, capital intensive, high-tech] is weakening as these stages now overlap." Furthermore, they added, "The concept of blurring or compression of stages of industrialization can be extended to the process of de-industrialization. De-industrialization happens when manufacturing's share of employment begins to decrease, with the surplus absorbed in services."

The aim of this study was to explore ways to skip the so-called "dirty stages" of development and examine related issues in the context of Whittaker et al.'s "compressed development" concept in the Southeast Asian region, with a particular emphasis on the role of education. For this purpose, we focused on a country that has recently passed the take-off stage—Thailand—as a case study.

2 Compressed Development

Late developers are assumed to be in the early stage(s) of development (i.e., traditional, transitional, and take-off) with the goal of reaching the final stage of "high mass consumption." Late developers are generally assumed to proceed through the five stages in the same order as the developed countries did. Whittaker et al. (ib.), however, noted that, with compressed development (1) stages can occur simultaneously and (2) the time of development is becoming much shorter (sometimes less than a decade) in late-developing countries or regions.

In a case study of Asia-Pacific Economic Cooperation (APEC) countries and business cooperation, Haworth (2013) discussed the importance of the role of human resource development in the development of Asia, especially in relation to GVCs. He pointed out that the late development model assumes that development stages happen sequentially. Howarth noted, however, that "There is an unprecedented level of compression of experience in comparison with older developed economies. From a workforce perspective, it is possible as a consequence of this level of compression to pass through the transition from agriculture into mass

production in manufacturing and on into the service sector in under a decade" (2013, p. 252). An important point here is not only the compression of time, but also the compression of stages. Another point Howarth made was the engagement with GVCs in real time. Under the compressed development model, government should provide a post-compulsory education system—that is, vocational training, higher education and research-based learning, improved postgraduate research programs, and generally improved and more sophisticated skill trainings. In addition to government-business cooperation, Howarth discussed cooperation between the education and labor ministries in some APEC countries. In this context, the education sector is being asked to provide educated or skilled labor to labor markets according to the business sector's needs. This type of cooperation enables developing countries to further compressed development.

Whittaker et al. (2007) built on Sen's (1999) argument that development is the process of expanding human freedoms and agency and removing "un-freedoms." Whittaker et al. wrote that "the East Asian model is characterized by (1) an emphasis on basic education from the beginning of the development process, if not before, (2) wide dissemination of economic entitlement, through education and training, land reform and credibility, and (3) a deliberate combination of state action and use of the market" (p. 18).

In this paper, an interview survey was conducted to determine people's aspirations for the future in response to governmental policy on human resource development, with a particular focus on education as a means of future development.

3 Method and Results

3.1 Interview

Face-to-face in-depth interviews of 15 participants from urban and rural areas of Thailand were conducted in this research project. Residents of two cities (Bangkok and Chiang Mai) were interviewed. Thailand was chosen because it is a relatively newly developed country in Asia and its society is experiencing rapid changes. A survey research company based in Bangkok helped with recruiting participants, conducting and interpreting interviews in the local language, and recording the interviews and other logistical factors. A total of 15 individuals or households were selected from Bangkok (the capital) and Chiang Mai (the second largest city) from five social and economic classes (SECs) (Table 1). Participants were recruited by local research staff in accordance with the research team's instructions, which were to (1) select at least one participant in each of the five SECs, and (2) have as much variation in gender, age group, occupation, and educational level as possible in each of the study areas of Bangkok(rural), Chiang Mai (urban and rural).

There were five participants from Bangkok (all urban), five from urban Chiang Mai, and five from rural Chiang Mai (Table 1). Interviews were performed by

Table 1 Distribution of household interviews

	Central Thailand	North Thailand		Total
	Urban (Bangkok)	Urban (Chiang Mai)	Rural (Chiang Mai)	
SEC A/B/C	3	3	3	9
SEC D/E	2	2	2	6
Total	5	5	5	15

SEC social and economic class. SEC A is the highest (approximate income >1,00,000 baht/month) and SEC E is the lowest (approximate income <10,000 baht/month)

following a questionnaire developed by the research team in advance. The questions and exact wording used varied slightly on a case-by-case basis, depending on the situation. Participants were asked about their current living standards, social networks, and future aspirations. The interviews were conducted in August 2016 in the local language (Thai) by an interviewer from the research company accompanied by a Thai–Japanese interpreter and the Japanese research team members. A camera crew was also present to record the interviews.

3.2 Results

Recordings and transcripts of the interviews were used as the basis of our analysis. The data obtained were mainly qualitative, with only a limited amount of quantitative data, so it would not have been appropriate to analyze the data with a complicated statistical analysis. Rather, the data were analyzed qualitatively in the context of participants' lifestyle choices and their surrounding environments.

When asked about their own or their siblings' children, respondents generally expressed the importance of education in pursuing better lives. They also emphasized the importance of help from other family members—especially in the case of households from lower SECs—and the importance of family as the most important safety net in economic terms now and in the future.

Table 2 shows the responses of participants by household income level. Participants in the higher income group reported living easier lives than those in the middle and lower ones. Participants in middle- and lower income groups responded that their everyday lives were not easy, but that they wanted to support themselves and their families on their own. Even members of lower income households, however, appeared to own enough basic household appliances, such as televisions, refrigerators, and washing machines. In addition, almost of all the participants had mobile phones most of which were smart phones.

Most of the lower income participants told us that these electronic items had been given to them by relatives or sometimes by their business customers. In the homes of higher income individuals, participants were observed to own more expensive appliances, such as a spa bath in each bedroom. Even so, higher income individuals—in both Bangkok and Chiang Mai—generally reported that "there are still richer people than us."

Table 2 Interview results by income

	Comments
Higher income (SEC = A)	• General: Life is good but it could be better • Quote: "There are still richer people than me out there. I want to have a little more money to give me freedom. Anyway, I don't expect to be a millionaire."
Middle income (SEC = B, C)	• General: I want to support myself and my own family. My future goal is to be able to support my parents and/or siblings • Quote: "My income covers my own expenses. I also help my parents on some expenses. I want to have my own house."
Lower income (SEC = D, E)	• General: I experience more difficulties in my life than others in terms of money and relationships with family members, but I don't feel it's the end of the world • Quote: "Planning ahead for the long term causes stress and depression. Therefore, living day by day and achieving short-term goals is the best solution."

Table 3 Interview results by region

	Results
Bangkok	• Fulfilling basic needs is not enough for happiness; better products or services are desired on some occasions • Security is derived from having more money and property
Chiang Mai urban	• Seeking a better life, with education and money, can open doors • I want more money but I don't want a trade off for less free time
Chiang Mai rural	• Simple living • Meeting basic needs is the main factors for happiness

Table 3 shows the results by region. Participants in every region told us that they wanted their children (or nephews or nieces if the participants had no children) to have a good education—at least a bachelor's degree—regardless of their own level of education or income class. One female who lived in Bangkok and a male who lived in urban Chiang Mai, both of whom were from a lower SEC class and lived in an inner-city area, gave the same reason: they wanted their children to get out of the areas where they currently lived.

Education was said to be important by almost all participants from all regions and income classes because of the high level of competition in the labor market. Some higher income families sent their children abroad for education, whereas in lower income families the children may have had to partially support themselves after finishing high school. Some younger participants (in their 20s or early 30s) told us that they received fellowships, in part because of recommendations from their high school teachers. Our participants believed that education was a way to

open doors in a young person's career and would provide more career options, and hence more financial security and a higher standard of living. They believed that the quality of life would also be better with more education. Better careers in this context means "white collar" and "professional"—that is, working in an air-conditioned office and not outdoors doing manual labor. The participants' use of smart phones and access to social networks and online news might have had an effect on this viewpoint.

Considering the importance, almost all participants placed on education, choosing a school was perceived as important, because popular or standardized schools have a higher quality curriculum and greater resources for personnel. However, the choice of school depended on family income. Higher income people could more freely choose well-known schools with high standards, where their children would receive a quality education and be surrounded by similar peers. A school's distance from the home was not a big problem, higher income families can afford to send their children to Bangkok from Chiang Mai.

Lower income parents often had to choose the nearest school to save on transportation costs. Also, cheap or free tuition was an important factor for this group. They believed that all schools should have the same standard of education, but some respondents stated that the schools did not have the same standards. English and third languages were considered to be important, because knowledge of other languages would benefit the children in the future in the world of work. Higher income parents, therefore, were more likely to send their children to more expensive bilingual (Thai and English) or international schools in Bangkok. These types of school are not currently available in Chiang Mai.

When participants were asked about their futures, they expressed concern about uncertainty in politics and the happiness of their children and themselves. The main factor they identified that would help them to achieve their aspirations was money. In addition, they noted that the current political instability in Thailand directly affects the overall economy and that the next election would lead to real democracy and greater credibility from a foreigner's perspective; they considered that this, in turn, would enhance the Thai economy.

Differences were observed among members of the different SECs in terms of future aspirations. As noted in Table 2, one respondent from a lower SEC stated that "Planning ahead for the long term causes stress and depression. Therefore, living day by day and achieving short-term goals is the best solution for me," whereas a typical middle class participant responded, "My income covers my own expenses. I also help my parents on some expenses. I want to have my own house." A participant from the lower SECs had trouble covering everyday expenses, and managing debt was his most serious issue every day. Even though his situation seemed hopeless, his neighbors often lent him money when he needed it and his divorced wife often visited and made sure his daughter had enough food and clothing. Meanwhile, middle and higher SEC participants had more options: for example, they owned their own houses and could expand their own businesses.

4 Discussion and Conclusion

People in all income classes and areas were aware that education was critically important to their own and their children's future—that is, it was their path to a better life.

In terms of building a sustainable society, the concepts of compressed development and its impact on developing countries have been discussed in this paper. Our case study showed that education was perceived to be the key to improving people's lives in the future; in a broader sense, education is the key to social development, which, along with the environment and the economy, is one of the three factors of "sustainability."

The compressed development model seems to define the reality of current development paths, especially in Asia, and human development is the key to promoting compressed (and more sustainable) development. Our survey showed that people in Thailand recognize the importance of human development.

In general, people (especially those in the lower SECs) owned more household equipment than we had expected, given their respective SECs. The reason seemed to be family ties: relatively wealthy family members supplied less well-off family members with household equipment. Thus, family ties appear to play an important role in closing gaps in the standard of the livings of the society. From the viewpoint of impacts on the environment, increasing ownership of energy-consuming household appliances will have greater energy-related impacts on the environment, particularly if the items are older, second-hand, and not energy efficient. Furthermore, almost all participants had a mobile phone, allowing them greater access to social networks and online news. This access may help to form images of a "sophisticated" lifestyle or "desirable" type of work.

Family was an important safety net as well, especially for people in lower SECs. Current social, political, and economic conditions also influenced people's perceptions of their "hopes for the future."

People understood and were aware of the benefits of the national government's policy on human resource development, e.g., scholarships. They reported that education was important for a better future. Even participants in the lower SECs knew that they could receive benefits through scholarships. Some parents saw education as a key for their children to get away from the areas where they currently lived. Through family ties, family members and neighbors could share in the benefits of education as well.

Further investigations will be needed to expand on these results in both Thailand and other Asian countries—for example, by comparing newly developed countries or regions with countries or regions that are still underdeveloped to answer the following questions. Is the idea that "education is the key to a bright future" appropriate for other areas in Thailand or other Asian countries? If not, how does people's understanding differ? Do different attitudes about education have an impact on a nation's economic development?

Our survey was limited to observations of 15 participants in and around two of the largest cities in Thailand, so it is difficult to generalize these results to Thailand as a whole or to other people in developing regions. The results should be treated as a case study and "snapshots" of a small group of people in Thailand. For greater generalization, a larger and more nationally representative sample will be needed. In addition, people's attitudes and situations may change as government policies change.

The idea of a "sustainable lifestyle" or a "sufficient economy" has special meaning for Thai people in connection to the late King Bhumibol Adulyadej, who passed away just after our survey work. The Sufficient Economy project had been led by the late King; this concept was popular among Thai people, and all our participants were aware of it. This topic, however, remains the subject of another research paper.

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A Systematic Approach to Adopt Sustainability and Efficiency Practices in Energy-Intensive Industries

Karin Tschiggerl and Milan Topić

Abstract

The foundry industry is counted among the energy- and resource-intensive industries, and thus an important contributor to impacts on climate change. On a global level, the production of casting parts is expected to increase, with China, USA and India as the main cast producers, and the automotive sector as the main purchaser. While the production of castings is one of the oldest production processes in human history, there are still weaknesses regarding sustainable operations, amongst others due to the asset intensity and different energy cost situations on global level. Political and legislative actions were taken to force sustainable practices in Europe, which means a challenge and a responsibility for foundries at the same time, to adapt their processes, and to adopt sustainability and efficiency management. This paper describes a systematic model approach combining a synthesis of top-down and bottom-up analyses and establishing sustainable practices in foundries. The approach follows the Plan–Do–Check–Act cycle and allows to identify and capture energy and resource efficiency potential while considering life cycle aspects within a highly specific and complex industry. The paper also highlights the importance of transdisciplinary collaboration regarding the realization of sector-specific energy efficiency and integrated into value chain networks. The benefit of the approach is its application on different sustainability maturity levels, and its potential to be adopted in different energy- and resource-intensive industries.

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Keywords
Energy-intensive industries · Energy efficiency · Foundries · Life cycle aspects · Transdisciplinarity

1 Introduction

The foundry industry is counted among the energy- and resource-intensive industries, and thus an important contributor to impacts on climate change. Foundries are represented in nearly every country in the world, the annual production of casting parts mounts up to more than 100 million tons. On a global level, the production of casting parts is expected to increase, with China, USA, and India as the main cast producers, and the automotive sector as the main purchaser. An interesting fact to be pointed out is the nonlinearity between production output and efficiency of production. Looking at the top 10 cast producing countries, the number one in amounts is the last one regarding efficiency (Turner 2015).

While the production of castings is one of the oldest production processes in human history, there are still weaknesses regarding sustainable operations, amongst others due to the asset intensity and different energy cost situations on global level.

Political and legislative actions were taken to force sustainable practices in Europe, which means a challenge and a responsibility for foundries at the same time, to adapt their processes, and to adopt sustainability and efficiency management. Globally, restrictions seem to refer rather to guidelines and voluntary initiatives than obligatory actions. One of the newly formed actions is the so-called Paris Agreement dealing with the mitigation of greenhouse gas emissions, adaptation, and finance, which will only be started in 2020 (UN 2015a).

1.1 The Sustainable Development Goals and Their Implications for Energy-Intensive Industries

The United Nations General Assembly adopted the Sustainable Development Goals in 2015, comprising 169 targets under 17 goals (UN 2015b). They are related to issues like poverty, education, and environment. Addressing all countries worldwide, on a micro-level also individual organizations are demanded to make a contribution. Regarding this and the focus of the underlying paper, two out of the 17 goals can be pointed out: Goal 9 "Industry, Innovation and Infrastructure", and Goal 12 "Responsible Consumption and Production". Taking a closer look at the targets, the following shall be considered (UN 2015b):

- By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and

environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
- By 2030, achieve the sustainable management and efficient use of natural resources
- By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
- By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse
- Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle

With regards to this representative targets, and the questions of "How to?" and "Where are we now?" the search for adequate solutions has to start. It seems clear that a one-sided disciplinary viewpoint won't be able to resolve the problem. As a first step, however, the problem has to be analyzed and evaluated, which leads to the so-called "energy efficiency gap" (Hirst and Brown 1990).

1.2 Addressing the "Energy Efficiency Gap"

Energy-intensive industries are challenged more than other industries in finding adequate solutions to capture the energy concerning targets on the Agenda for Sustainable Development. This leads to the question why there are still weaknesses in the implementation of energy conservation measures. A number of studies deal with barriers hindering energy efficiency in foundries (CFA 2003; Davies 2012; Eronen et al. 2013; Helber and Steinhäuser 2011; Trianni et al. 2013). The self-assessment of foundries considering a potential cut-down of 15% in energy consumption leads to the so-called "energy efficiency gap", which was studied by several researchers (Hirst and Brown 1990; Jaffe and Stavins 1994; Rohdin et al. 2007; Thollander and Ottosson 2008). According to Schmid (2004) the disproportion between the techno-economic possible and the actual realization can be explained through the following aspects (Fig. 1):

- Insufficient rating of economic potential: Internal hidden costs (i.e., costs for information or the implementation) are mainly not considered in the calculation of the economic potential. This leads to an overestimation of the economic potential (Jaffe and Stavins 1994). In practice, the risk assessment of investments is stricter than assumed in models and analyses. Especially in small and medium sized enterprises (SMEs), a lack of capital lead hinders the implementation of effective measures, and thus a lower application of cross-sectional technologies because of the heterogeneity of the industry.

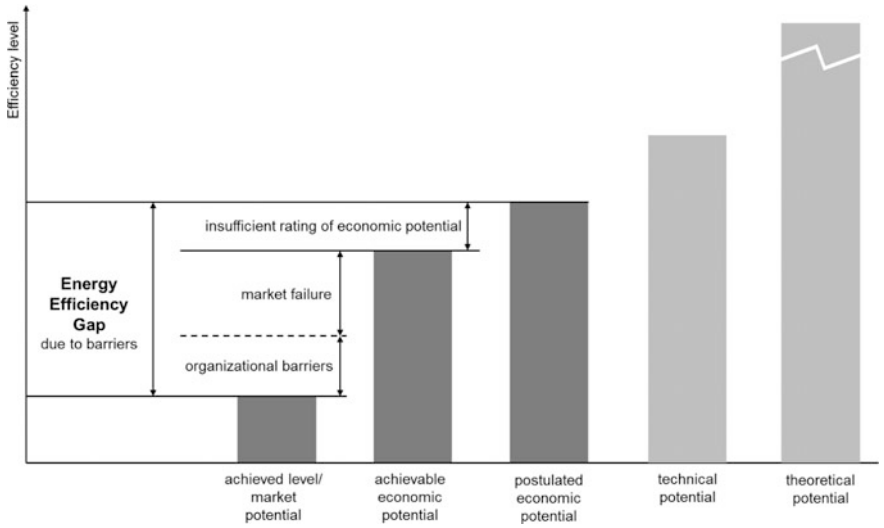

Fig. 1 Levels of energy efficiency and the "energy efficiency gap". *Source* Posch (2011) based on Schmid (2004)

- Market failure: This barrier appears when the mechanism of supply and demand does not allocate goods to the actors giving most value to them. This in turn can be attributed to externalities, market structures, insufficient provision of information, and asymmetric information (Sorrel et al. 2004). Externalities are costs or benefits that are not reflected in the market prizes of energy-efficient products, but transferred to the public in the form of external or social costs (i.e., environmental costs or subsidies). Together with biased competition (i.e., monopolistic or oligarchic markets) they have strong influence on the pricing of energy and thus the profitability of energy-saving measures. Imperfect information is a result of the incomplete information that is provided by market actors to generate profits. This means costs for a purchaser aiming at adequate and comprehensive information regarding energy consumption characteristics of a good. Asymmetric information on the other hand is explained by an unequal share of information: problems of adverse selection, where lower qualities become accepted in the market, and the investor-user-dilemma, where the investor cannot gain the economic benefit of a measure.
- Organizational barriers can be reduced to split incentives in companies, principal-agent-problems, and conflicts between individual and corporate targets. Split incentives may occur if different departments are responsible for the planning and the calculation of an investment. Principal-agent-problems typically happen between the management, that rates energy efficiency as an important topic ("top-down" decisions), but on operative level measures are not implemented due to "alibi"-reasons. Least, the bounded rationality in decision taking allows subjective preferences in the selection of projects (Sorell et al. 2004).

At the same time, it has to be distinguished between different levels of energy efficiency that can be defined by various determining factors. Therefore saving potential can be differentiated by stages, as shown in Fig. 1 (Posch 2011):

1. Theoretical potential: described as the difference between the actual and an ideal process. In practice, the theoretical thermodynamic potential is not realizable.
2. Technical potential: can be unlocked through the implementation of the existing most energy-efficient technologies. It does not take into account economic considerations.
3. Economic potential: is generally based on idealized framework conditions from the neoclassical theory. The estimate of the economic potential results from the implementation of the most energy-efficient technologies (for replace, upgrading, and new investments) within a certain time frame, which are cost-efficient under the given market prizes.
4. Market potential: also called anticipated potential and result of the energy efficiency gap. It can be seen as the potential that is captured without changes of the macroeconomic and internal framework conditions. A forecast of the economic potential is difficult as the share of barriers to the energy efficiency gap is not certain.

To identify the energy efficiency potential, methodical conditions have to be considered, besides the defined energy efficiency level. According to Posch (2011), the possible savings depend, amongst others, significantly from considered technologies (for example, cross-sectional vs. sector-specific technologies), defined criteria regarding profitability, and reference values for energy (i.e., values for a reference year or trend scenarios).

Practical experiences complete these findings, as the combination and interdependence of barriers implicate increasing complexity (Coss et al. 2015), and therefore complicate the implementation of energy and resource efficiency in organizations. On the other hand, the evaluation of critical values and data sources becomes crucial for the identification of energy efficiency potential. They have fundamental impact on findings, thus the precision of analyses is the basis for the deduction of measures. As an integrated approach can reach complex dimensions, imprecisions in the assessment of potential might occur.

2 Methodological Framework

The methodological framework for the development of a model approach includes basic theories regarding Industrial Ecology and transdisciplinarity, recognizing the importance of a systems viewpoint and the integration of economic, ecologic, and technical aspects. This aims at making use of existing energy efficiency potential and to overcome implementation barriers.

2.1 Industrial Ecology

Dealing with industrial settings broaching the issue of sustainability requires the adoption of a systems perspective. Thinking in systems enables problem solving by identifying a system's structure that explains behavioral patterns in various situations. As well, systems thinking demands a shift from linear to circular causality, considering relations, interactions, and feedbacks within and crossing the system (Chai and Yeo 2012). In face of urging sustainability problems in material, energetic, and technological fields, a dynamic sampling and the development of strategies for managing complex systems are central. After all, a better understanding of complex systems becomes one of the most important challenges of Industrial Ecology (Von Gleich 2008). This can be described as "the study of the flows of materials and energy in industrial and consumer activities; the effects of these flows on the environment; and the influence of economic, political, regulatory, and social factors on the flow, use, and transformation of resources" (White 1994). More detailed, Graedel and Allenby (1995) point out that the concept of Industrial Ecology "requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a systems view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal. Factors to be optimized include resources, energy and capital." To this effect, topics regarding energy efficiency are typically included within the concept of Industrial Ecology. While sustainable development goes beyond, efficiency strategies can be seen as a needful way within the Industrial Ecology approach with a high starting potential (Jochem 2003).

The complexity within overall sustainable development and Industrial Ecology topics induces approaches that help to overcome the barriers faced by disciplinary boarders which hinder capturing existing efficiency potential and to benefit from adopting a systems view. To this effect, it requires to open the "black-box" of the techno-sphere, to analyze and to design it (Von Gleich 2008).

Regarding the latter argument, the discipline of techno-economics gained importance in the last decades, facing the demand in sustaining the innovative capacity in industry. To generate practical sustainable answers, that cannot be solved on a disciplinary level but very well depend on the expert knowledge and the methodological accuracy of different professions, the combination and synergies resulted in the development of this quite young discipline. Therefore, techno-economics refer to an alliance of technology (respectively science and engineering), economy (in the sense of micro-economics), and sociology.

2.2 Transdisciplinarity

Regarding the complexity and uncertainty of human–environment systems and to address issues of sustainable development, transdisciplinary research processes turned out to be adequate (Düspohl et al. 2012) and lead to a broad adoption in this

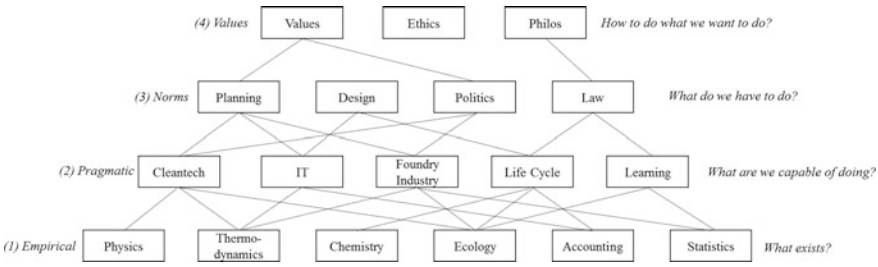

Fig. 2 Transdisciplinary setting of the addressed problem. *Source* based on Max-Neef (2005)

research field (Schaltegger et al. 2013). As Max-Neef (2005) suggests, research relevant to solve current pressing problems should be transdisciplinary. He developed a matrix composed of four levels (values, norms, pragmatic studies, empirical research), where a transdisciplinary action includes related components from every dimension. Applied to the underlying research issue of sustainable practices and energy efficiency in a specific industrial environment, the transdisciplinary setting illustrates the modular composition adapted to Max-Neef's matrix (Fig. 2), similar as it was used by Spreng (2014) for energy research. The dashed lines show any vertical relation including all four levels and the transdisciplinary actions of the addressed problem.

Important characteristics of transdisciplinary research are reflexivity as a part of knowledge production and the enabling of "mutual learning" between scientific and nonscientific actors (Jahn et al. 2012). As Mittelstrass (1992) stated, a transdisciplinary approach has a dynamic nature, as problem-solving efforts are generated during application. Thus, the diffusion of solutions and results occurs in their generation process which also occurs in participatory action research.

3 Results and Analysis

Motivated by current legal challenges and conditions for the foundry industry the research project "EnEffGiess—Development of a life-cycle oriented approach for the assessment of energy-efficient, sustainable foundry products" was started. The objective was to generate a process and evaluation model that enables to sustain the energy efficiency in foundries. As argued in the methodological framework and given the specific implications for energy-intensive industries, the need for a multi-level approach can be deduced. With the developed model, which is based on technical, economic, and environmental methods, it becomes possible to rate different foundry products regarding their energy consumption. As a result, "hot spots" and potential for measures to increase the energy efficiency can be identified.

3.1 Generation of a Systematic Model Approach

Starting point for the development of the model approach are strategic considerations and targets regarding energy topics. Following the idea of the PDCA cycle (Plan–Do–Check–Act), an analysis regarding the previous implementation of energy-related issues and their controlling shall follow to gain an overview of the actual energy situation of an organization. This demands a viewpoint from a strategic level, declared as the "top-down" approach, which impacts the operative level and at the same time requires production-related information, analyses, and processes. Thus, the model has to be established on different management levels: the top-down approach on the strategic and with interfaces to the operative level, and a bottom-up approach situated on the operative level. Figure 3 abstracts the frame and the compilation for the model design.

The model was developed applying a modular proceeding (Coss et al. 2015). This allows to analyze not only diverse operations but also structural differences of the foundry industry. Operations include the design and production, creation of tooling and prototypes, machining and assembling of casting and components placed in downstream assembly lines (CFA 2003). The modules were defined as main or support modules. This follows a description of the European Commission (2005), which includes, i.e., pattern making, mold and core production, melting, casting, metal treatment, etc. A production site is represented by the composition of used modules. This leads to a hierarchical structure including three levels:

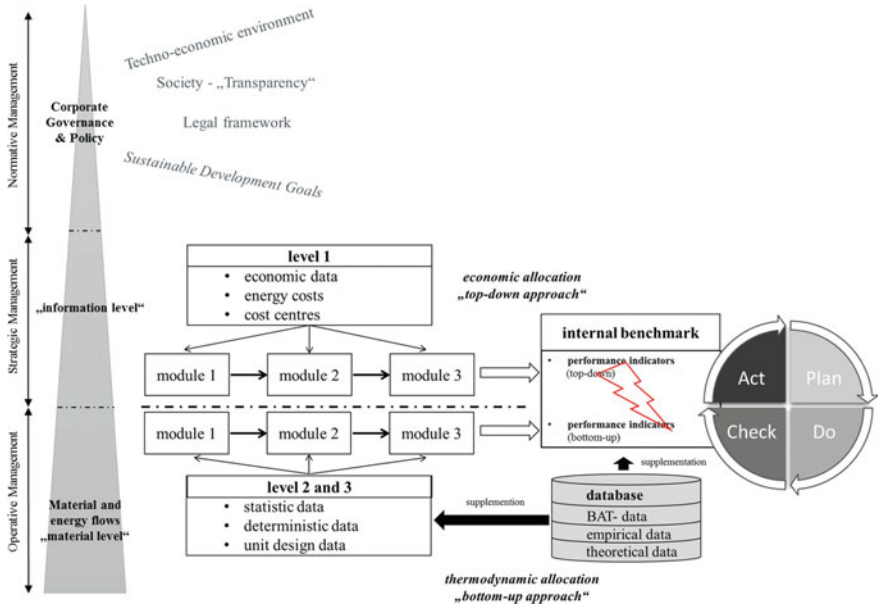

Fig. 3 Systematic model approach following the PDCA method. *Source* based on Coss et al. (2015)

enterprise level (level 1), main and support modules (level 2), and units/aggregates within a module (level 3). In doing so, key processes and key performance indicators can be generated. As well, economic and technical data are deployed to uncover energy efficiency potential. The benefits refer to more lifelike insights, detailed consumption rates on single-product level, and furthermore to the detection of information deficits and hindering mechanisms.

Analyzing data on process and product level helps to identify the most promising energy efficiency potential (Coss et al. 2015). Through the modular compilation it becomes clear that differences may occur when top-down and bottom-up results are compared. This is the reason why such deviations between economic allocations and thermodynamic calculations indicate undepicted energy efficiency potential. The following Fig. 4 illustrates the stepwise proceeding, with step 2 indicating the top-down approach and step 3 the bottom-up approach. The latter refers to a product-oriented view, which enables the identification of best process routes, as well as the comparison with substitutes and further integration of life cycle aspects. This is to say, that a detailed input/output balance generates the basis for the life cycle assessment of a product or product system.

The innovative character of the model is a comprehensive modular approach that generates a novel description and assessment of heterogeneous foundry products. As it considers various data sources and different methodical approaches aiming at different objectives, the role of a high quality, profound data basis, and transparent communication flows gain an importance. The resulting database includes empirical, theoretical and Best-Available-Techniques (BAT) data.

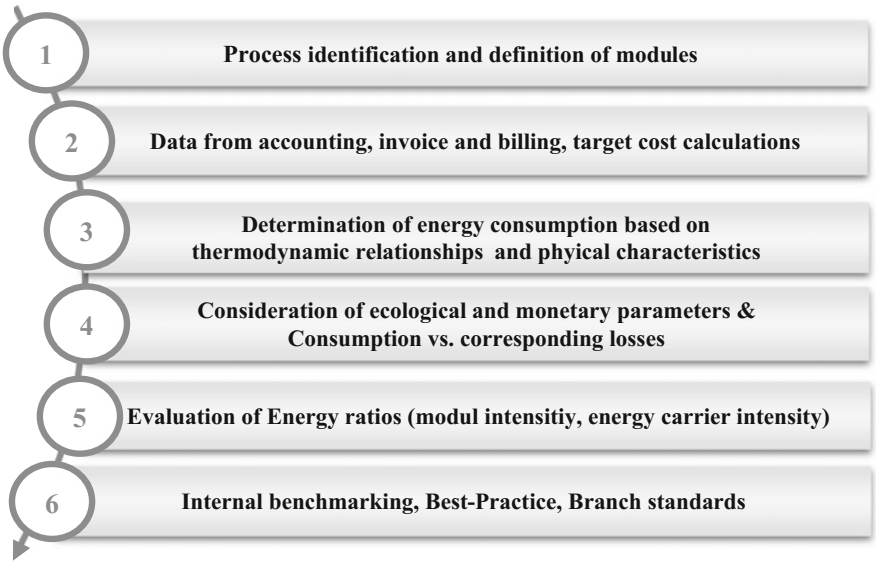

Fig. 4 Proceeding in the model design

During the application of the model in six diverse pilot foundries it turned out, that data were inconsistent or simply not available. Therefore, an iterative proceeding for the data acquisition is advisable (Coss et al. 2015). This means that traditional data collection with checklists and questionnaires should be complemented by a process visualization which is discussed by members from different departments as well as external actors, as, for example, researchers or consultants, technical engineers, etc. Frequent meetings or workshops help to identify input and output parameters on module level, possible losses and potential recycling, as well as they support the verification of data and the improved allocation of resources and costs. Applying such a methodology raises awareness within a company as several team members will be involved, thus it opens a "black box" and follows a participatory, transdisciplinary manner where know-how is generated and diffused during the whole process. Another benefit in the underlying project was that insights into different complex processes and products, as well as deductions for the whole foundry industry could be generated.

Summarizing, the systematic model approach addresses several important aspects: the heterogeneity of the studied industry with diverse products and processes, benchmarking, and a life cycle perspective (Coss et al. 2015), and participatory knowledge-generation and learning processes.

3.2 Integrating Life Cycle Aspects

Analyses considering the whole (product) life cycle gain on importance regarding industrial activities and their affiliated influences on the natural environment and requirements for a sustainable development. Beyond that, the consideration of life cycle aspects supports and gives added value to the identification of (cost-)effectiveness when capturing energy efficiency potential. The standardized method of Life Cycle Assessment (LCA) helps to analyze environmental aspects and potential impacts of product systems over their whole lifetime ("from cradle to grave"; Austrian Standards Institute 2006). LCA shows relevant benefits regarding the improvement of the energy performance and resource intensity on corporate level. Transparency of energy and material flows, and combined with monetary parameters, LCA helps to identify the most auspicious energy efficiency measures on different levels (Coss et al. 2015; Tschiggerl et al. 2016). This refers also to a consideration of the whole value chain, where it becomes even more important to find branch or industry-specific solutions, and to make use of synergies along the value creating process.

4 Conclusion

Networks to support Sustainable Development have been established increasingly after the milestones for our current understanding of the term, namely the Brundtland Report and the Agenda 21. Since then, sustainable development was in

fact displayed in its global dimension and became a mainstreaming issue. However, with the rising interest in energy-related issues and a political as well as an economical focus on energy efficiency, energy-intensive industries are challenged more than before in increasing energy efficiency, to reduce the use of primary and raw materials, and to use renewable energy sources (Tschiggerl and Wolf 2012). The question that arises is how individual organizations can implement global policies and goals—as represented with the highly topical Sustainable Development Goals—on a corporate level.

The aspect of complexity and heterogeneity in foundry production and structures may lead to unidimensional assumptions of energy efficiency. For example, a focus only on primary energy demand may risk inhibiting product innovations, which are an important step toward a cumulated energy and material efficiency. However, such energy efficiency strategies from a technical viewpoint are related to the level of efficiency, the process topology, and the component part (Knothe 2013). For the foundry industry, transparency in energy consumption and information about energy flows is fundamental, not only to meet regulatory demands but also to identify useful effects. Corresponding trends may include the increased implementation of energy management systems, energy ratios, and benchmarks, as well as advanced sensor, communication and analyzer systems.

The developed systematic model approach allows a holistic and structured proceeding in the identification of energy efficiency potential. Through combining as well strategic and operative levels not only the efficiency is on the radar but as well aspects beyond a company's boarder that influence decision-making regarding effective measures. Applying a life cycle perspective expands the technical viewpoint to an ecological one and makes use of synergies from the transdisciplinary project setting.

Besides efforts to bridge the energy efficiency gap in the foundry industry, the financial examination in relation to energy efficiency and environmental impacts becomes more important. Energy costs, strongly depending on the volatility of markets and politics, have significant influences on life cycle costs (Rudolph et al. 2010) especially with regards to the asset and investment intensity in this industry. The follow-up costs are relevant to gain meaningful cost information. Foundries need to know about it when they intend to implement new production units or for the assessment of new production processes (Aurich et al. 2009). Operators or users on the other hand are interested in follow-up costs regarding increased degrees of efficiency enabled by cast parts.

These information, respectively, conclusion is valid for energy-intensive industries in general. Therefore, the proposed systematic model approach may be applied to any industry featuring a high level of energy and corresponding resource intensity. To apply the methodology and getting out the most of it, a well-grounded data setting is necessary. As practical experience uncovers this is not the fact, even in well-structured and organized companies. Therefore, data quality based on intensive communication in the sense of an active stakeholder dialogue is essential in realizing solutions and considering life cycle perspectives, and thus capturing the energy efficiency gap and achieving the stated energy targets within the Sustainable Development Goals.

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Author Biographies

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Part III
Holistic Approaches, Stakeholders Engagement and Education for Sustainable Development

Environmental Campus Birkenfeld—A Role Model for Universities on How to Contribute to the Implementation Process of the Sustainable Development Goals

Klaus Helling

Abstract

In order to make use of the significant potential of the science of sustainability, it is crucial to further develop the science system and especially the subject "sustainability" at universities. Transformation knowledge, as well as trans-disciplinary cooperation, will have to play an important role in science. An integrative and interdisciplinary approach is necessary to establish an education for sustainable development. Environmental consciousness and social aspects cannot simply be added to existing subjects. According to sustainable development, both should be a recurring theme in the whole course of studies right from the start. To be able to cope with the challenges of the twenty-first century on a national and international level, it is important to encourage a scientific culture that works on the future problems of our society across the borders of special disciplines. The key elements to achieve a "highly efficient zero emission university" are the networking of all involved actors, the development of renewable energies, participation in sustainable education as well as the improvement of existing systems. This will be exemplified by the Environmental Campus Birkenfeld, which was founded in 1996. This campus can be considered Europe's first Zero-Emission Campus and is one of Germany's greenest universities.

Keywords

Umwelt-Campus Birkenfeld · Zero emission · Sustainable development goals · Material flow management

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1 Introduction

Sustainability is a trend and a central topic of our time and people all over the world are dealing with it. Due to the cooperation and initiatives with different actors, the universities have a huge impact on sustainable development in society (Leal Filho 2011). The operation of universities has to meet the requirements of sustainable development, including first and foremost ecological and economical aspects such as buildings and heating, consumption of paper, usage of electronics, etc. The Environmental Campus Birkenfeld is a good example of innovative sustainability: research and teaching are implemented directly and thus enable sustainable actions. The students (citizens of our future) are involved in the process of implementation in comprehensive courses of degree programs, interdisciplinary team work, in seminars and in the integration of students from different courses of studies. The implementation takes place in national and international projects with companies, municipalities, regional authorities, governmental authorities, ministries, and other scientific institutions.

The paper is structured as follows: Chapter "Using Design Thinking and Facebook to Accompany Women in Solving Water Problems in Morocco" provides a short history of the Environmental Campus Birkenfeld, which was founded in 1996 as a branch of the University of Applied Sciences Trier. Chapter "A Critical Review of the Role of Indicators in Implementing the Sustainable Development Goals" demonstrates how sustainability is embedded in the facilities and explains selected green technologies which are installed. The following part provides an overview of the integration of sustainability in the study courses of the Environmental Campus Birkenfeld. Chapter "Corporate sustainable strategies in Dom Pedro I industrial road axis, São Paulo, Brazil" focuses on research projects for sustainable development and exemplifies how students can be integrated into research based on material flow management.

2 Short History of the Environmental Campus Birkenfeld

In 1993, the state of Rhineland-Palatinate made the future-proof decision to establish the Environmental Campus in Birkenfeld/Neubrücke (ECB) as a new campus of Trier University of Applied Sciences. Up until 1992, the estate and facilities had been used as a reserve military hospital for the US army in Germany. The residential campus concept follows the model of US universities, which combine living, learning and working in one place. In 1994, the renovations began and little by little new and modern seminar rooms, lecture halls, laboratories and a broad infrastructure were built. The residential campus concept with academic departments, libraries, residences, as well as social and sports facilities in one single place has been further developed during the following years.

Teaching started in the winter semester of 1996/1997. In the first year, approximately 175 new students were expected. In reality, more than 550 students enrolled in one of the five degree courses. Currently, more than 2700 students and employees work together to create solutions for present and future challenges in twelve Bachelor's, four Joint Bachelor's and twelve Master's degree programs as well as eight research institutes and five competence centres.

3 Zero Emission Campus

Due to the extensive utilisation of sustainable technologies, ECB is the first Zero-Emission Campus in Germany. Energy and heat are supplied by a neighbouring biomass combined heat and power station, which uses waste wood and biogas as primary energy source. Innovative building standards and environmental technologies legitimate the claim of being a real Zero-Emission Campus. Students live and learn at a unique university (Figs. 1 and 2).

Special technical features at the ECB include:

- Ground collectors/supply with outside air,
- Heat exchanger for outgoing air,
- Solid absorber for excess heat utilisation,
- Transparent thermal isolation, e.g., in front of massive walls,
- Daylight guidance systems,
- Automatic aeration system,

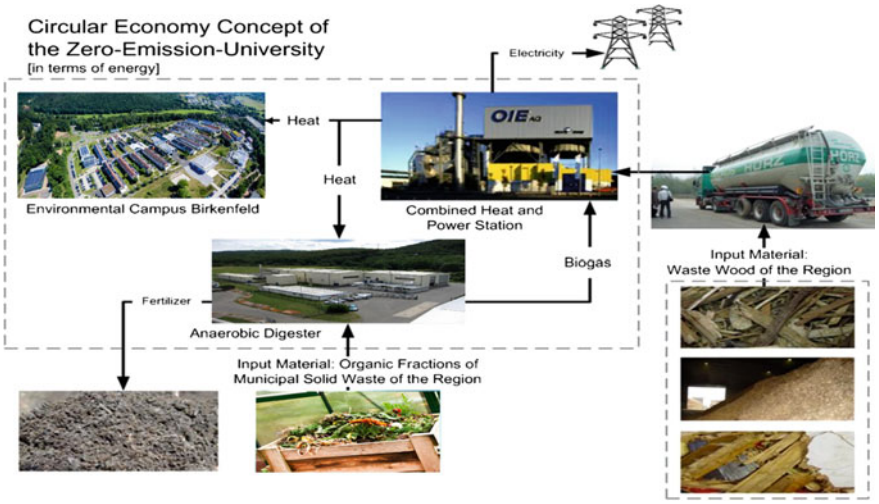

Fig. 1 Zero-emission energy concept (*Source* ECB)

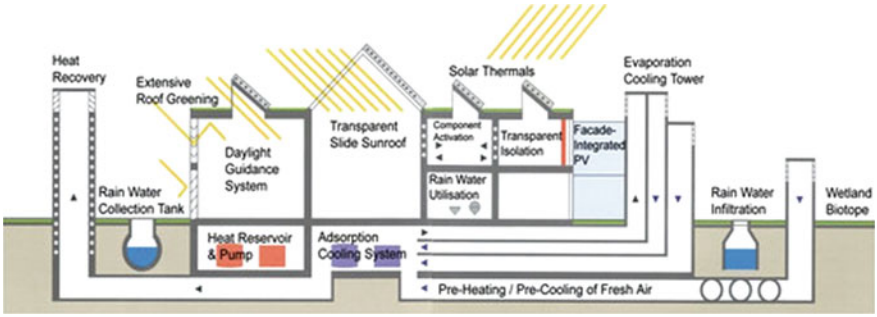

Fig. 2 Environmental technologies in Birkenfeld (*Source* ECB)

- Solar collectors and cells (photovoltaics, solar-thermal) and
- Storm water system.

In the vicinity of the campus, an eco-industrial park was constructed aiming at the optimization of regional material and energy flows connecting the campus via a district heating and a low voltage electricity transmission grid. In 1997, the wood-chip power station was inaugurated with an installed thermal capacity of 28 MW utilising annually 65,000 tons of low and high contaminated waste wood from forestry, agriculture, landscape gardening and industry to produce up to 8 MW heat, 37.5 tons per hour of steam and up to 8.3 MW electricity for the Environmental Campus, the neighbouring industry facilities and the national electricity grid. Furthermore, a cogeneration unit utilises the biogas output of the nearby anaerobic digestion plant treating annually 40,000 tons of organic municipal solid waste collected in the rural districts of Birkenfeld and Bad Kreuznach.

The remaining energy demand is covered by renewable energy installations at the campus itself. The various photovoltaic systems installed on the rooftops and in the hallways with an installed capacity of 510 kWp cover another 40% of the total electricity demand. The performance of different photovoltaics (PV) module types and mounting systems are continuously monitored, displayed and employed as a subject for teaching and research. The use of solar energy is completed by various solar thermal installations with a total of 135 kW and a collection area of 270 m^2 augmenting the heating system during the cold months.

The Zero-Emission concept of the ECB is also extended towards biotope and biodiversity management creating and maintaining protected areas and green rooftops. Rainwater is received onto retention surfaces and infiltrated into natural water bodies or allowed to channel towards the ground water. Parts of the rainwater are collected after a mechanical purification in two tanks and used for various grey water applications such as toilet flushing, irrigation and as a coolant for an absorption cooling system. The discharge of rainwater to the sewer system is already avoided in the present system.

Though "Zero-Emission Mobility" is a future-oriented topic globally, it is a well established and an evolving area at the ECB. A successful E-Mobility platform with a demonstration unit attracts a lot of attention at present. In order to minimise greenhouse gas emissions resulting from commuting, a car share system based on electric vehicles is planned. As a step towards the infrastructure development in Zero-Emission Mobility, PV-car ports shall be installed on campus in order to complete the already existing rental option of e-bikes.

For ECB's technical features the documentation "Environmental Campus–Experience Green Technologies" is offering a detailed description (Hartard and te Heesen 2016). Since 2004 the ECB has been publishing environmental reports. This reporting has been further developed to sustainability reports based on standards from the Global Reporting Initiative (GRI) (download of selected reports: www.umwelt-campus.de).

4 Education for Sustainability—Study Courses at ECB

The 2030 Agenda for Sustainable Development contains 17 Sustainable Development Goals (SDGs) including new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The goals are interconnected—often the key to success on one will involve tackling issues more commonly associated with another. The SDGs work in the spirit of partnership and pragmatism is to make the right choices now to improve life, in a sustainable way, for future generations. They provide clear guidelines and targets for all countries to adopt in accordance with their own priorities and the environmental challenges of the world at large (www.un.org/sustainabledevelopment).

Having adopted the new Agenda in September 2015, the international community recognised that education was essential for the success of all 17 of its goals. Education represents Sustainable Development Goal 4 which aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". Education is the key to sustainable development. The Incheon-Declaration includes principles for the integration of sustainability oriented knowledge in all stages of education with access for everyone, starting with kindergartens and schools and followed by vocational trainings, academic programs and advanced training courses. The Education 2030 Agenda signed in Incheon was entrusted to lead and coordinate by UNESCO with its partners (UNESCO 2015).

The ECB is an entirely environmentally oriented university in Germany and combines future-oriented research institutions with the intimacy and personal attention of a small liberal university. Here starts the concept of "sustainable education" with the aim to motivate citizens to become committed to sustainable development in companies, politics, science or schools and as members in associations, church or unions. Many of the future's national and international operating specialists and managers pass universities where they get the special and basic

knowledge they will need for their future actions as well as competencies for their future tasks. Thus, the embedding of a science of sustainability gains great importance, especially in academic teaching. Also, the students demand that we offer the topic sustainability on a large scale and that we foster it. Environmental consciousness and the concept of sustainability act as the link between the 12 Bachelor's Degree Programs and the 12 Master's Degree Programs as well as the 4 Dual Bachelor's Degree Programs at the ECB and support an intensive and interdisciplinary cooperation between the different disciplines. The concept of the two faculties "Environmental Business Management/Environmental Law" and "Environmental Planning/Environmental Technology" provides an interdisciplinary education in the framework of a material cycle for the sake of Sustainable Development. All courses mainly focus on environmental issues and try to implement the approach of Sustainable Development. Life Cycle Assessment, Integrated Product Planning, Material Flow Management, Sustainable Balanced Scorecard and Eco-Management are only some of widely used key words emphasising the importance of an environmental mentality here at the ECB. Environmental protection and sustainability constitute the link between technical, economic, and legal courses of studies. The majority of the study courses at the ECB are taught in the German language, but specific Bachelor and Master courses are taught in English. Figure 3 provides an overview about all study courses in Birkenfeld. So far more than 4000 students have earned a Diploma, Bachelor or Master degree at the ECB.

The English language courses are providing an opportunity for students from all over the world to study in interdisciplinary Bachelor's and Master's Programs at Germany's most sustainability-oriented university. They incorporate all aspects necessary to meet the demand of young students seeking a global sustainable perspective and to strike a balance between business and technology. For exchange students, the Environmental Campus offers the Study Semester program which runs each April to July (summer semester) and October to January (winter semester). It consists of 6 modules per semester from various disciplines. All courses are 4 h per week and fully credited within the ECTS system, providing a total of 30 credits for one semester. Courses take place in small international study groups. The teaching atmosphere fosters teamwork, intercultural competence and applied problem solving via integrated case studies (www.umwelt-campus.de/studysemester).

In addition to the already established exchange programs "Principles of Sustainable Business" and "Environment and Technology" the new Bachelor course "Sustainable Business and Technology" (B. Eng.) is highly interesting for international students and university cooperations.

In six semesters, students will study business and engineering through innovative learning concepts. Focussing on sustainability, green technologies, and a globally interrelated perspective future graduates will be provided with excellent key qualifications and enabled to master the challenges of our time. Real-life business projects as well as training in organisation, methods and communication skills complete our students' academic and personal profile. As a special benefit, German language and intercultural communication modules will pave the way for a

Bachelor Courses - German Langugage	Master Courses - German Language
Environmental Economics and Business Administration (B.A.)	Environmental Economics and Business Management (M.A.) - Combined with Dual Degree Programs -
	Sustainable Change (M.A.)
Economic and Environmental Law (LL.B.)	Business and Energy Law (M.A.)
	Insolvency and Reorganisation Law (M.A.)
Renewable Energies (B.Sc.)	Environmentally Oriented Energy Technology (M.Sc.)
Industrial Engineering/Environmental Planning (B.Sc.)	Bioprocess and Process Engineering (M.Sc.)
Bioprocess, Environmental and Process Engineering (B.Eng.)	Digital Product Development - Mechanical Engineering (M.Eng.)
Biological and Pharmaceutical Engineering (B.Sc.)	Applied Computer Science (M.Sc.)
Mechanical Engineering - Product Development (B.Eng.)	Business Administration and Engineering (M.Sc.)
Engineering Physics (B.Eng.)	Media Informatics (M.Sc.)
Applied Computer Sciences (B.Sc.)	
Media Informatics (B.Sc.)	
Dual Bachelor Courses - German Langugage	
Sustainable Resource Management (B.A.) - Dual Study Course – Production Technology (B.Eng.) - Dual Study Course – Biological and Pharmaceutical Engineering (B.Sc.) - Dual Study Course – Environmental Informatics and Business Information Systems (B.Sc.) - Dual Study Course –	
Bachelor Courses - English Langugage	**Master Courses - English Language**
Sustainable Business and Technology (B.Eng.)	International Material Flow Management (M.Sc.)
Study Semester:	International Material Flow Management (M.Eng.) - Dual Master Degree Programs with Japan, Turkey, Brazil and Morocco -
Principles of Sustainable Business	
Environment and Technology	

Fig. 3 Study courses in Birkenfeld (*Source* ECB)

possible professional life in Germany or German enterprises abroad. Figure 4 summarizes the key elements of this Bachelor course which will start in 2017 (www.umwelt-campus.de/sbt).

At the master's level, ECB has been offering the English study IMAT courses for more than 10 years. The IMAT—Master in International Material Flow Management—trains young and motivated students from all over the world in International Material Flow Management based on the experiences that the lecturers gained through the project work with companies and city authorities all over the world. This project work helped to establish sound and sustainable waste management systems, water management systems, and renewable energy systems.

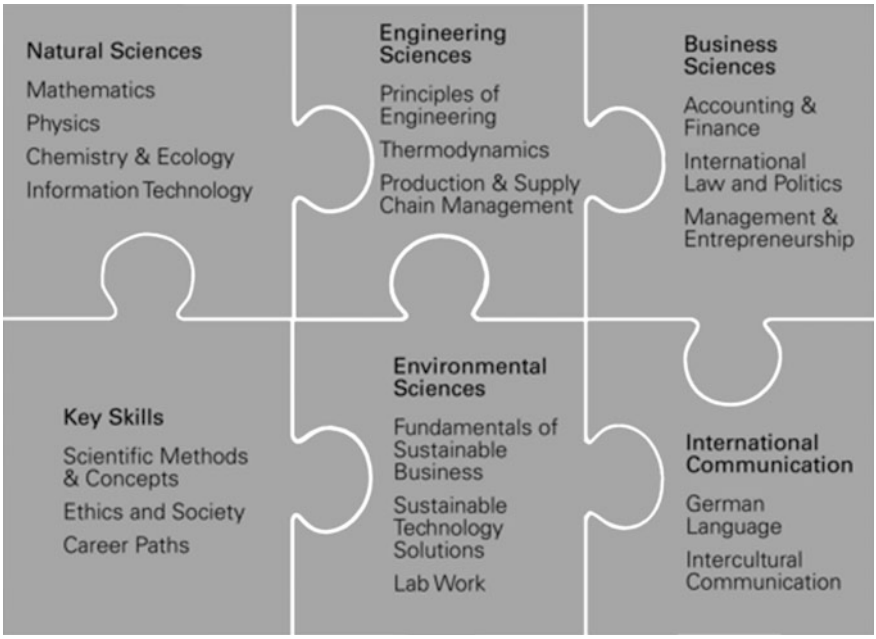

Fig. 4 Key elements of "Sustainable Business and Technology (B.Eng.)" (*Source* ECB)

The faculty consists of various specialists from different research areas with international experience. Whether they are specialists in mechanical engineering, microeconomics, communication, and ethics or specialists in IT systems, renewable energies, and environmental policy, our faculty members all share the key idea of managing a better, more sustainable world. This vision becomes reality through innovative environmental technologies, professional business plans, and efficient systemic management strategies. Hence, IMAT is not just focussing on the theoretical background of material flow management. With the support of their lecturers, students will develop a large number of real projects. Therefore, they will gain the practical experience they need in order to successfully start their international career in the field of green business. The surrounding elements of the program are just as unique as the contents and approach of the IMAT programs.

The IMAT Master of Engineering programs are operated as dual degree programs jointly with young and leading university partners from Japan, Taiwan, Turkey, Morocco, Mexico, and Brazil attracting students from neighbouring countries, focussing on developing or transition countries. Furthermore, these partner universities serve as "regional hubs" for research and Zero-Emission project development. After spending two semesters at the partner university the students move to the ECB where they discover innovative technologies hands-on and in real-life operation. In the future, the numerous IMAT dual degree programs will be transformed into a "Global IMAT University Network" offering an internationally

accredited joint IMAT degree with various partner universities around the globe. In parallel, an International Material Flow Management Research Center will be established to foster the university–industry relationship. IMFM-RC aims at applied research and offers students a head-start in their future career by offering access to a global partner network (www.imat-master.com). The IMAT networking university project is supported by the German Academic Exchange Service (DAAD) and the Federal Ministry of Education and Research (BMBF).

5 Research for Sustainability—Institutes and Concepts at the ECB

Research is a very important part of sustainable development. In Rhineland-Palatinate's Law on Universities, it is codified that applied research is an integral part of the tasks of universities of applied sciences. The requirements of research for sustainable development do not result from technological development anymore, but from global social and institutional innovations (system innovations). In addition, perspectives of economic, social and cultural sciences need to be integrated in order to make transformation knowledge possible (variety of perspectives). Target knowledge and transformation knowledge combined enable transdisciplinarity which connects possible and desirable development and the knowledge to design specific processes of change. Thus, through participation, society, economy and politics become trans-disciplinary stakeholders of the science for sustainability.

Even in the guidelines for applied research at the ECB, there is a strong link between the thematic issue of material flow management and Sustainable Development. Right from the beginning importance has been attached to the interlinking of research and teaching which is achieved by students' participation in research projects. The annually received external funds serve as an indicator for the success of the applied research. The total amount of these external funds focusing on sustainability yet clearly exceed the 5 million mark. The funds result from industrial projects and public research projects. They are analysed, planned and implemented in existing institutes with numerous project team members. The following are leading research institutes at the ECB:

- Institute for Applied Material Flow Management (IfaS)
- Institute for Software Systems (ISS)
- Center for Land Research (CLR)
- Institute for Micro Process Engineering and Particle Technology (ImiP)
- Institute für Business and Technology Management (IBT)
- Institute for Renewable Energy Law, Energy Efficiency Law and Climate Protection Law (IREK)

The Institute for Applied Material Flow Management (IfaS) is the biggest research institute of the Trier University of Applied Sciences located at the ECB. IfaS was founded in 2001, thanks to the initiative of a few committed professors from the disciplines of Material Flow Management, Ecology, Business Management, Physics/Process Engineering and Communication/Ethics. The aim of IfaS is to promote the sustainable optimisation of regional and operational material flows in specific and practice-oriented projects worldwide. Nowadays, the interdisciplinary team includes nine professors, 55 professional staff members, and various interns and student assistants from the following areas:

- Business Administration
- Environmental Sciences
- Systems and Supply Engineering
- Electrical Engineering
- Civil Engineering
- Energy Technology
- Industrial Engineering
- Mechanical Engineering
- Process Engineering
- Spatial and Environmental Planning
- Agricultural Engineering
- Biology/Ecology
- Environmental Law.

The core working areas of IfaS are international material flow management, strategic material flow management, and research on zero emission approaches, energy efficiency and renewable energies, sustainable mobility options, biomass use and cultural landscape management and public relation.

IfaS strives to integrate and strengthen sustainable structures on a communal and regional level by analysing and optimising material and energy flows. The institute applies innovative, interdisciplinary and holistic approaches to address environmental challenges and offers long term system optimisation and elaborates sustainable energy and regional development concepts. The key elements of their work are a comprehensive analysis of existing material and energy flows, generation of knowledge and provision of holistic regional material and energy management solutions. The concept of "Material Flow Management" was defined by an Enquete Commission of the German Parliament as follow-up action of the Rio Conference in 1992. "Management of material flows is the goal-oriented, responsible, holistic and effective influence of material systems, whereby the targets come from the environmental and economic areas, in consideration of social aspects. The objectives are developed on an operational level, in the chain of the participants involved in a material flow or on the national level" (Enquete Kommission 1994).

The IfaS uses the approach of material flow management (MFM) to optimise regions and companies in more than 30 countries all over the world (Heck 2002). For companies, industrial MFM leads to cost savings, more sustainable products

and production, reduction of risks and helps to development cooperation with partners along the supply chain (vertical cooperation), within the same industry (horizontal cooperation) and with neighbours (diagonal cooperation or eco-industrial parcs). Industrial MFM is related to the cleaner production approach (Helling 2015). Furthermore, IfaS uses MFM in a regional context to optimise material and energy flows within the region, to use regional potentials and to generate regional added value (Helling/Heck 2016). The Zero Emission Village (ZEV) Weilerbach was the first implementation of a regional material flow management concept (Helling 2012). The ZEV project began with an as-is-analysis in 2001 which looked for the regional potentials and defined the target "Zero Emission". IfaS has developed dozens of projects for a carbon neutral development of Weilerbach together with local stakeholders and investors. Since then, more than 200 million Euros have been invested in reaching the goal "Zero Emissions".

IfaS has developed and established an educational concept to integrate students in applied research for MFM (IfaS 2016). The Travelling University (TU) is a study module at the ECB in which students from different backgrounds can participate. This transdisciplinary seminar is organised in form of a project and develops solutions for practical problems. The TU started in 1999, and since then this seminar has become a regular part of an interdisciplinary curriculum at the ECB. Owing to its reference and cross-linking to other projects held at the ECB with similar sustainable aims, the TU project was among others a part of the University of Applied Sciences' contribution to the EXPO-2000. Moreover, this program was integrated into the IfaS activities in Sweden, China, Poland, Turkey, Brazil, Canada, Serbia, Cap Verde, Mexico, Sri Lanka and Morocco. Together with partners from municipalities, ministries, companies and many other actors learn how to plan and to implement sustainable solutions for real world problems. The students have to collect data, discuss with stakeholders, develop technical solutions to solve the problems and last but not least they develop a business plan that should underline the feasibility of their idea. The Travelling University represents the best practice of project-based learning and gives students the opportunity to put their acquired knowledge into practice in real time. The following example describes the concept of TU.

In 2014, TU undertook a project in Sri Lanka. The main objective of this TU was to convert one of IfaS' partner universities—the UvaWellassa University of Sri Lanka (UWU)—to a "Zero Emission Campus", which is to be modelled after the Environmental Campus Birkenfeld. Eleven Students from different study programs with different nationalities made a ten days trip from Birkenfeld to Sri Lanka. The weeklong activities there included a number of meetings with the university and public officials including the Mayor of Badulla city, fact-finding missions to the neighbouring communities and private sector stakeholders, field visits, public relations activities, etc. Besides the preliminary task and the key objective of TU '14, it was also aimed to conceptualise a Regional Material Flow Management (RMFM) plan for Badulla Municipal territory of which UWU is a key stakeholder. The RMFM aimed to provide the framework for the utilisation of regional material flows (such as municipal solid waste, agricultural residue, regional biomass, etc.) by

creating synergy between local public and private organisation with UWU. The results of the TU were presented in a public event by the students, where the preliminary findings including the technical and financial feasibility of the project were shown. This occasion was graced by a large number of dignitaries including the Mayor of Badulla city and the Vice Chancellor of UWU and other representatives of the region and the university. The project was recognised as the first of its kind not only in Sri Lanka but also in South Asia (Dasanayake 2014).

6 Conclusion and Outlook

The Environmental Campus Birkenfeld has established sustainability in the operation of the university and also in education and research. In Germany, the ECB has become a partner in the university initiative "HOCHn". This initiative should help to integrate sustainability in more and more universities in Germany. Furthermore, the German Sustainability Code will be further developed for the needs of universities and applied in the participating universities to improve their sustainability reports. The Sustainability Code for Higher Education Institutions seeks to strengthen these institutions in their role as agents of change and bearers of social responsibility (www.deutscher-nachhaltigkeitskodex.de/en).

As a zero emission campus, the ECB is one of the greenest campuses worldwide. An important task for the future is to transfer the Zero-Emission Campus concept to universities all over the world. To fulfil this goal, IfaS has established a university network to implement sustainable education in international material flow management in a global IMAT Master's program. The ECB is also establishing study courses offered in English to educate students from abroad.

IfaS applied research aims to implement MFM solutions in projects in more and more countries and collaborates with different research partners. An example of this great partnership was a side event at the climate conference COP 2016 in Morocco on Zero Emission Universities.

In conclusion, universities play a vital role in implementing the new Sustainable Development Goals and they should improve their activities in all areas (operations, education and research). The graduates of today are the leaders of the future and they must be enabled and motivated to change our world towards the goals of Sustainable Development.

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Author Biography

Professor Klaus Helling born in 1964, graduated in Business Administration in Göttingen (1989) and got his Ph.D. at the University of Osnabrück (1994). Together with a German chamber of trade, he developed an information network for environmental consultants. After that, he joined an international consulting company located in Saarbrücken as leader of the department for Environmental and Quality Management. Since 1998 Klaus Helling has been working as a professor for Environmental Management and Business Administration. Since 2001, he has been Dean of the Faculty of Environment, Business and Law at the Environmental Campus of Birkenfeld (ECB). The ECB is a campus of the University of Applied Sciences Trier. In 2001 he was one of the founders of the Institute of Material Flow Management (IfaS). For more than 20 years he has been working on the cutting edge of economical and ecological development of private and public institutions.

Indigenous and Sustainable Environmental Virtues in St. John Paul II Village in Infanta, Quezon (Philippines)

Rowel T. San Sebastian

Abstract

To illustrate the practical application of the concept of sustainable development in the context of ecological crisis, this paper used a phenomenological method that is centered on the understanding of prevailing philosophies, orientations, and experiences existing in the locus of study—St. John Paul II Village in Infanta, Quezon. The St. John Paul II Village mainly houses the poor victims of the 2004 flash flood. These victims consist of families whose heads are mostly subsistence farmers and fishermen. Almost 1000 people died and at least 450 others went missing as huge logs and other forest debris rapidly flowed down from the Sierra Madre mountain range and bulldozed entire communities. Moved by the people's depressing condition, the local church of the Prelature of Infanta sought help from individuals and organizations to build St. John Paul II Village and help people regain their livelihoods. The people live with a common aspiration: to live in a harmonious community far away from environmental tragedies and problems. The researcher listened and reflected thematically on the indigenous environmental virtues that emerged and were articulated out of the lived experiences of his co-researchers. The researcher's eidetic insight recognized his co-researchers' practice of indigenous environmental virtues as a way to holistic spirituality which finds its expression towards sustainable development, and hence, contributes to the implementation of the SDGs.

Keywords

Virtue · Virtue ethics · Environmental virtues · Phenomenological method

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1 Introduction

My paper aims to see the environmental virtues that have been lived and practiced by the significant leaders of the St. John Paul Village in Infanta, Quezon. Further, this also aims to look for meanings and leading to powerful insights within the context of sustainable development. St. John Paul II Village is a resettlement site located in the uplands of Bgy. Agos-agos, Infanta Quezon where beneficiary families were flash flood victims from Infanta, Real, and Gen. Nakar that consist mainly of subsistence farmers and fishermen. The poor families of this village were greatly affected when the big rivers overflowed after several days of heavy downpour brought about by the typhoon that culminated in the evening of November 29, 2004.

The village, which was named after St. John Paul II has been fully constructed, 2 years after the area has been hit by the typhoon. The initiatives of the Social Action Center of the Prelature of Infanta with the help of the National Social Action–Justice and Peace office (NASSA-JP) of the Catholic Bishops' Conference of the Philippine made it possible for its full completion of 200 duplexes in 2006. The constant monitoring and supervision of the Social Action Center of Prelature of Infanta contributed to what they are called now a model community within the area.

Today, this small village has been in existence for almost a decade. Its residents have been living with the common aspiration, to live in harmony as a community and the rest of creation in their environment that is far from the threat of any tragedy. Their common struggles and real witnessing on how to live in an ecologically sustainable manner would be my data for possible integration and articulation of the sustainable development.

2 Review of the Related Literature

In pursuing my study, I explored the following related literature which are significant and very helpful in guiding me in the development of my paper. I utilized the genius of our Philippine culture in order to draw out some indigenous environmental virtues in our context. I believed that virtues are expressed in different ways in different cultures. For instance, expression of justice in the United States is affected by the American esteem of personal autonomy and its respect of personal rights. Their health care system, for example, really protects the rights of the individual in soliciting the informed consent of the patient before any health processes take place. This understanding of justice differentiates itself from justice in our country where the emphasis relied on "smooth interpersonal relationships" (Keenan 2005).

Ethically speaking, each culture has its own virtues (Statman 1997). Philippine culture, for example, has its own dominant virtues manifesting in our specific cultural values and traits, such as hospitality, religiosity, family ties, patience, joy, and being highly relational. These Filipino virtues became the basic ground for possible articulations of environmental virtues that are unique and meaningful for the Philippine context which is responsive to the ecological crisis.

This study cited prominent anthropological virtues that I believed coming from the prism of the Filipino culture and they are related to my study which is focused more on environmental concerns.

2.1 Virtue of *Pakikipag-Kapwa*

It is a natural tendency of the Filipinos to blend and harmonize with people. In common celebrations, Filipinos like to include even the outsiders (who are not family members) in our joyful feelings and *salu salo* (table fellowship). Filipinos love human interaction and company. This acceptance of others is manifested in the sense of *pakikipag-kapwa* (sense of community). The relationship here can involve the *ibang tao* (outsiders) or *hindi ibang tao* (family) category. It is interesting to emphasize that *kapwa*, as Virgilio (1994) described, is the concept which embraces both categories, namely the *ibang tao* and the *hindi ibang tao.* Hence, the presence of everybody is recognized here. The *kapwa tao* is treated as equal regardless of status quo, race nationality, belief, and sex (Table 1).

Table 1 Profile of my co-researchers

Names	Age	Years of residency	Position
Aladino A. Reguyal	56	9	Administrator, St John Paul II village Leader, Social Action Center of The Prelature of Infanta/SJPII Village
Marife Ritual	40	8	President of Homeowners' Association of St. John Paul II Village Member, Board of Directors
Romeo S. Ritual	45	8	Head of the Family Expert on indigenous way of farming and fishing
Joel O. Abrao	34	9	Professional Catechist Leader, Social Action Center BEC Organizer, *Munting Sambayanan Kristiyano*
Elsie T. Delfin	45	7	Block leader, *Munting Sambayanang Kristyano* Mother Butler of the Church Leader, Organic Farming in Greenhouse
Angelique T. Detera	20	8	Secretary, Board of Directors Organizer, youth association Vendor, SAKADAHAN (cooperative store) Elected Barangay Councilor

2.2 Virtue of *Sapat*

The virtue of *sapat* comes into picture wherein Filipinos associate it with equality. *Sapat* mentality recognizes that God made the world and the material creation to serve the needs of all God's people and not only a few.

With an economic focus, some scholars, like Walden Bello and Sean McDonagh (1996), see economic globalization as another form of colonization in a sophisticated manner. They pointed out that this system of globalization is primarily based on the takeover of the land, its agricultural, metallic, and mineral wealth that is normally done through the exploitation of the labor of the indigenous and poor people. It is being done for the benefit of the few, with its high consumption of energy and waste.

Beroya and de Mesa (1995) have chosen the indigenous term of *sapat* to stress a life of sufficiency in the midst unlimited growth and accumulation of the earth's good of the modern trend. Actually, *sapat* is the Filipino term for "enough" or "sufficient." They explored *sapat* principles as follows: "(1) Enough of the destruction of the environment, (2) Take from nature only that which is enough, (3) Eat and buy only what is enough and needed, (4) Each person must have enough to sustain a healthful and dignified life (Beroya and de Mesa 1995)." It is very clear that what they are advocating here is the value of *sapat* because Filipinos are all dependent on one another to care for and preserve the goods of this world. The only way to preserve our resources is to practice the spirit of *sapat* for the good of all.

2.3 Virtue of *Kagandahang-Loob*

The spirit of *kagandang- loob* is visible in the cultural horizons of the Filipinos. A person who has *magandang- kalooban* (De Mesa 2003) is being attested to the way she/he relates well with *kapw*a both to humans and nonhuman creatures. A person who has this *kagandahang- loob* aims to promote the well-being of *kapwa.*

To know more about the language and philosophy of *loob*, I looked on Filipino concept of *loob* of Albert Alejo (1990). He describes *loob* metaphorically as the core (*buod*) and the world (*daigdig*) of endless relationships. It is not just a core part of the person, but a "world" of relationships towards others, the society and God as well. It is a reality when we relate well with others. It is a movement from within to outside. A person's loob is best manifested in the way he/she relates with others (*kapwa tao man o kalikasan*) Hence, the concept of *kagandahang-loob* is always situated in the context of a relationship. I used also some literature that have something to do with the study of virtues in the Philippine context. For instance, the books of Fr. James F. Keenan namely "Proposing Cardinal Virtues" (Curran and McCormick 1999), "Engaging Virtue Ethics in the Philippines" (Keenan 2001).

I used the works of Dr. Mina Ramirez on some underpinning virtues on her writings such "The Dominant and Popular Cultural Systems in the Philippines",

"The Filipino Culture of Insecurity", and "Social Individualism, Sustainability and Globalization (Ramirez 2012)."

Despite the different forms and strands of virtues in the Philippines context as described by my related literature, I found out that there was no study done on specific ecological orientation based on the lived experiences of a particular community. My research unveiled insights into the environmental virtues that are lived and practiced by some leaders of the St. John Paul Village in Infanta, Quezon.

3 Method

My study intended to present reflectively my co-researchers' lived experiences that would serve as my context to see their local expressions of desirable virtues that have been continuously articulated since the 2004 tragedy there.

3.1 Research Design

Phenomenological method.

3.2 Participants, Sampling, and Setting

My co-researchers who are community leaders of St. John Paul Village in Infanta, Quezon were selected based on the following criteria:

1. They are permanent residents of St. John Paul II Village
2. Their residency in the village ranges from 5 to 11 years considered as sufficient enough to establish long-term familiarity in the place.
3. They are the present leaders of the village and have been leading the community for at least 3 years.
4. They are open, available, and willing to share their lived experiences.

3.3 Data Collection

In collecting lived experiences, I used the following:

1. Guide questions to gather the lived experiences of my co-researchers that met the criteria of the study.
2. In pursuing dialogue with my co-researchers in a non-structured way, open-ended questions were asked using my formulated guide questions.

3. Another important source of qualitative data is 'Memoing'(Miles and Huberrman 1984) It is where I was able to do field notes and recorded what I heard, saw, experienced and thought about in the course of collecting and reflecting on my co-researchers' lived experiences.
4. I also used video and voice recorder, camera, and DVD disks to document the interview and story-telling sessions.
5. Lastly, I transcribed the stories I was able to gather and prepare them for thematic reflection.

Then the key ideas and statements were determined and identified by sorting and putting them together. This will be the basis for an overall description of meanings and insights relevant to the articulation of a new environmental ethics.

3.4 Data Analysis

I used the following processes in doing my reflective analysis and interpretation of our lived experiences.

1. Gathered narratives or lived experiences from my co-researchers.
2. Identified/highlighted significant statements, sentences, quotes from the stories.
3. Formulated themes arising from these statements.
4. Clustered the aforesaid themes generated in the narrative accounts of my co-researchers by putting together those themes with similar meanings. Next is to integrate or see the interrelationships of those themes that lead to the eidetic insight.

4 Results

The data presented in this section are the results of the interviews conducted with my co-researchers. This section also consists of my thematic reflections which I drew out from their shared experiences regarding their practice of environmental virtues. On the basis of this phenomenological study, sustainable development can be conceptualized and contextualized as consisting of the following themes and environmental virtues.

4.1 To Live a Simple Lifestyle: Virtue of *Sapat* (Temperance)

My co-researchers are advocating this virtue *sapat* whose main concern is the economy of efficient use of God's creation. They are trying to see to it that each

person in SJPII village must have enough to sustain a healthful and dignified life (Beroya and de Mesa 1995). Kuya Allan (Reguyal 2014) reiterated that.

> Actually, I have my sibling outside the country who offered me an opportunity there. But I said, what for? We are only three in the family, and it is impractical and nonsense to leave them. We don't have material things but what is important is my family. We ate three to five times a day. We can't bring material things when we die. What is important is when we rest at night we are at peace because my family is complete and we're all together.

This statement claims that if the choice had to be made, wealth is less desirable than certain other qualities of life which lead us to contentment—family, love, and domestic peace. To live a simple lifestyle is also manifested in the character of Kuya Mio (Ritual 2014b) who shared his experiences in fishing and farming:

> I see to it that I do not abuse environment where I get my livelihood activities. For instance, I do not use cyanide and dynamite fishing though many of us are using it. Yes, they can profit a lot in an easiest way, but I think there is a long term effect to all of us, because there will be no longer fish in the same area where we go our day to day fishing. We will go further and further far away just to look for another area where we can do our fishing activities. So it is unfair to the majority of us who do not use illegal fishing. Only few will benefit from such wrong actions but many will be affected most especially in the future wherein the young generation will be deprived of a good opportunity to enjoy what we are enjoying now. I think, what we need is to be just and fair so as everybody would have the good opportunity to enjoy the goods on the body of water both in the river down to the ocean.

> The same treatment must be given to the land wherein due respect and care must practice in using her. As human beings, she also got tired. We need to give her ample time to rest. Based on my experience, if I observed that my crops are not too good and have few fruits then I presumed that she is already exhausted that is why I do not abuse her by insisting her to bear more fruits through the use of fertilizers and other chemicals. I will no longer till her soil for a while and allow her to take a rest until she becomes fertile again. Thus, the virtue of temperance must be practiced here wherein I need to wait on her good condition and not to be greed in profit. While waiting, I go to fishing in order to meet our day to day needs.

Sapat is tantamount to the virtue of temperance which is described as "the patiently acquired mastery of the body" (Pinckaers 1996). The purpose and goal of temperance are "man's inner order, from which alone this 'serenity of spirit' can flow forth. 'Temperance' signifies the realizing of this order within oneself (Pieper 1966)."

Temperance can be practiced as a good disposition through vigilance, self-control, and moderation. The practice of temperance as vigilance, self-control, and moderation is so relevant in today's environmental destruction due to excessive use of chemicals for greater profit and consumption. Ate Elsie (Delfin 2014) articulated the same sentiments when she mentioned,

> I'm courageous enough to face the challenges with my daughter. I used my husband's money wisely to ensure my daughter's future. I started a small business like animal husbandry and joining micro finance program. Here, we can loan as much as 10,000 pesos to start a simple business. I used the money properly and save as much as we do to buy necessary things to live. We don't usually ask for more, just to have enough is quite okay, like to ensure food on the table every meal.

…. If ever a politician approached me and offered money in a condition that I'll transfer to other location. I'll stay here forever. I will still opt to stay here because it's hard to transfer. It's difficult to adjust, to meet new faces, new environment, and new community. I will never ever leave this place in exchange for everything. Life is different here. When we were in Manila, we experienced a polluted area. Here in the province, we have fresh air, nice environment. I enjoy living and mingling with the community of the poor. We have a simple lifestyle but rich in kindness and happiness. We are rich, figuratively speaking, because of the stability in dealing with others. We are happy because people here are helping one another. I am proud of the community here.

4.2 Serving the Needs of All God's People Not Just for a Few: Virtue of *Atag* (Community Service)

Kuya Allan (Reguyal 2014) promoted this virtue of *atag* by serving the people in the St John Paul II village with sincerity and care. As a Social Action Center leader, he fights for the common good of the people and it is implied in his statement that,

Illegal logging and the so-called carabao logging became rampant here and then due to *tongpats* (red tape or money given to the public officials) intended to some official in DENR or other public officers. It is because of greed and self-interest of some of them that they did not bother the bad consequences of what they were doing. For me, what is essential is to see the greater impact of what we are doing. This is what I always asked myself if I am going to enforce a policy, is it beneficial to all or to a few people only. I always see to it that I need to prioritize the majority that would be affected by such policy. I always consider the interest of the majority although there will be few people that will be sacrificed and suffered for the sake of all.

With the cooperation of the people, they are able to enjoy and to settle little by little their way of life in the village. This is observable on what Kuya Allan (Reguyal 2014) mentioned,

One of the fruitful consequences of our hard works is many of our people living here are happy and hopeful than we first time we came here wherein many of them are worried. They were thinking where they were going, they did not sure if they would stay here or not, they did not know where to get their livelihood, they did not affirm to themselves if they would come back to their previous places where the tragedy took place. However, they are now so sure to themselves that they are already settling down in the land of Agos Agos (the barangay name where the village is located). They are already rooted here little by little, they already have their jobs, they are able to send their children to schools, they have settled themselves that their lives would start all over again here in the village. Secondly, we already have water and electric supplies, cable tv, school up to grade four, while grade 5 will be coming this school year 2014–2015. With the initiatives of the people inside the village, we are able to lobby to our government officials particularly to Department of Education (DEPED) to give us such opportunities. Of course with the help of Barangay and Municipal officers we were able to get those amenities and privileges. We have the celebration of the Eucharist here every Sunday. All of these are because of the initiatives of the people here. This is our strength because we are organized and there are corresponding leaders in every aspect of life within the community.

In terms of peace and order policy in the village, they imposed proper discipline. Everybody is welcomed to coordinate with the Social Action Center officers. They talk about this through proper channeling and processing, though the proper decisions are made by the Social Action Center officers. As regards to the community service of the people, Kuya Allan (Reguyal 2014) mentioned that,

> We have "*ATAG*" (mass work) here. To implement when and where he said *atag* be done, we conduct various meetings. The community agreement is proceeding first by blocks, then to our general assembly. They have *atag* every first Saturday of the month. Then the general *atag* is every second Sunday of the month. Our a*tag* has many faces, it could be done through spiritual, economic, and social concerns. In spiritual the aspect, we have bible study service. We have mass every Sunday. In social aspect, those people who have misunderstandings we try to reconcile them through dialogues. In economic aspect, we talk about different possible livelihood activities. We have the green house project wherein we plant organic vegetables and fruits.

This is a voluntary service but based on my observation, everybody is willing to participate because the leaders themselves are the ones who set good examples to the people. The first initiative is often coming from the leaders themselves like what Kuya Joel (Abrao 2014) was doing when he said, "As a leader, I should show leadership by example although I have my weaknesses. If you are the living example, people will follow. Don't just make rules, you have to show them that you are the one doing it first… We are also planting trees near the river where we get our water every second Saturday of the month as part of our *atag* (mass work). That is our contribution in protecting the nature. We benefited from here and we just gave something in return to preserve her." The same practice is being done by Ate Mafie (Ritual 2014a) when she said,

> The *ATAG* is done on the second Sunday so that they are used to collect waste. The *Munting Sambayanang Kristyano* (MSK- Basic Ecclesial Community) leaders check it and they put a name on it, if it is not properly segregated, corresponding punishment is enforced. We talk and discuss it in a meeting to identify what block it is and the persons involved. This is how we care for our environment with our little ways and means.

Aside from their practice of *atag* in the spirit of *bayanihan* (community service), it is also used as a positive reinforcement for a particular minor violation in the village. If somebody violated the existing policy, Kuya Joel (Abrao 2014) reiterated that,

> Here in our village, if you violated rules, it's a case to case basis. You will be given an automatic termination if you committed the following grave violations; selling illegal drugs, adultery, and other heinous criminal cases. In other minor offenses like curfew, in the first offense, you will render three hours *atag* (community service), second offense is equivalent to 6 h *atag*, third offense is equivalent to 9 h *atag*, and the fourth offense is subject to termination. Our laws are democratic in nature and fair enough for the common good. We completed it for almost 1 ½ years with the guidance of kuya Allan, Ate Myan and other SAC officers. We give copies and circulate the enacted laws to all homeowners. Then we have general assembly wherein people can give comments and suggestions. Thus, they can

> tell us that they don't know the laws here because they are involved in every law that we are implementing here. There is a democratic process wherein we made the laws known to all and promulgated it before them. And we are open to change them if there is a valid reason to do so. So when they violated they know the corresponding consequences of their actions. The worst scenario that I ever encountered so far was about a man cohabitating with his married female neighbor. We have four such cases here. They have nothing to do with it because they violated it, so they have to leave the village.

Everybody knows the policy of the village because it is properly disseminated to the people through democratic processes. It is meant for all and not for a selected few only. Everybody is involved from the very beginning of its enactment to its implementation. He (Abrao 2014) also mentions that

> In terms of implementing our laws, we practice due process. It is done through proper channeling from the Peace and Order Committee (POC) to Grievance Committee, to Board of Directors (BOT) and finally to Social Action Center (SAC). But if it is a criminal case, we turn it over to the *Baranggay*. If it about illegal drugs, we let the Baranggay Drug Abuse Council or PIDEA and policemen handled it. So cases like this made our work easy. Not only one person will solve the problem but the people or community themselves are involved in resolving it.

The idea of *atag* is also explicitly expressed by Ate Elsie (Delfin 2014) who shared that they use it as a punishment to the delinquent children in the village. She said,

> Sometimes, children are so naughty. They get others' property. We resolve it by talking seriously with the parents, the leaders are giving them a warning and if needed corresponding punishment is imposed. Our punishment is called "*ATAG*" (community service through manual work). If they are minors, the parents do the *atag*, but if they are able to do it, parents usually order them to do the *atag* so that they experience the suffering and also to know their wrongdoings. The process of this is well and good. It is one of the formations we do. It leads the youth to a right path. We teach them lessons.

Atag is also a good vehicle for the community to promote camaraderie and acquaintance among them. It is through *atag* that they gather at least once a week in order to render community service without strings attached. The community is active because they know that they are doing it for the common good and for the proper maintenance of the SJPII village. Kuya Allan (Reguyal 2014) always advised them "to love their own place, respect the people and their formations and their prelature's vision." With the spirit of *atag*, little by little they are able to build their community as a model community within the area. Kuya Allan (Reguyal 2014) once said,

> With encouragement and cooperation, the villagers can do small things based on our ways and means. Imagine, we are composed of 378 households, and if everybody would give one peso every day, then we can do a lot of things. For instance, we could repair of our canals, and we could cement of some pathways and etc. The villagers are more festive and merry than outsiders if ever there is an occasion here. For the reason that, youths are so organized and active in doing their tasks and responsibilities. They are the ones who handle the different socio-civic activities here.

4.3 The Sense of Connectedness with Other Creatures: The Virtue of *Gapo* (Ritual During Planting Period)

The relational and holistic approach of looking at reality is very evident from the life of some of my co-researchers. Ate Mafie (Ritual 2014a) reiterated that they have to perform a lot of rituals and ceremonies because they believed in the active participation of supernatural beings in their everyday affairs. This only shows that there are a great number of lesser gods and spirits inhabiting different places such as mountains, valleys, rivers, seas, and etc. These places are their own special domain so that passing through would usually utter "*makikiraan po*" (excuse me) as a sign of permission and respect. Ate Mafie together with her family believes that these spirits could be good or bad. So in order to please these spirits, they have to perform the *gapo*, and other rituals. They should offer gifts to the spirits to make them generous so as nature yields bountifully.

This belief of Ate Mafie (Ritual 2014a) reveals an animistic mentality. She believes in the environmental spirits that need to be appeased for a bountiful harvest and good catch of fish in the river or sea, or even doing it to deflect from any illness and misfortune. The *gapo* rites can be an expression of courting the favor the various spirits in the farm or sea and appease them for everyone's well-being. This belief shows that humans need to relate properly to other supernatural beings around them in order to have harmony with them. Perhaps this is the main reason why ordinary Filipinos do not abuse the natural environment as if they are objects for human's satisfaction and enjoyment. They treat the natural environment as part and parcel of the larger community wherein everyone ought to be respected and protected in order to have harmonious relations.

This relational and non-anthropocentric mentality is reinforced by her husband, *Kuya* Mio (Ritual 2014b), who treats his farm as we are human beings to be loved and to be caressed:

> I usually talk to them and listen attentively whether they have problems to be attended to. I am so sensitive to their growing period until they can stand on their own. My parental guidance is always there most especially during their crisis, difficulties, and troubles. The same with my plants, I am a full-time parent to them who is always available and responsive to their needs

Moreover, his practice of *gapo* during planting seasons is also a clear manifestation of this relational and holistic approach of looking at the reality. He (Ritual 2014b) maintained that.

> Aside from treating them as we are, I do practice the *gapo* rites during planting season. It is a ritual wherein I say a prayer while planting. You can utter any kind of prayer, in my case, I do spontaneous prayer because I do not know and memorize the formula prayer of the Catholic. I just whisper a simple prayer like this, "Please Lord, bless my plants and make them more fruitful…I do believe in your greatness and mercy, I am humbly asking for your blessings and guidance, please take care my plants from any harm and nurture them with

> your love, send more rain to make them more alive and greener. Let them grow and bear more fruits so as I can share with others your generous blessings. Give me strength and health as so I can perform well and handle them with care and love…and so forth and so on. I say a prayer in accordance with my capabilities, there are no exact and formula prayers. I do pray with my heart and soul…I just allow the Holy Spirit to guide me in my spontaneous prayers.
>
> While praying, I eat sweet candy or sugar if there is no candy available to make my water melon become sweeter too. It depends on what kind of crops you are going to plant, for example, if I plant squash, I am going to eat bubble gum to make it more sticker. If I plant water melon, I normally eat sweet candy preferably color red like "lips" to make it more color red and sweet. If I plant peanut, I see to it that my stomach is full, I eat a lot because the elders told us that my peanut would become bigger with full of peanut inside its cover. If I plant camote tops I need to be nude and then cover my erected penis and testicle with soil while digging soil to bury the first three stems of the camote tops. Of course, I do this during the night wherein nobody can see me. I do this kind of *gapo* to harvest big fruits as big as my big genital. I am also sensitive to the cycle of our nature, for instance, I prefer planting with my *gapo* during high tide to make my crops bigger and heavier in weight. I also plant crops depending what months they are suited. If the rainy season like June to October, I plant rice and other green crops that are water dependent. It is because we do not have water irrigation here, so we depend only on the rains during such seasons. If summer, I plant water melon, camote, corn and other crops that could survive without much water.

The same practice is also being shared with me by Ate Elsie (Delfin 2014) who said,

> I practice also some rituals in planting. I do *gapo* too. I pray that God gives us more harvests. I must have sweet candies while praying and planting. Any candies, like red nips, so that my fruit tastes sweet too. It must be red so the watermelon would bear red fruit. It is proven many times. I pray the I believe, I also ask the intercession of San Isidro, and San Marcos. But I always mention the name of San Roque to grant us grace and bountiful harvest. We normally put *gapo*, even in camote, we put *gapo* to taste it sweet with matching sticky rice. I also need to have teeth - gritting thrill while planting to ask for a sticky squash. After the planting, breath again and everything becomes normal. This is what we call *gapo*. This is a term from our elders.

Their practice of *gapo* per se is a valuable ritual in the context of Filipino interpersonal relationships. It is because Filipinos give high regard to interpersonal relationships. Filipinos love human interaction and company. This acceptance of others is manifested in the sense of *pakikipag-kapwa*. The relationship here can involve the *ibang tao* (outsiders) or *hindi ibang tao* (one of them) category. It is interesting to emphasize that *kapwa*, as Virgilio Enriquez described, is the concept which embraces both categories; namely, the *ibang tao* and the *hindi ibang tao* (Virgilio 1994). Hence, the presence of everybody is recognized here. The *kapwa tao* is treated as equal regardless of status quo, race nationality, belief, and sex.

The practice of *gapo* is a clear example of our inclusive culture. For they treat the farm as their *kapwa* too that needs to be prayed for and persuaded for a good harvest. They wish to relate not in terms of the master–servant category but in terms of friendship. They show it when they treat them as human beings. It implies that no one is above the other. Their unmerited gestures of *pakikipag-kapwa* with the farm in their practice of *gapo* made it quite clear that this was precisely what they have in

mind and heart—concern and respect for the life of each other including nonhuman being. The further challenge for us is to recognize such practice of *gapo* to nature wherein the individual entity is a member of a community of interdependent parts. People should embrace the earth as a community to which everyone belongs and which should be used with care and respect.

5 Eidetic Insight

The practice of indigenous environmental virtues as a way to holistic spirituality which finds its expression towards sustainable development, and hence, contribute to the implementation of the SDGs.

As we go through the thematic themes and environmental virtues as described above, we will find out that my co-researchers are mainly focused on how to make human life meaningful that promotes both human and environmental well-being in the community. They challenged individuals to transcend themselves in extending their concern and care to the environment through the practice of the virtue of *sapat, atag*, and *gapo.* They challenged individuals to be appreciative in one's relationship in the web of life through the said indigenous environmental virtues.

What is common to all of them is that they have faith conviction that God is calling them to a life of holiness and perfection. Their holistic spirituality through the supervision and guidance of the BEC program of the Prelature of Infanta provide them with motivation and inspiration to love their neighbor and the natural environment around them. This holistic spirituality as lived by my co-researchers is very clear and evident on how they relate to immanent God who is not out there in the sky. They believe that God is a personal one who granted their prayers and petitions. In return, they thought that such relationship with God should be manifested in their relationships with fellow humans in the community and with nature as a whole.

Sustainable development, as the saying goes, is not achieved overnight. Rather they are built little by little by small acts of *sapat, atag*, and *gapo*. It is not a course to be taught in the formal school but caught in my co-researchers life and practices in the village. Their environmental virtues offered moral principles of mutuality, companionship, and shared-project for flourishing and well-being of the ecological community. These principles led one to work in solidarity with the oppressed and poor nature today anchored on the organic model that the cosmos is a living organism, vital, sensitive and responsive.

This study affirms their struggles to create a community that speaks and listens to the different issues, concerns, and problems within the village. It articulates their social and democratic actions by discerning and deciding together in enacting and implementing its decisions. It also depicts their good camaraderie as one community by praying and celebrating their joys and sorrows together without any discrimination in age, sex, religion, and cultural beliefs. In other words, this study becomes a mirror wherein community leaders can see in their own eyes their social

action and work that have helped improve the people's ecological, social and economic condition in the village.

However, this study is not the only answer to do a holistic environmental spirituality but it addresses one aspect of the problems in sustaining an environmental concern—to develop faith convictions and moral lifestyles that are sustained by daily habits, dispositions and virtuous practices in caring for the environmental community. It is small but definite steps toward the establishment of sustainable development agenda in their context.

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Local Spatial Planning Processes and Integration of Sustainability Perspective Through a Broad Systems Perspective and Systematic Approach

Sara Gustafsson and Viktor Andréen

Abstract

Cities play an important role in forwarding sustainability. In Sweden, municipalities have a monopoly on spatial planning and are, therefore, key actors for developing sustainable cities. Through integrating sustainability concerns early in the planning processes they have a significant possibility to have an impact on other actors' towards increased sustainability. The aim of this paper is to discuss a process for how sustainability concerns can be addressed in municipalities' spatial planning. It is based on experiences from an on-going planning process in Linköping, Sweden. There is a rapid increase in the number of index-based assessment and planning tools for sustainable cities (e.g. BREEAM communities, LEED neighbourhood, CASBEE-City). In Sweden, there is a newly developed tool: Citylab action, which has clear connections to the UN sustainable development goals. However, from a city planning perspective the existing tools are often complex and lack conformity with other municipal processes. There is therefore a need for municipalities to reflect on which tools that are useful, what the local needs for support are, and to develop inclusive and broad planning processes with a broad systems perspective in which actor involvement is key, and where the city's overall strategies and policies, as well as national and international goals, are clearly disseminated.

Keywords

Municipal spatial planning · Sweden · Sustainability · Process management

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1 Introduction

Cities play an important role in forwarding sustainability (UN 1992). First, most of the global and regional sustainability initiatives are operationalized at the local level and second, they are close to the citizens and other local actors. This means that they have a good understanding of the local preconditions and needs. The planning processes within municipalities are thus important cornerstones in the development of a sustainable built environment on a community level. Through integrating sustainability concerns early in the planning processes the municipalities have a significant possibility to have an impact on other actors' behaviours towards a more sustainable development (Hjelm et al. 2011).

Spatial municipal planning has a significant potential in contributing to sustainability in a positive way. It is in the plans where ambitions are established and where the window of opportunity for developing sustainable cities is open. However, planning processes are often linear processes with give little space for feedback loops and learning. Furthermore, they are long-term processes involving many different municipal officers and politicians as well as other actors. This could be a problem given the fact that it takes a long time before changes become visible or measurable in the struggle towards sustainability and that the ones initiating the process might not be the ones finalizing it. The initial aims and sustainability ambitions might get lost over the years due to the time and changing personal perspectives. Even if environmental and other sustainability issues to a certain extent are regulated by national law in Sweden, there is still a need to further integrate sustainability into planning processes. During recent years there has been a rapid increase in the number of index-based assessment and planning tools to support this. Only to name a few, there are BREEAM communities, LEED neighbourhoods, CASBEE-City and BEST (for a compilation and comparison of these tools, see Baumgarten and Torgnyson 2014). In Sweden, the tool Citylab action (SGBC 2016), which has connections to the UN sustainable development goals (SDGs; UN 2015), was recently launched. From a city planning perspective, these tools are often complex and lack conformity with other processes within the municipality. Furthermore, the existing tools seldom address the management perspective, i.e. how to implement the more sustainable way of planning, nor do they problematize the ownership of the process or coordination responsibilities. This paper addresses this gap through reflecting on how to depart from existing tools and practices when integrating sustainability concerns in local spatial planning processes.

This paper focuses on the process of planning a sustainable city district, where different existing tools can play a role in different parts of the process and where management of the process is key, along with user-friendliness and local adaptation of and participation in spatial planning processes. It describes the process of how a municipality, in collaboration with academics, went about to develop a process management approach to for integration of sustainability perspectives into spatial planning processes, using the existing structures and competencies in a

communicative and collaborative way. Therefore, it has a normative approach, suggesting how planners could integrate sustainability perspectives in their processes at an early stage in order to develop sustainable city districts. The aim is to contribute with inspiration to other municipalities that face similar challenges and provide them with ideas on how to further develop their sustainability efforts in their spatial planning processes.

The study is carried out in the city of Linköping, Sweden, where a current city district planning process has been followed and studied. Suggestions for how to support the planning processes in order to enhance for integration of sustainability concern are based on experiences from earlier research in this field (see e.g. Hjelm et al. 2011) and from the experiences from the Linköping case presented in this study. Even though the empirical case and results are based on a Swedish case, the authors believe that some of the results and suggestions made in this paper are interesting in a wider context.

Linköping is the fifth largest city in Sweden (about 150,000 inhabitants 2016) and situated in the south-east part of the country. Linköping municipality is currently developing a new city district which will be subject to an urban living expo in 2017 with high outspoken sustainability ambitions (see Vallastaden2017 2016). This is not an average planning project, however, it is interesting to study how sustainability issues are dealt with in this type of city district development. There will be 1000 homes in Vallastaden, built by 40 property developers (with the involvement by as many as 40 different architecture companies). The city district can be seen as a test bed for different technical and social innovations. This study focuses mainly on the municipal planners' perspective on sustainability in planning Vallastaden.

2 Swedish Municipalities, Sustainability and Spatial Planning

Swedish municipalities have a long tradition of decentralization and self-governance (SALAR 2016). Their mission is regulated in national legislation (Swedish National Legislation 1999). For example, the municipalities in Sweden are responsible for the local provision of education for children and youth, social services (including care for elderly people), emergency services, water and sewage, security and waste management and spatial planning. How they choose to organize and structure their activities in order to fulfil their mission is fairly much up to each municipality. Furthermore, in Sweden, municipalities have a monopoly of spatial planning within their geographical territory. In conclusion, Swedish municipalities have a broad local action space and powers, which implies that they could have a significantly positive impact on the development towards a more sustainable city.

As mentioned earlier in this paper, municipalities have, in several global initiatives, e.g. in the Rio Declaration and in the Habitat process, been pointed out as key actors when it comes to forwarding sustainability. Swedish municipalities have

a long tradition of working with sustainability issues. Some issues are regulated through national legislation and national strategy documents. However, during the past decades, Swedish municipalities have gone beyond those issues regulated by law and tended to take on voluntary sustainability commitments to a higher degree than before (Emilsson and Hjelm 2005). There is a wide range of sustainability competency in municipalities and instead of being only an authority, the municipalities tend to become more of an actor among other local actors and catalyst in forwarding local sustainability (Emilsson and Hjelm 2009). Many Swedish municipalities have implemented Local Agenda 21 action plans, and many have also implemented environmental management systems (e.g. according to the international standard ISO 14001) (Emilsson and Hjelm 2002). This has helped them to organize and structure their environmental management in their organization. In many cases, it has also made them expand their environmental management to sustainability management through including the economic and social aspects of sustainability as well as expanding the range of actors involved in the management to also include external actors (Emilsson and Hjelm 2009).

The Swedish government has also declared (on a national level) that they want to take a leading role in fulfilling the SDGs (Swedish National Government 2016). Since many of these goals have clear connections to the local level, this means that the municipalities most likely will have to take a very active role in this work. Still, the 2030 Agenda is quite unclear on which role municipalities play in the SDG process. It will be interesting to see how Swedish municipalities embrace the SDGs in their strategies and planning processes, given their fairly high degree of maturity when it comes to sustainability management and their strong local position. This paper addresses an approach that could enhance for municipalities when integrating different sustainability visions, goals and ambitions into the spatial planning of new city districts.

2.1 Planning in Swedish Municipalities

In our research, we have studied how sustainability issues are/can be integrated into spatial planning processes and how these processes can be more inclusive in terms of actors as well as sustainability perspectives. Municipalities in Sweden have been criticized for not having broad enough dialogue with citizens during their planning processes (Delegationen för Hållbara Städer 2012). Even though dialogue to some extent is regulated in the Building Act (see Swedish National Legislation 1987), this is perceived of as insufficient. Municipalities could benefit from strengthening the deliberative processes through designating resources for citizen dialogue in their annual budgets (Delegationen för Hållbara Städer 2012).

Planning in Sweden is of tradition based on rational approaches (see e.g. Albrechts 2004; Fredriksson 2011; Healey 2009). Rational planning processes are often linear with little or no feedback and learning loops. The different phases of the rational planning processes are often clearly defined and there is also a clear task division between planners and politicians (Campbell and Fainstein 2003).

Furthermore, these processes are often distinguished by a top-down approach. There is, though, an ongoing transition towards a more communicative (meaning inclusive and more bottom–up) approach (Albrechts 2004; Fredriksson 2011; Healey 2009). Even though broader actor participation and communication renders a more complex planning process, it is important for the effectiveness and legitimacy of the planning to have inclusive processes (Fenton et al. 2015).

In this project, a more communicative approach to planning is suggested, in which actor collaboration is key. Having a more communicative approach where those actors affected by the planning are involved, embracing also a bottom-up perspective could improve the process (Innes and Booher 2004). This could contribute with valuable insights from different perspectives and from people with different competencies. It emphasizes the importance of dialogue and deliberation and strengthens the role of citizens and other stakeholders (Bishop and Davis 2002; Few et al. 2007). A precondition for this is that the municipality is open to include the ideas and suggestions from other actors in the planning processes and, in a way be prepared to make compromises, etc. This implies that it is less evident which steps that should be taken and by whom and when. There is a need for a certain degree of maturity in the municipal organization to be able to manage this approach (Gustafsson and Wihlborg 2016). This could challenge traditional planning processes to broaden the systems perspective and become more inclusive in many respects.

3 Methodological Approach

The project, on which this study is based, is a collaboration project between Linköping municipality, The Swedish National Board of Housing, Building and Planning, and Linköping University. It was initiated in 2012 and finalized in December 2016. The project has had an iterative approach with close collaboration with public officials in Linköping municipality and representatives for the urban living expo throughout the process and the outcomes have thus continually been validated with practitioners.

The foundation of this study is an inventory of national and international tools for sustainability concern in spatial planning (see Baumgarten and Torgnyson 2014) and of an analysis of existing planning practice in Linköping municipality. This contributed with an understanding of existing practice and existing support for integrating sustainability perspectives in spatial planning. This contributed to a comprehensive understanding of the availability of tools, their strengths and weaknesses along with an understanding of the current local planning practices and how they took sustainability issues into consideration. It also served as the basis for designing the workshops that would contribute to the development of a process management support that will be presented in this paper.

Several workshops with different purpose and scope were held together with the spatial planners over the project period. In the early workshops the current planning practices and integration of sustainability perspectives and where the planners felt that there was a lack of support, etc. Another important issue that was discussed was how the planners perceived the concept of sustainability and how that had an impact on the planning. One of the most important gaps that the workshop participants perceived of was the one between planning documentation and actual processes. Other issues such as goal conflicts and their restrictions due to legislation and commitment from citizens and developers were also raised. The workshops also generated ideas on how to go about to overcome the gaps and problems and how to more clearly integrate sustainability issues into spatial planning. Follow up was mentioned as a very important factor as it was considered unclear who actually had the responsibility to follow up and how this should be done and who ensures that requirements are fulfilled. Furthermore, developing an identity for a city district in the planning process before the development takes off was also considered important for the further planning process as this would enhance for the municipality in the discussions with developers and other stakeholders.

The reflections and ideas from the workshops fed into the development of a process management approach and a framework for how to manage sustainability issues in planning processes were formulated in a draft and further discussed in several workshops. The later workshops in this study departed from drafts and were discussed in different constellations of participants in order to validate and further develop and evaluate an approach that would be helpful for the municipal planners.

There was a broad participation of different expertise in the workshops, e.g. participation of public officials with responsibilities for:

- zoning/city planning,
- traffic planning,
- comprehensive planning,
- building permits, planning permission,
- land use and exploitation,
- town architecture.

Furthermore, municipal managers with an overall responsibility for environmental protection, strategic sustainability management issues, regional spatial planning and the CEO of the Vallastaden exhibition company participated in the meetings. Some of the planners participated in all workshops, while some only participated in one or a few.

As a complement to the workshops, individual meetings have also been held with some of the planners and strategists. In total, 23 persons participated in the different workshops and individual meetings and were thus involved in the development of the process management support approach.

The main focus of this study was to develop practical support to municipal planners, and the study has a practical approach. The workshops, meetings and interviews were important in order to validate the relevance of the process management support that was developed during the study. With the continuous discussions with the practitioners, the researchers got a good idea of what kind of support they felt they needed in order to enable integration of sustainability perspectives into the existing planning processes without creating new parallel processes. A process management support could have been developed based only on the inventory of existing tools, existing theories on planning and on documentation studies, however then it would have missed out on important practical issues and it would have been less relevant in practice. Furthermore, the actual process of developing the process management support was perceived of as an important outcome in itself by the participating planners and for the municipality since it led to an increased awareness of different planning division's responsibilities and attitudes towards sustainability and their responsibilities and led to a more active discussion internally among the planners related to planning and sustainability. Hopefully, this could inspire other municipalities to further develop their local planning practices in order to integrate the sustainability perspective and broaden their systems perspective in local planning.

4 Results and Discussion

This chapter presents the final outcome of the iterative process of developing a process management support for integrating sustainability perspectives into municipal spatial planning.

4.1 Process Management Support

Figure 1 illustrates the four steps of the suggested *process management support* approach that was developed within the frames of this study. First of all, as a pre-step in the planning process, it is important to develop a comprehensive understanding of a planning project of which steering documents that affect the planning processes and what these say about sustainability (both national legislation, local policies, goals and other political ambitions). The municipal politicians should, therefore, for each term of office, compile a list of prioritized sustainability goals, steering documents etc. that should be guiding for all spatial planning projects in the city. This would enhance for a more coherent sustainability approach of the municipality and it would also facilitate the following-up process. This list should then be the point of departure for the four steps (Fig. 1). For each city district planning project onwards, this list will be discussed and related to in order to ensure that the actual project is in line with the municipality's overall sustainability ambitions.

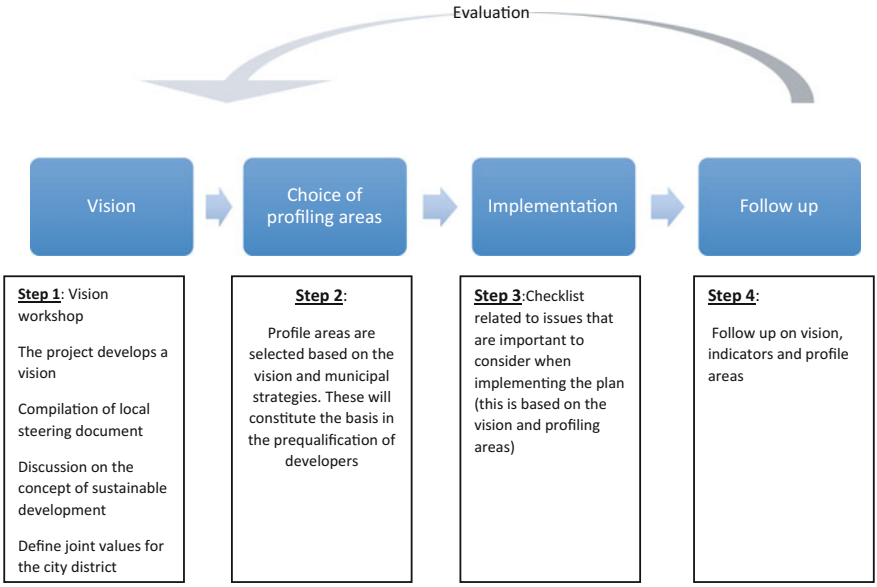

Fig. 1 Illustration of the different steps of process management support for an improved integration of sustainability issues into the spatial planning processes

4.1.1 Vision

The first step of the planning process, as suggested in this study, consists of a "vision workshop". Here, the public officials organize a workshop led by an external facilitator. This workshop is divided into two parts and starts with a thorough discussion about the concept of sustainability. Sustainability is often interpreted in different ways and it is important that the planners within the project discuss how sustainability should be looked upon in this particular planning project and how it should be addressed. The workshop participants brainstorm around values that should identify the particular city district that is the planning object, and reflects on words that they want to connect to the city district. The compilation of the steering documents serves as point of departure and inspiration for this brainstorming exercise. Once there is a gross list of value words the workshop goes into its second part in which the participants cluster and compile the identified values and identify their common denominators. This, in turn, leads to a number of key words that describe the planned city district. The vision is then formulated based on the keywords.

4.1.2 Profile Areas

In step two, the vision that was developed in step 1 is concretised through selecting profile areas for the city district. The profile areas could be identified in different ways and based on different existing tools. In the case of Vallastaden in Linköping, the profiling areas are based on the new Swedish Citylab action tool. Citylab action

has developed 17 profile areas (partly based on the UN SDGs), see SGBC (2016) and this project has used these as a basis (for a more detailed description of the profile areas developed for the process management support in this study, see Gustafsson 2016). However, the identification of profile areas for the city district could also be done based on inspiration from Breeam communities, LEED neighbourhood or other similar tools/initiatives. The identification of profile areas is made through workshops where local politicians, citizens, constructors and other external actors are invited to contribute. Through this type of collaboration, there is potential for the municipality to use so called "green-nudging", which is a way of trying to make people change towards a more sustainable behaviour through positive reinforcement (see e.g. European Commission 2014). It is important to include future citizens and other actors that will be active in the city in the planning process in the endeavour of realizing the vision for the city district. The number of profile areas to be chosen for the city district must be decided by the planning group and on what is feasible. Strategies, measures and indicators are developed for and based on each of the chosen profile areas in order to ensure that they are efficiently addressed and effectively measured (for an example, see Box 1). Strategies are used for pinpointing the more overarching areas (such as the Profile area in Box 1), while indicators are used to quantify the development or progression in the profile area. Several indicators can be used to measure one strategy from different perspectives.

Box 1. Example of a Profile Area and Its Suggested Strategies and Measures

Profile area X: adaptation to climate change

Description: The planning project aims at increasing the city district's resilience against external and internal changes such as cloud-bursts, rising sea levels etc.

Examples of strategies and measures:

- The planning project performs an impact assessment with regards to risks for flooding.
- A strategy is formulated for managing future climate changes in terms of flooding, surface water management and increased outdoor temperatures.

4.1.3 Implementation

Both the vision and the profile areas are important cornerstones for the implementation of the planning project. Having the systematic approach suggested in this paper means that the vision is clearly influenced by the municipality's overall steering documents and strategies. The profile areas are based on the vision for the planned city district are chosen and thus also in line with the municipality's overall strategies and steering documents. Furthermore, through discussing the profile areas

with those actors that are involved in and affected by the planning process, a common understanding is created. However, it could still be a challenge to convert the vision and the planning ideas to practice.

The vision and the profile areas could help the municipality in communicating the ambitions of the city district and it could also be used when developing criteria for the pre-qualification process of contractors. In a pre-qualification process, the municipality can, to a certain extent, set up a level of ambition to which contractors and subcontractors should comply with in order to have a chance to get a contract in the planned city district area.

Pre-qualification is often used for architectural purposes, however, this could also be done for features not only related to architectural expressions and buildings, but also for the space between the buildings, covering the whole city districts. For example, one such issue could be for the potential contractor to demonstrate that they can provide an integrated solution where sustainability is core (related to energy solutions for buildings, green spaces between the buildings, sustainability conscious choices of building materials and ideas on how to enhance for sustainable transport within the city district). This approach has been tried out for city district planning projects in Stockholm (MICASA 2012), but so far having this type of pre-qualification processes is uncommon in Sweden. Applying this type of pre-qualification process where the profile areas are included, would enhance not only for the city district to address its vision and fulfil its strategies but also for the city to achieve its overall sustainability ambitions. Having this approach could also be a way of stimulating the developers to develop innovative solutions as well as overcoming the restrictions set in legislation related to the possibility to demand high sustainability performance from developers.

In order to end up with effective goals and indicators, it is of utmost importance that these are developed in a way that makes them possible to follow up. Otherwise there is a risk that they end up as paper tigers and not a useful and effective process management support. The vision and the profile areas also have to be an integrated part of the external communication throughout the process with the contractors and other external actors in order to manifest the vision and the ambitions with the planned city district. Furthermore, it is important to have a continuous communication related to the vision of the city district internally among the public officials and the politicians in the municipality in order to develop an awareness and engagement. This should not be done in a separate process, on the contrary, it should use existing channels of communication and existing structures.

Collaboration is key throughout the planning process. This is often built-in in already existing planning processes, yet it is important to reflect on the forms of collaboration and what the collaboration will contribute with in the project. Different actors should perhaps be involved in different phases of the project and in different forms (Fenton et al. 2015). In the collaboration, it is important to strive for win-win situations in order to motivate actors to participate. It is also important to understand that different actors have different agendas and visions and participate for different reasons. The collaborating partners need to develop an understanding of each other's world views in order to achieve the best outcomes.

4.1.4 Follow Up

As mentioned earlier, spatial planning is often connected to linear processes and to long time frames (in Sweden it can sometimes take up to 10 years from the start of a planning process until the plan is realized). Many planners and other actors are involved in the process, but given the long-time perspective, it is not always the same people that start and finalize the plan. Furthermore, sustainability is a long-term commitment, and it takes many years before results from measures and changed behaviours are measurable or visible. Therefore, continual follow up and learning is pivotal in order to develop effective processes leading to continual improvements. It is important that the follow up is thought of already in the planning phase in order to ensure that the indicators, etc., are formulated in a way that is possible to follow up. If follow up is performed continually throughout the process, the results could be a useful input into the managers' planning ahead when developing strategies, etc. With clear and concrete routines for follow up and evaluation as well as continuous documentation on progress on the strategies and indicators enhances for the municipality to get a clearer idea of the progress in the actual city district project. It would also provide input to the overall sustainability reporting of the municipality.

Even if a planning process has a follow-up procedure, it does not automatically mean that the process is evaluated in order for the experiences to feed into coming planning processes and in order to develop a learning process. In order to improve the planning practice in the municipalities, there has to be some kind of discussion related to what has been learnt during the process, what would be done differently in upcoming projects and how the planning practice, in general, could be improved.

4.2 Reflection on Communicative Planning Processes

The discussions with the public officials in Linköping reveal that there is a need for a more strategic and structured approach on how to integrate sustainability issues into spatial planning. The suggested process management approach could enhance for a broadened systems perspective when it comes to sustainability in spatial planning, both content wise and in relation to the inclusion of different actors. To be able to develop such an approach, the organizations need a certain degree of maturity and Senge et al. (2005). This broadened perspective could make the municipality more prepared to face new sustainability challenges and to adopt national and international initiatives. The way the process management is designed, it also contributes to the adoption of the UN SDGs since the profile areas have a clear connection to these goals.

It is important to have a transparent and open dialogue in spatial planning and to involve different types of actors, such as developers, citizens and business. The actors that are to be involved in building the city district also needs to be involved early in the process in order to create a shared vision and mutual commitment to this vision Innes and Booher 2004). This would also strengthen the role of citizens and other stakeholders (Bishop and Davis 2002). Having this approach, we move from

government to governance in which the citizens and other private actors, together with the municipality co-create new policies and plans. The municipality becomes one actor among many (Pierre and Peters 2000).

Even though this study suggests an approach inspired by a communicative and more bottom-up approach when integrating sustainability issues into the planning processes, a certain degree of governmental involvement in planning and implementation of sustainability policies is clearly acknowledged for effective local action (e.g. through funding, guidelines et) (see e.g. Baker and Eckerberg 2007; Fleming and Webber 2004). Hence, a certain level of rationality is needed in planning in order to make the planning processes feasible. With the suggested process management support, these two perspectives are combined since the regulations and governmental directions set the baseline, and the actors develop visions and strategies with these as a point of departure.

5 Conclusions and Recommendations

One conclusion from the discussions in this paper is that spatial planning processes (at least in Swedish municipalities) need to have a broader systems perspective, both when it comes to integrating sustainability perspectives and when it comes to actor involvement. The workshops organized within the frames of this study is an interesting illustration of this, where planners from different divisions of the municipality met and discussed issues over the organizational boarders. These types of meetings were apparently seldom held within the municipality where more strategic and overarching issues related to planning were discussed. It is important that people with different competencies and experiences from different parts of the planning processes meet and discuss the planning processes on a more general level in order to be able to get an understanding of how their own part contributes to the whole process and how the process can be improved in order to be more effective and efficient.

Actor collaboration and communication is therefore key in this process and it is important to address the issues in a way that is appropriate and relevant for the involved actors. This means that the municipal planners have to reflect on why, when and how the different actors should be involved in the process. To do this in an effective way, it is important to use already existing structures and routines and not to invent new ones. It is also important to let collaboration relations take time to develop and mature. The different actors need to develop an understanding of each others' agendas, world views and values, and with theses as a point of departure identify possible fields in which there are joint interests and potential for win–win situations.

Developing sustainable relations with stakeholders could also enhance for continuity and mutual learning. If the municipality could function as an anchor tenant for the local actors, and if the actors together develop a mutual way of

collaborating, there is a better preparedness for integrating new initiatives and policies, such as the UN SDGs.

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Designing Green Marketing Across Industries: A Conceptual Framework and Implications for Consumers and Transdisciplinary Research

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Abstract

Understanding what marketing messages trigger sustainable consumer behavior is one of the key issues for companies to be able to design effective green marketing. The goal of this paper is to present a conceptual framework for a green marketing approach that includes product, industry, production processes, and supply chain specific considerations to be utilized in the design of green product marketing for the mass markets. Based on a literature review, we have created a conceptual framework with industry-specific aspects on the basis of unique features in seven industrial sectors that are of relevance to the personal needs of consumers from an environmental perspective, but are focusing on the product-specific aspects of the marketed products. The originality of this study lies in the proposition that green marketing should use the actual product features as a starting point and not focus only on green consumers. The greenness of a product should be an additional dimension that adds to the competitiveness of the product when compared to conventional products. Theoretically, we propose that a transdisciplinary approach that integrates

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sustainable supply chain management perspectives to green marketing would benefit companies designing green marketing approaches and consumers making green product choices.

Keywords
Green marketing · Sustainable consumption · Sustainable supply chain management

1 Introduction

The development of the green consumer markets has slowed down as there is not enough understanding of the information that consumers would actually need to do green purchasing decisions (Chekima et al. 2016b). In order to sell green products to the consumer masses, the focus should not always be on sustainable or eco-friendly product features. Instead, companies should focus more on marketing their products to give the impression that they are satisfying consumers' basic product needs on the product level. Green products should be appealing to consumers and also help to lead sustainable lifestyles, e.g., by providing healthy nutrition, spending money wisely, and satisfying personal lifestyle needs. Consumer market segmentation is not necessarily the best approach to developing the green product markets (Luzio and Lemke 2013). The strong focus on green consumers and various green lifestyles does not help to address consumers in the mass markets who need to also start buying more green and sustainably produced products to spread sustainable consumption patterns successfully on a large scale as targeted, for example, in the UN Sustainable Development Goal (SDG) #12 "Ensure sustainable consumption and production patterns" (United_Nations 2016). The use of an industry-specific approach to green product marketing to consumers on mass markets without green consumer segmentation requires a new perspective in green marketing.

Research on consumer behavior and purchasing of green products has shown that, generally, only green consumers select their products based on environmental and sustainability criteria (Ottman 2011). Primarily, only green consumers favor eco-labelling, trust expert insights, and appreciate the availability of green products in stores (Ottman 2011). However, they can do non-green product choices when they do not have time to compare product information, when the green products are clearly more expensive, or when seeking environmental information on the products requires extra effort before the purchasing (McDonald et al. 2009; Young et al. 2010).

We have created a conceptual framework that presents how unique characteristics of different product categories in different industrial sectors could be used to promote more sustainable consumption and green products. The focus is on the product-specific aspects of green products that have personal value to the users and thus can have a distinct influence on the purchasing decisions of consumers. This is

demonstrated especially in the food sector, where organic food is marketed as a healthy food option. Markets for organic food have grown lately, for example, in China (Liu et al. 2013). The popularity and availability of Fairtrade products has also shown clear growth on the consumer markets, especially in the UK, where in addition to reasons of doing a socially responsible choice, consumers buy Fairtrade products for personal reasons (Yamoah et al. 2016).

A product-specific approach to green marketing allows to present the product and highlight its features so that consumers understand how it responds to their personal needs and what use benefits there may be. Green consumer behavior segmentation (e.g. LOHAS, dark green consumers, etc.) (Ottman 2011) is not necessarily applicable to all product categories a consumer may use, as consumers can be irrational and emotional in their product choices (Hawkins and Mothersbaugh 2010). Thus, consumers may buy organic food but may not necessarily act as responsibly when selecting a mode of transportation or when buying fashion clothes.

This paper is structured in the following manner. First we explain the conceptual background based on our literature review. Then we present the individual aspects that have been included in the conceptual framework. The final section discusses the contribution and limitations of this work, and possible directions for future research.

2 Conceptual Background

The term green marketing is used in association with marketing practices and policies that address environmental issues with the target of profiting from it by satisfying consumers' needs and company level objectives (Leonidou et al. 2013; Brindley and Oxborrow 2014). In green marketing strategies or programs companies target to achieve their strategic goals while minimizing their harmful impact on the environment. This is implemented on various levels of the marketing strategy based on marketing mixes, for example, the 4 P's: Product, Price, Place (distribution) and Promotion in a sustainable and eco-friendly way (Leonidou et al. 2013). Green marketing can be crucial in the overall sustainability development of a company and it is tightly linked to eco-design and green sourcing (Zhu et al. 2005).

Consumer behavior and psychology research study pro-environmental behaviors in the purchasing, use, and disposal of products that have environmental impacts. Theoretical models commonly associated with sustainable consumer behavior refer to ethical values when explaining sustainable consumer behavior in association with environmental issues (Phipps et al. 2013). Although there are various theoretical models that have also been empirically tested, they are not very reliable as consumers' perspectives and lifestyles are not necessarily stable nowadays and consumers do not always act in pro-environmental ways even though they claim to support environmental values (Devinney et al. 2010; Holt 2012).

It should be noted that the experiences consumers gain during purchasing situations vary, and these can influence consumers´ values and future purchasing choices (Young et al. 2010), which highlights why companies should focus on creating as positive experiences to consumers as possible, also with reference to the non-green criteria in green products and the unique features of the products they are marketing. Non-green criteria, e.g. product features, habits, and special interests of consumers, have a tendency to reduce the effectiveness of the green criteria and green marketing argumentation in the purchasing context, thus the brand, specific product features, the price, earlier product experience, reliability, appearance, design, color, or serviceability can be more important to consumers than the green criteria (Young et al. 2010).

Building on green marketing literature, we propose a conceptual framework for designing green marketing for different kinds of products from different industrial sectors. We have conducted a literature review, and studied the way green marketing has been addressing consumers and how green marketing messages have been referred to in the literature. We have analyzed green marketing approaches in different industrial sectors and found that so far, research on green marketing is addressed mostly in the seven following sectors: (1) food, (2) detergents, (3) forest and wood products, (4) apparel and fashion products, (5) travel, tourism and hospitality, (6) energy, and (7) rental and remanufactured goods.

We propose that: As green products need to foremost fulfill the product requirements that have been set for conventional products by consumers (Ottman 2011), these requirements need to be emphasized in green marketing. Similarly, information on the production processes, green supply chain (GSC)/sustainable supply chain (SSC) operations and industry-specific aspects also need to be scrutinized beyond the product-specific details and included in green marketing.

Below we will first present the kinds of marketing approaches that have been used to market green products in the above mentioned industrial sectors. Then we introduce more specifically the kinds of details incorporated in green marketing messages. And finally we summarize these points in our conceptual model.

2.1 Marketing Approaches for Green Products Across Industrial Sectors

Currently, the main barriers for sustainable consumption are considered to be the lack of information, organizational issues for implementation, and financial support (Newton and Meyer 2013). In addition to the six strategies of sustainable marketing communication presented by Ottman (2011), we propose that more information on the industry-specific aspects of products need to be taken into account in green marketing.

When integrating sustainability factors into marketing, multiple dimensions of sustainability need to be understood (Simpson and Radford 2014). A factual and informative approach may not always be sufficient to motivate consumers, as emotional messages can also encourage them to participate personally in achieving

sustainable development goals (Von Meyer-Hoefer et al. 2015). When promoting green purchasing, resorting to cultural values and green advertising are the main ways to motivate consumers, and the amount of environmental knowledge is not considered to be as significant (Chekima et al. 2016a). The cultural values and beliefs that consumers have are something that they adhere to in order to conform with their social network. Consumers should be reminded how they are a part of nature and thus consume sustainably (Chekima et al. 2016b). When marketing green products, producers should also pay attention to the availability of products and after-sales support to make sustainable consumption a positive experience for consumers (Biswas and Roy 2015). They should also determine whether other social or economic information would be more relevant to consumers like in the case of Fairtrade products.

Promotion of sustainable food can be done by emphasizing the positive aspects and benefits of consuming sustainable food, with a transparent view to the industrial conditions (Soler 2012). Genetically manipulated organisms (GMO) food is not favored due to health reasons primarily, not so much due to ethical or environmental aspects, and the distrust towards GMO food is used by small farms to promote certified organic food (McCarthy et al. 2016). In the case of detergents, the products and their packaging need to have relevant environmental description that motivates consumers that are easily persuaded and already highly involved in green trends. In the apparel and fashion industry, both extrinsic and intrinsic features have been associated with products—so that extrinsic features related to brand, pricing, packaging, country of origin, and intrinsic features related to style, design, color, care, and quality are highlighted in the marketing; extrinsic features are more related to the activities of manufacturers and retailers and not so much to the actual product (Jung et al. 2016).

In household consumption, the current barriers for sustainable consumption are considered to be lack of information, organizational issues for implementation, and financial support (Newton and Meyer 2013). With regards to energy consumption, in the emerging markets more effort is required to motivate consumers to actually consume in a sustainable manner (Sonnenberg et al. 2014). To further develop the rental service and remanufacturing of goods, the feedback from users should be used systematically in order to develop the aspects in rental goods that appeal to green consumers (Tu et al. 2013) as well as other consumers.

2.2 Green Marketing Messages: Product Specific Information with Reference to Green/Sustainable Supply Chain Management

Green marketing messages should be product-specific, as consumers get more involved with the product category if it is presented in the marketing message (Cummins et al. 2014). Producers should share more information on the environmental impact of their products during their whole life cycle. This implies the need to incorporate supply chain information since the supply chain members, from raw

materials extraction to the final product delivery to the end-consumer, all have an impact on the life cycle of the product. To make environmental and sustainable information available, it is necessary to study and assess sustainability practices along the supply chain as most products and services originate from suppliers located worldwide. Consumers need to be encouraged and given the feeling that they can individually have an impact when solving environmental problems, e.g. by recycling, saving energy, and changing their consumption behavior. Communication should concentrate on promoting the role of sustainable consumption as a means for reducing environmental impacts (Biswas and Roy 2015).

The way companies communicate their corporate sustainability does not necessarily have an impact on consumers, because consumers are skeptical about the companies' green marketing initiatives, and thus green marketing should concentrate on providing information on the benefits of green and sustainable products (Stolz and Bautista 2015). Green marketing of green products could be done with a focus on the product-specific aspects including additional details on what materials have been used and what are the product's environmental benefits. Product quality and concern for health and environmental issues motivate green food consumption (McCarthy et al. 2016). Marketing of sustainable food consumption could concentrate on promoting and gaining the confidence of consumers that their purchasing behavior is critical for positive sustainable development globally (von Meyer-Hoefer et al. 2015). In the case of forest and wood products, marketing messages could focus on, for example: Country of origin, environmental impacts (sustainable forest/plantation management, carbon footprint, portion of recycling) and material (type of wood, material composition, additives, health effects of additives, comments of the producers) (Appelhanz et al. 2016; Osburg et al. 2016). In the case of the apparel and fashion industry, when promoting eco-friendly products, a positive "ethical consumption attitude" can be highlighted by esthetical aspects, branding, and sustainable features of the products, as esthetical aspects and information on the greenness of the product can mediate pro-environmental beliefs of consumers (Jung et al. 2016).

In the travel, tourism and hospitality sector, information on sustainable consumption activities that make the consumers' life easier and more pleasant on a hedonistic level can be more effective than factual information on environmental issues (Miao and Wei 2016). Communicating in ways that promote positive environmental behavior can result in favorable hotel experiences, as consumers can save in their laundry costs, and the cost savings that hotel visitors gain from pro-environmental behavior can be invested in eco-friendlier services and products (Miao and Wei 2016). The overall strategy would then be to associate environmental sustainability of the operations with the overall business sustainability (Miao and Wei 2016).

When it comes to household consumption, cost savings resulting from higher energy efficiency of green apartments, green aspects of housing, and health related aspects could be better communicated to promote green buildings (Hu et al. 2014). Also in the energy sector, the price of biofuels and availability at gas stations need to be solved properly and communicated to consumers (Van De Velde et al. 2009).

In the case of rental and remanufactured goods, companies should ensure that product attributes, in addition to the environmental aspects, are as good as they are for conventional products (Michaud and Llerena 2011). Remanufactured products are considered green if the way remanufacturing benefits the environment is communicated to consumers as consumers expect that the greenness of a product is an additional attribute on top of the products' other features (Michaud and Llerena 2011).

3 Conceptual Framework

Green marketing is one of the most commonly used terms when referring to the marketing of eco-friendly products (Ottman 2011). In green marketing, the main focus is on the greenness of products, but this may also include elements of social responsibility, e.g. references to Fairtrade programs (Ottman 2011). When creating green marketing campaigns, there are many aspects that need to be taken into account when approaching identified markets and consumers especially on the mass markets. Often the argument in the literature is that different consumer segments should be approached differently, and often companies do green consumer segmentation based on either socio-demographics or green lifestyles, however, the benefits of green consumer segmentation based on ethical and pro-environmental values has also been questioned (Devinney et al. 2010; Holt 2012). In order to build up the green product markets, we present a conceptual framework for basing green marketing on product-specific and industry-specific characteristics that are also relevant to non-green consumers on the mass markets.

Based on a literature review, we have formulated a conceptual framework that helps to highlight per industrial sector, what industry-specific aspects should be taken into account to generate more effective green marketing approaches and messages. The literature review was conducted according to a systemic approach defined by Booth et al. (2016) and Fink (2005). We conducted searches in the Web of Science and Scopus with no time limits focusing on research topics covering green marketing messages and promoting sustainable consumption, with possible references to green and sustainable supply chains.

In our conceptual model, first, the consumers' product requirements for conventional products should be fulfilled by the green products and this should also be apparent clearly in the green marketing messages. Secondly, the green marketing should present the key environmental aspects of the actual product, production processes, and supply chain operations that are of relevance to that specific industry. A transdisciplinary approach to green marketing that refers both to product and supply chain related aspects would according to our proposition benefit both companies designing green marketing approaches and consumers making green product choices.

In addition to getting product information and environmental information from the green marketing messages, consumers also use in purchasing situations information and experiences they get from other sources. These can include the actual product itself, any news or information distributed outside the company on the production processes and supply chain related matters, in addition to industry-specific aspects that include information that is relevant to any company operating in that industrial sector. Consequently, it is in the best interest of both companies and consumers that this information would be incorporated in the green marketing. In Fig. 1, the thick arrows are used to indicate messages or information flowing to consumers, and the thin arrows indicate direct and indirect impacts that the activities within the company and external industry-specific aspects have on the green marketing.

Industry-specific aspects in the overall framework refer to commonalities in an industrial sector that also have an impact on the details that may be included in the green marketing messages, such as industrial standards, environmental regulations and legislation. However, the industry-specific aspects may also be something unique for an industrial sector that is dependent on the product categories of that sector. For example, in the food industry, consumers value significantly the

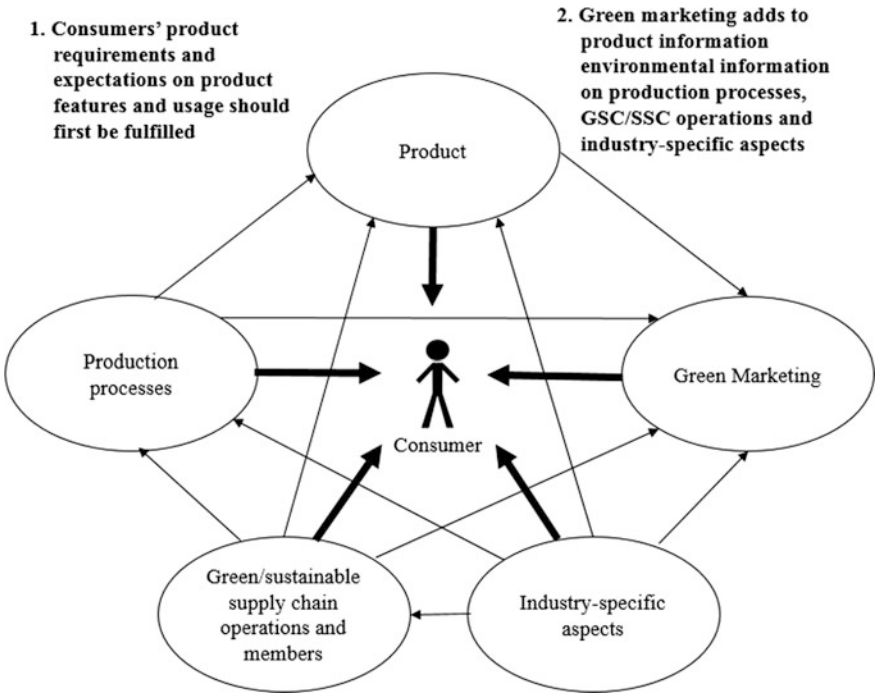

Fig. 1 Conceptual framework for designing product-specific green marketing for the mass markets

cleanliness, avoidance of pesticides on farms, non-GMOs, and short transportation distance of food products.

Factors that impact green marketing on the product-level include: all the product features that are also available in conventional products, raw materials, cost savings (e.g. energy consumption of product), consumer safety, product quality, take-back services, reparability and customization. The details on the production processes that are of great relevance to green marketing messages are, for example, the design, cost savings (e.g. energy consumption in production), workers' safety, quality management, and environmental management. Based on a multi-stakeholder approach, Fritz et al. (2017) underline a set of 36 sustainability aspects that are relevant in the automotive and electronics sectors to share sustainability information on. Following Fritz et al. (2017), some aspects from the green/sustainable supply chain operations and members that could be relevant in green marketing are the avoidance of hazardous substances in products and production, the workers' minimum salary and health benefits, product quality and safety (of consumers and workers), energy-efficient production, the impact of operations on biodiversity, supplier selection, and community engagement. For extracting sustainability information on a specific product, companies and supply chains would require a robust information system and the development of meaningful environmental indicators for consumers, as suggested by Schoeggl et al. (2016).

Details on products, production processes and green/sustainable supply chain operations to be included in green marketing can vary per industrial sector. These aspects should thus be highlighted for each product differently. Table 1 summarizes the key aspects per industrial sector that have been associated in the literature with green marketing in that sector. These aspects have been referred to the most frequently in the reviewed literature on green marketing. In addition, we have included some specific aspects that could highlight the uniqueness of the products in green marketing messages.

A cross analysis of the sectors indicates that in the case of the food, forest/wood, and apparel/fashion industries the two shared aspects that could be incorporated in green marketing are healthiness and toxicity/harmfulness, which is supported by the findings of Fritz et al. (2017) concerning the most relevant aspects for sustainable supply chain management. Possible toxicity/harmfulness is also an important aspect in the detergents, apparel/fashion, and energy sectors. The non-allergic aspects are highlighted in the detergents and apparel/fashion industries. The food and travel, tourism and hospitality sectors share the aspect of local production that can be referred to. The forest/wood and apparel/fashion sectors focus on esthetics and natural materials, while apparel/fashion and rental/remanufactured goods have in common the quality and durability aspects. Cost savings are highlighted in the travel, tourism & hospitality and rental/remanufactured goods sectors. Of course, the aspects of quality and durability could be also highlighted in the case of products from the forest/wood and apparel/fashion sectors (see Table 2).

Table 1 Industry-specific factors to be considered in green marketing on product level per industrial sector

Industrial sector	Industry-specific aspects
Food	– Healthiness – Cleanliness – Use of pesticides – GMO – Local production – Transportation
Detergents	– Non-toxic – Not harmful to children nor people with allergies – Less impact to personal living environment, including swimming and drinking waters in the neighborhood
Forest/wood products	– Look and feel of wood, i.e. esthetics – Possible values associated with hand-made products and carpenters' skills – No synthetic materials – Handling with non-toxic wood preservatives – No health risk in the use of the product, can also be used safely by small children – Possibility to recycle
Apparel/fashion	– Natural materials that do not irritate or cause health problems – No strong color agents or dyes used – Luxury products that are of good quality and long lasting
Travel, tourism and hospitality	– Cost savings to hotel customers as towels and bed sheets are not changed daily – Shampoos and soaps are in larger containers that are filled in – Food from local producers
Energy	– Green energy produced from renewable energy sources – Energy produced locally
Rental/remanufactured goods	– Good quality of products – Antique value – Cost savings

The green marketing approach should be informative and motivational in all of the cases, and it would be ideal if feedback from consumers could be used to develop the goods as well as the marketing messages. Extrinsic and intrinsic viewpoints need to be taken into account when promoting green products. When promoting sustainable consumption, companies should aim at creating positive consumer experiences (Pine and Gilmore 1998).

Labelling is very helpful in the case of food products and detergents. Also in the case of forest products, labelling has been developed far. However, for the other studied sectors, labelling has not been so far used extensively, and for this reason we have left labelling out of the conceptual framework.

Table 2 Cross analysis of the commonalities among the industry-specific aspects

Aspects in marketing messages	Industrial sectors
Healthiness	Food, forest/wood products, apparel/fashion
Cleanliness	Food
Use of pesticides	Food
GMO	Food
Local production	Food, travel, tourism and hospitality, energy
Transportation distance	Food
Toxicity/harmfulness	Food, detergents, forest/wood products, apparel/fashion, energy
Non-allergic	Detergents, apparel/fashion
Impact to own neighborhood	Detergents
Esthetics	Forest/wood products; apparel/fashion
Handmade/artisanal	Forest/wood products
Natural materials	Forest/wood products, apparel/fashion
Recyclability	Forest/wood products, travel, tourism and hospitality
Quality	Apparel/fashion; rental/remanufactured goods
Durability	Apparel/fashion; rental/remanufactured goods
Cost savings	Travel, tourism and hospitality; rental/remanufactured goods

4 Discussion

Companies are struggling with the question how to address their customers and consumers with green marketing and how to design green marketing messages that would be effective (Chekima et al. 2016b). The common belief is that by appropriate consumer segmentation green marketing can better promote sustainable consumption also among those consumers who are not truly green consumers. The segmentation of green consumers for green marketing purposes is not necessarily beneficial for companies, as this implies that there would be another group of consumers that would be deliberate and consistent in their unsustainable consumption of goods (Luzio and Lemke 2013). It is not simple to generalize the consumer segments over several industrial sectors, as it is challenging even alone in one sector (Verain et al. 2012).

The demand and consumption of green products is still very complex and inconsistent among consumers, and as segmentation on the basis of arbitrary sustainable consumption behavior is not considered worthwhile, the personal value of products to consumers should come first in green marketing. Additional environmental information on how the product choice is also reducing consumers' ecological footprint should be provided, and this information should also be useful when comparing products on the markets. This could give consumers a positive feeling that by making the product selection they can at the same time fulfill their product level needs as well as lead a more sustainable lifestyle. However, for some

consumers the greenness of a product is not a positive feature, but instead it raises doubts in their minds on the possible lower quality of the product in comparison with conventional products. Thus, product features need to be highlighted similarly as for conventional products and presented first, and this should be followed by additional information on the environmental impacts of the product, and could be targeted also for those consumers that are more environmentally conscientious and responsible.

Retailers play a very important role locally and globally since they have relations with consumers and manufacturing companies and their supply chains (Styles et al. 2012; Delai and Takahashi 2013) and may have important market power to influence the market demand and offerings for green products (Styles et al. 2012). This is particularly true with regard to non-green consumers whom retailers may be considered to have the duty to educate and promote green products to (Styles et al. 2012). Retailers need to incorporate green policies within their core activities, train their employees so that green marketing can be transmitted to consumers at the point of sales (Delai and Takahashi 2013 based on UNEP 2011; Styles et al. 2012). Retailers need to select suppliers based on transparent criteria that consumers can access such as certification schemes or environmental management systems (Styles et al. 2012). In addition, retailers can participate in the design of more sustainable products with their supply chain partners (Delai and Takahashi 2013). All these activities require the collaboration between supply chain partners (Xu and Gursoy 2015) and the implementation of a robust information system (Yildiz 2011; Xu and Gursoy 2015; Appelhanz et al. 2016; Chan et al. 2016) to communicate the relevant information for building green marketing for consumers and supply chain partners (Marquardt 2010; Delai and Takahashi 2013).

In most companies green marketing is designed with a top–down approach without considering what consumers really want to know (Marquardt 2010). This remains a gap as observed in our literature review. Even though there are internal drivers, like top management, who wish to contribute to sustainable development and cost reduction, and external drivers such as consumers' requirements for more transparency and market positioning, it is still the regulators that remain one of the main initiators of the design and promotion of green products for consumers. Companies invest in green product design and manufacturing to avoid risks of non-compliance (Styles et al. 2012). In Hong Kong, for instance, it is a must for companies to inform consumers about the energy efficiency performance of their products (Chan et al. 2016). Some studies show that consumers are sometimes willing to pay a premium price for sustainable products although these products may not cost much more than standard products (Styles et al. 2012). Hence, for consumers that are not sensitive to green products and rather buy based on the price, consumptions patterns may drastically change if no premium were set on green products and the price of "non-green" products was higher. Such an approach should be further investigated to assess its plausibility and impact on the economic systems worldwide.

Even though globalization has had some impact on the consumer markets and there is clearly a need for a mass market approach to green marketing, there are still different cultural values and national differences among consumers worldwide that may need to be addressed locally and the conceptual framework should be adapted accordingly. However, the CSR activities of companies are only effective when they are apparent on the product level also in the non-green attributes and not presented as mere greenness of the products (Humphreys 2014). The social aspect of consumption also needs to be addressed when formulating green marketing approaches, as sustainable consumption values and lifestyles have not been spreading among consumers as effectively as expected (Holt 2012).

One of the limitations of this research is that there may be research published outside of the Web of Science and Scopus databases where we did our searches. Another limitation is that we did not cover exhaustively all the relevant studies relevant to this field (e.g., books), however, the target has been to select the studies that are appropriate for the purpose of this study (Booth et al. 2016).

Future research should look at retailers´ involvement in the green marketing campaigns of companies. In addition, by improving the transparency of the companies' operations and supply chains, and including more information on the green supply chain activities of companies, green marketing messages could promote more sustainable consumption. Finally, due to specific industry requirements, further research could also address the impact of green marketing on enhancing information exchange on green/sustainable supply chain management. Green marketing may also be useful to promote green/sustainable supply chain management activities and raise awareness among supply chain partners, to enhance cooperation among partners and stimulate voluntary actions to improve the sustainability performance of supply chains.

5 Conclusion

On the basis of our literature review, we have created a conceptual framework that proposes a way to reach out to consumers on the mass markets and promote sustainable consumption. The main proposition is that green marketing targeted towards consumers should start by highlighting the actual product features that fulfill consumers' product requirements from a personal viewpoint with reference to industry-specific aspects that are also relevant from the environmental perspective. Then green marketing messages should introduce environmental information on the product, including details on production processes and green/sustainable supply chain management. The greenness of the product should be used to improve its competitiveness when compared to conventional products.

The classification of consumer segments in different industrial sectors with green products is very divergent, which could be seen in the outcome of our literature review. Our approach does not use consumer segmentation as a basis and it could be used also to address non-green consumers on the mass markets. In our view,

green marketing should not focus only on green consumers. Green marketing messages should be designed so that they are targeted for both green and non-green consumers based on existing product user groups and are easily understandable to all consumers in the purchasing situation. The marketing messages should include clear, precise, authentic, and trustworthy information and be product-specific with a special reference to the industrial sector it is produced in.

To promote sustainable consumption, the variances in product-level information for different product categories within a certain industrial sector need to be taken account. In addition, more cooperation and information exchange between supply chain partners is necessary to be able to extract information consumers and retailers need to make their purchasing decisions. Information exchange shall ideally be supported by a management system that enables the sharing of necessary information, from the raw material extraction until the final product launch, among all supply chain partners and up to the retailers and final consumers.

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Challenges of Ecosystem Resilience: An Aspect of the Sustainability Science Approach in the Study of Environmental Awareness in the Selayang Municipal Council, Selangor, Malaysia

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Abstract

This article discusses a conceptual framework for developing environmental awareness among the Malaysian people via sustainable development principles and the dialogic change model. The conceptual model was developed based on the principles of the integrated pillars in sustainable development and the dialogic change model. Two main component data were used: awareness campaign activities data and complaints data. The awareness campaign hard data were obtained from the various government agencies that contain the awareness

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campaign activities such as the Town and Country Planning Department (TCPD), the Department of Environment (DoE), and the Ministry of Health (MoH), among others, for the past 10 years (2005–2015). The complaints data were gathered from the Selayang Municipal Council (*Majlis Perbandaran Selayang*—MPS). Generally, people are more aware of the changes that take place in the urban ecosystems as the recipients of rules or policies made by authorities. The level of awareness among the Malaysian people now has improved. The people take action through the Municipal Council via telephone calls, face-to-face complaints and emails. This article uses the complaints by the residents in the MPS, which is located in the Selangor State, as a case study to investigate the level of awareness and actions taken by urbanites in urban areas. The main findings of the study are issues related to cleanliness of the resident's area and maintenance, among others, and the major implications for planning policy and ecosystem resilience will be drawn in this article.

Keywords
Ecosystems resilience · Sustainability science · Environmental awareness · Sustainable development · Malaysia

1 Introduction

Cities in fast-growing Malaysia are now grappling with safety issues regarding personal, family, and neighbourhood well-being, which have troubled cities in the developed world in the past (e.g. in the United States, see Jacob 1962; Myers et al. 2011). Wealth creation propelled by greater participation of the private sector through foreign direct and local investments has put in place advanced physical, social, and cultural infrastructures that, in turn, contribute to socioeconomic progress and a better quality of life for urbanites. This is a testimony for attaining sustainability and modernity (Malaysia 2010, 2011). Those cities all over the world are the generators of growth is equally true for cities in the Malaysian nation state. More than 50 years of independence from the British colonial administration has increased the space for Malaysia to create responsible governance that attracts foreign capital owners to come and set up their branch export production industries in the main cities. Consequently, the trickle-down effects can be visualised in the modern expanding cities with ultra modern communication facilities, housing, high-end shopping complexes, and excellent all-weather highways connecting regions and cities. Yet, the socioeconomic achievement has generated downside consequences lately in the form of rising social problems that are generally petty in nature but of a great nuisance to urbanites.

Since gaining independence in 1957, the continuous and rapid growth of the Malaysian economy has led to improvements in well-being by varying degrees, but it has also brought about environmental degradation, rapid urbanisation and industrialisation. In urban areas, the surface water, groundwater, air, land, and

natural resources are all seriously polluted, which adversely impacts human health in these areas.

In the context of a rapidly urbanising world, understanding complexity and managing human–environment interactions within urban areas is vital to balancing the interdependent social and ecological goals of sustainability (Ash et al. 2008; Bettencourt and West 2010; Clark 2007). Urban planning can tackle these sustainability challenges by addressing the inherent links between the interacting economic, environmental, and social components in human–environment systems (Wilkinson et al. 2013; Wu 2013a). A comprehensive planning approach has the potential to harmonise human–environment interactions and mitigate the harmful impacts of urbanisation (Andersson 2006).

Urbanisation is increasingly affecting environmental quality and ecosystem patterns on a global scale (Piorr et al. 2011; Wu 2013b). Changes in the use of land depend on place-specific factors that shape the spatial organization of metropolitan areas and are in turn influenced by the socioeconomic and planning context on both the national and regional scale (Hall and Hay 1980; Couch et al. 2007; Turok and Mykhnenko 2007).

Urbanisation presents one of the most pressing and complex challenges of the twenty-first century. The design, management, and function of cities are likely to shift substantially based on demands created by two powerful trends. One trend involves a growing awareness of a threat to the sustainability of the earth's natural environment. The second is the rapid rise in the number of people moving into and living in cities (Alusi et al. 2011). Combined, these trends call for the massive development of new buildings and infrastructure, along with new social and cultural institutions, to accommodate a large number of city dwellers without irreparably harming the natural environment. This paper focuses on the complaints by the residents of the municipality located in the Kuala Lumpur Extended Mega-Urban Region (KLEMUR). Hence, this article discusses a conceptual model of developing an environmental awareness among the Malaysian people. Generally, people are more aware of the changes that take place to the urban ecosystems as the recipients of governmental rules or policies. However, they need to be aware and take actions to sustain the ecosystem services and functions as well. The level of awareness among the Malaysian people now has improved.

2 Sustainable Development: The Dialogic Model of Environmental Awareness

2.1 The Arguments

This study is preliminary in nature. It is asserted here that resident complaints in the municipality about the management of the municipal environment, especially in and around their housing neighbourhoods, are the outcome of a system of the process as outlined below.

The level of environmental awareness and sustainable development among people around the world is low, especially in developing countries such as Malaysia (Shaharudin 2015). Several studies showed that Malaysian people's awareness of sustainable development is still at a low level in practice (Pauziah 2004; Meereh et al. 2010; Sharipah et al. 2012). Meanwhile, at specific levels of society, for example, Azapagic et al. (2005) reported that a worldwide survey of undergraduate engineering students on how much they understanding about sustainable development was low. At the society level through Local Agenda 21 Program, shows a lack of awareness among the community resident led to a lack of participation, which is a challenge for local authorities to manage the areas (Zan and Ngah 2012). Therefore, the level of community awareness need to be enhanced. Hence, awareness and concern regarding the causes and adverse impacts of environmental issues need to be measured in an environmental awareness context (Karatekin 2014).

It has been said that the higher individual cognitive level to environmental issues and the cause-effect schemes, the higher the intentional environmental behaviour. Deficient environmental awareness of overwhelming environmental problems, urbanisations, industrialisation, deforestation, rising global temperatures and degradation of biodiversity impedes the achievements of policymakers' efforts to counter the environmental stresses, resulting in quality of life getting off track (Keles 2012). Quality of life can be multifaceted from the viewpoint of economic, ecology, social and human aspects (Marans 2012; Keles 2012). Eventually, quality of life is always linked to environmental studies; therefore, it captures the attention of policy makers when planning and managing living environments (Marans 2012). Because policymakers are concerned with quality of life, gauging the environmental awareness among Malaysians is considerably significant to the efficiency of policy planning. Without considering the intervention of public environmental awareness, the design of policy can cause unexpected outcomes from the environmental protection programme.

3 Detailing the Model

3.1 Harmonising the Sustainable Development Concept and Dialogic Change Model

Using the sustainable development principles and dialogic change model, we propose a conceptual model for environmental awareness among the Malaysian society. The interrelating principles of environmental integrity, economic stability, and societal well-being were used as a basis for developing the dimensions of sustainability (World Commission on Environment and Development [WCED] 1987). Serving as the background, the sustainable development principles are linked to the

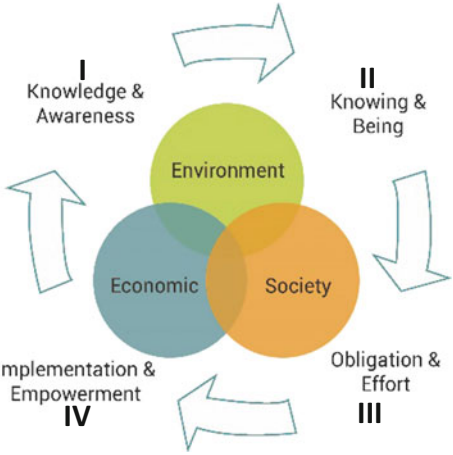

Fig. 1 Changing behaviour model for sustainability

dialogic change model. The dialogic change model harmonises the principles of sustainable development mentioned previously through changing behavioural values. We call the model a Changing Behaviour Model for Sustainability (Fig. 1).

At the forefront, the concept and principles of sustainable development (WCED 1987) are derived from the model based on two basic components: (1) interlinkages of economic growth and stability, environmental integrity, and society well-being; and (2) supporting ideas for sustainable development, such as education, that are embedded in the sustainable development concept. The values from the education system—*knowledge and awareness, knowing and being, obligation and effort*, and *implementation and empowerment*—are used as dynamics of the people's changing behaviour to achieve sustainability as a whole.

The model consists of four phases in the cycles. First, *Knowledge and Awareness*, which comes from tacit knowledge or explicit knowledge (Polanyi 1996), refers to the knowledge and awareness that people obtain from formal education systems, such as schools, and informal education systems, such as extracurricular activities about, for example, how we preserve and manage the environment to achieve sustainability as a whole. Second, *Knowing and Being* refers to what the people understand the importance and function of the environment surrounding them, including flora and fauna. If the people understand the importance of the environment, then they will give a full *Obligation and Effort* to preserve and conserve the environment for their economic growth and stability as well as societal well-being for now and the future. Therefore, finally, the *Implementation and Empowerment* stage is translated into taking action from the *Obligation and Effort* stage. The implementation is followed by empowerment to continue the process for the enhancement of the whole system. Examples of the values embedded in the people in the municipality are shown in Table 1.

Table 1 The phases of changing behaviour for sustainability

Phases	Level	Values
Phase I	Knowledge and awareness	• Knowledge of the importance of the environment • Awareness of the environment
Phase II	Knowing and being	• Understanding • Learning
Phase III	Obligation and effort	• Commitments • Energy • Strength
Phase IV	Implementation and empowerment	• Positive action taken • Doing by learning

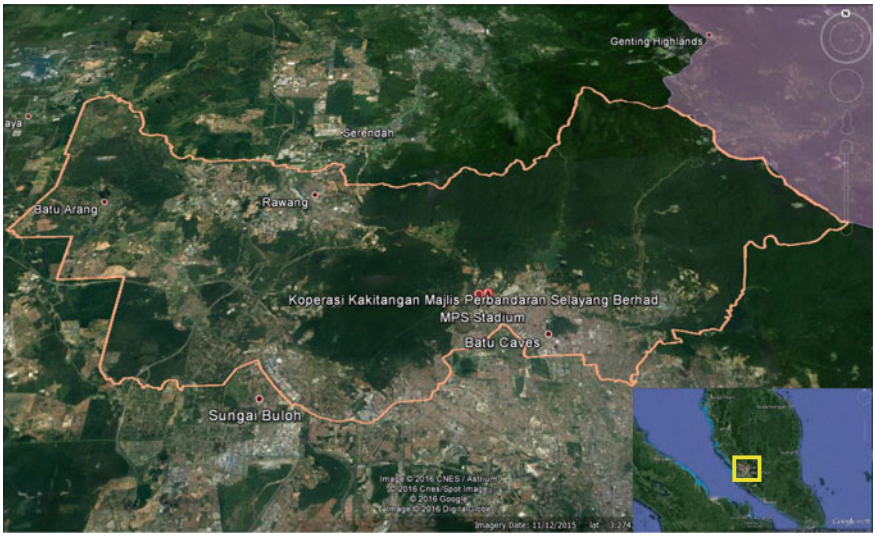

Fig. 2 The study area, Selayang Municipal Council, Selangor, Malaysia

4 The Study Area

The Selayang Municipal Council (MPS) is located about 20 km to the north from Kuala Lumpur (area of 549.33 km^2) and consists of three subdistricts: Setapak, Rawang, and dan Batu. In 2000, the population was 555,410, which increased to 682,226 in 2010. This area is rapidly developing socioeconomically (Fig. 2).

The MPS is a local government authority that administers urban land in Selayang, Selangor, Malaysia. Previously known as the Gombak District Council (*Majlis Daerah Gombak*—MDG), the MPS has been operating since 1 January 1977, under Act 171, Local Government Act 1976. The administration covers the Mukim Rawang, Mukim Batu, and parts of Mukim Setapak. The MPS gave

birth to several previous local government councils, such as the Gombak Town Board, Town Board Rawang, Kuala Ampang Municipal Board, and Sacred Area PKNS Taman Batu Caves Industrial Area. The MPS has several small offices or branches located in Batu Arang, Rawang, and Sri Gombak, for example.

5 Methods of Data Gathering

The conceptual framework was developed based on two main components of hard data. First, the awareness campaign activity data for the past 10 years (2005–2015) was gathered from the Town and Country Planning Department (TCPD), peninsular Malaysia; the Department of Environment (DoE); and the Ministry of Health (MoH). Second, the complaints data were drawn from the MPS. The complaints data available in the municipality were used in ensuing analyses, including the spatial distribution analysis. This article mainly uses the complaints data by the residents in the MPS located in the Selangor State as a case study to investigate the level of awareness and actions taken by the urbanites in these urban areas. The complaints are based on the neighbourhood boundaries and include the types of complaint, channels of complaint, and percentage of the complaints that were settled by the local authorities. These data were then analysed through the model in Fig. 1.

6 Results and Findings

Through the various ministries, agencies, and departments of the Malaysian government, sustainability initiatives have been conducted based on the environmental awareness programme, especially in the urbanised areas throughout the country. The programmes were conducted throughout past two decades. Table 2 summarises the environmental awareness government initiatives in urban areas.

7 Translating Knowledge and Awareness into Implementation and Empowerment

7.1 The Spatial Dynamic of the People

Generally, people are more aware of the changes that take place to the urban ecosystems as the recipients of governmental rules or policies. However, they need to be aware of environmental issues and take action to sustain the ecosystem services and functions. The level of awareness among the Malaysian people is then can be improved. The actions are taken by the people to the MPS via telephone calls, face-to-face complaints, and emails. The main findings of the study are issues

Table 2 Government initiatives of environmental awareness in urban areas

Initiative programme	Description	Period	Implementation	Implementing agencies
Healthy city	• A process to achieve a better physical and social environment • Committed to the development and maintenance of the physical and social environment that supports and promotes health and quality of life	1994	• Access to health facilities • Effective and efficient waste management system • Neighbourhood cleanliness campaign • Healthcare campaign • Encouragement to practice a healthy and balanced diet • Encouragement to use public transport • Walkways and bike paths • Cleanliness in the market, public toilets, and food stalls • 10,000 steps programme	Ministry of Health
Smart city	• Buildings and environment: Building management systems need more focus on efficiency and sustainability • Health: information communication &technology (ICT) -infrastructure ready for next-generation application • Energy. Need for an upgrade of the level of sustainability • Education: growing need to implement e-learning through electronic media • Transport: lower the dependence of private transport (which is due to the low quality of public transport) • Digital media: mobile penetration already close to 100%, but household broadband penetration (HSBB) less than 40% availability	2009	• Government construction of Low Energy Office and Zero Energy Office, which are accommodated by government agencies • Focusing on water efficiency and savings through integrated water management at buildings monitoring of water usage through smart meters • Households provided a rubbish bin; rubbish collected twice a week, while recyclables collected on a separate day • Economic transformation programme (Healthcare) —senior living • Building up solar power capacity, which gives additional benefits to enhance energy independence, fulfil the green agenda, increase energy security, increase employment, and catalyse local manufacturing and foreign direct investment • Building a health sciences education discipline cluster; building an advanced engineering, science,	Department of Environment (DoE), Ministry of Natural Resources and Environment

(continued)

Table 2 (continued)

Initiative programme	Description	Period	Implementation	Implementing agencies
			and innovation discipline cluster; and launching Educity in the Iskandar region • Promoting green technology and ensure sustainability development of the nation, full exemption of import duty, and excise duty on hybrid and electric cars (below 2000cc) • HSBB plan calling for Telekom Malaysia to deploy high-speed fibre access within the greater Kuala Lumpur area	
Sustainable City	• Inhabited by people dedicated to minimization of required inputs of energy, water and food, and waste output of heat, air pollution—CO_2, methane, and water pollution • Competitive economic • Sustainable environmental quality • Prosperous community Optimum land use and • natural resources • Efficient infrastructure and transport • Governance effective	2014	• Economic competitiveness through economic growth, poverty eradication, and private investment • Quality of environmental sustainability that has risk management and is environmentally sound • Community prosperity viewed through a residential location, community facilities and recreational areas, quality of life, safety, and demographics • Land and natural resources used optimally through changes in land use, urban development and heritage conservation, agriculture, and tourism • Infrastructure and transport productivity through efficient utilities, solid waste management, transportation systems, and sewage and waste management • Governance through an effective delivery system, strengthening institutions, and enforcement and monitoring	Department of Environment (DoE), Ministry of Natural Resources and Environment
Safety city	• The approach taken to resolve the security issues that occur in urban areas	2004	• Design and implementation of a secure physical environment, separation of pedestrian walkways from vehicle passage, and GIS mapping of crime	Federal Department of Town and Country Planning, Peninsular Malaysia; Ministry of Urban Well-Being, Housing and Local

(continued)

Table 2 (continued)

Initiative programme	Description	Period	Implementation	Implementing agencies
	• Defined as a city with environments that are free from all threats to physical, social, and mental well-being • Free from violence, such as thefts, snatch thefts, burglary, and so on causing loss of life and injury, property damage, and social illness • Free from natural disasters such as floods and landslides • Free from social and moral deterioration such as drug addiction, white collar crime, corruption, abuse of power, and low integrity and moral deterioration • Free from any kind of accident inside and outside the building such as fires and road accidents		• Empowering the target area by providing a police station or mobile police station, providing security mirrors, warning signs of crime, security alarms, and motorcycle parking lock; installing closed-circuit television (CCTV) on business premises and adequate lighting; and ensuring public walkways are not shielded from public view to generate appropriate activities in areas prone to crime • Management, participation, and community awareness through education, public awareness, and publicity; increase patrols in the housing area and providing a fixed agenda local authority monthly full council meeting	Government

Source Compilation by the author from various documents and years

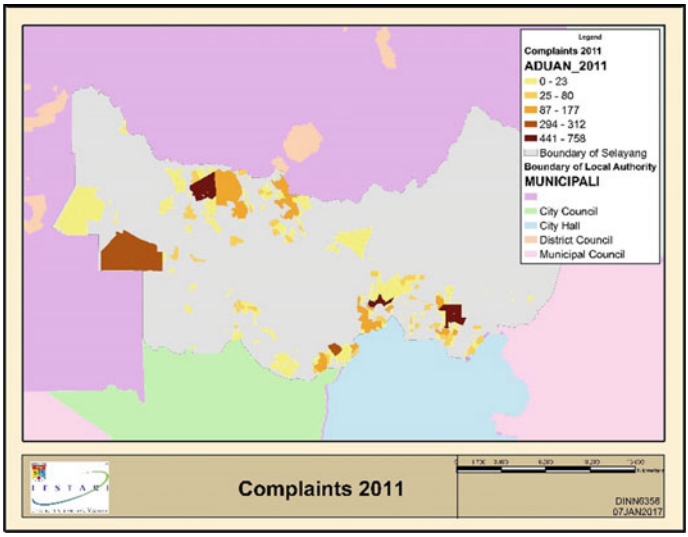

Fig. 3 Spatial distribution of complaints, 2011

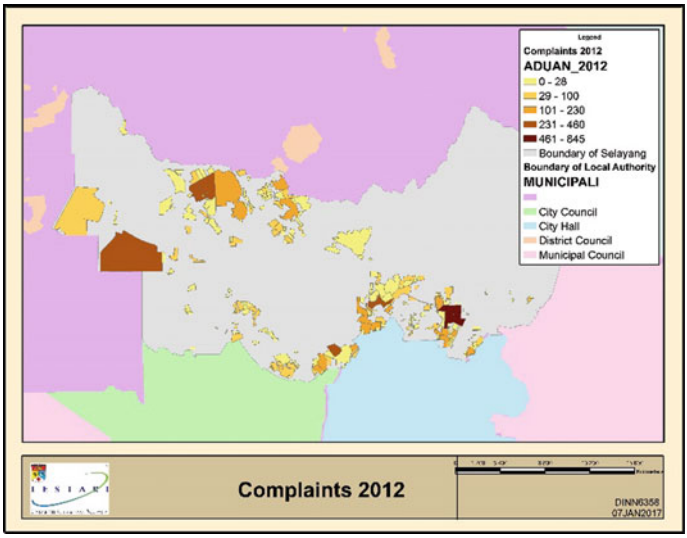

Fig. 4 Spatial distribution of complaints, 2012

related to cleanliness and maintenance of residences, among others. The major implications are to the planning policy and to the ecosystem resilience. Figures 3, 4, 5, 6 and 7 show the spatial distribution of complaints by the residents regarding environmental problems for the period from 2011 to 2015 at the neighbourhood level.

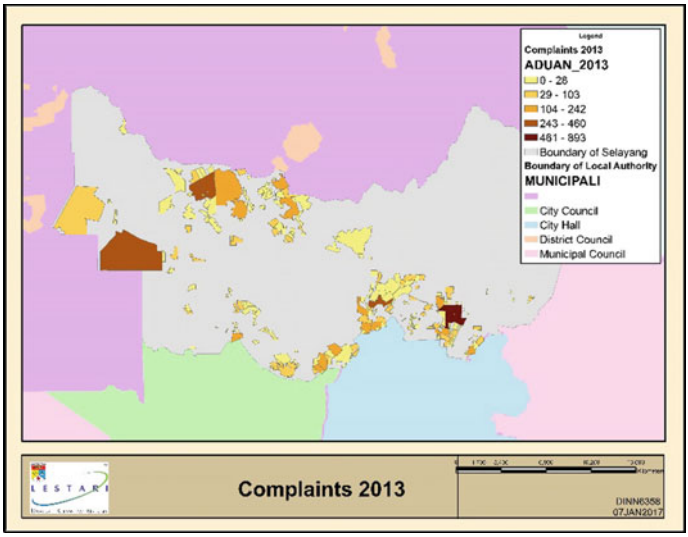

Fig. 5 Spatial distribution of complaints, 2013

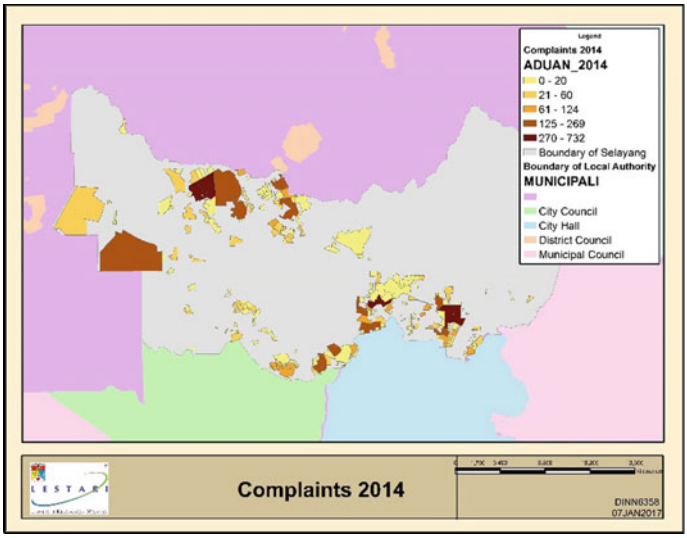

Fig. 6 Spatial distribution of complaints, 2014

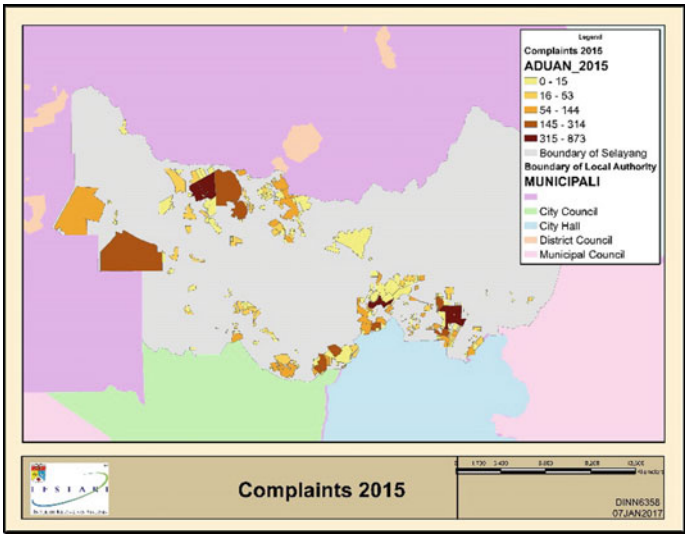

Fig. 7 Spatial distribution of complaints, 2015

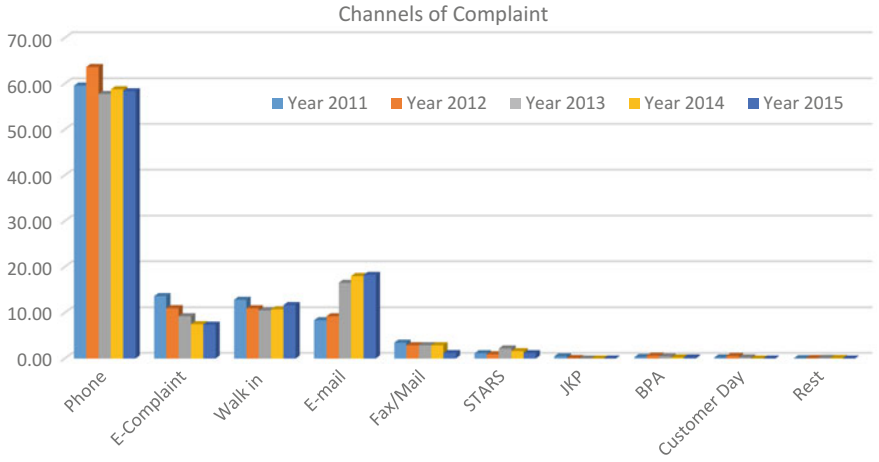

Fig. 8 Channels of complaints by residents, 2011–2015

8 Types of Complaints by Residents

The types of complaints by the residents include maintenance issues such as blocked drains, rubbish and litter, uncut grass, broken street lights, broken drains, fallen trees, and unpruned trees. These are the main complaints by the residents according to the neighbourhood boundaries. The resident's association plays an important role in linking the people to the local authority to ensure that the complaints are taken care of by the local authority.

9 Channels of Complaint

Based on the top 10 channels of complaints provided by the local authority, when residents complain, they mainly use the telephone (59.57% in 2011, 63.65% in 2012, 57.77% in 2013, 58.76% in 2014, and 58.37% in 2015), followed by using the e-complaint systems provided by the local authority (13.60% in 2011, 11.01% in 2012, 9.20% in 2013, 7.48% in 2014, and 7.39% in 2015). Residents walking into the local authority office was the third main channel of the complaint where the number of people complaining using this channel was about 12.82% in 2011, 10.95% in 2012, 10.49% in 2013, 10.70% in 2014, and 11.64% in 2015. The trends of complaint channels were shown in Fig. 8.

10 From Science to Policy: Science-Policy Interface Addressing Environmental Awareness

Although this study is somewhat preliminary due to data problems, it nonetheless has policy implications. Figure 9 summarises the science-policy interface diagrammatically. This study focuses on a small aspect of the sustainable city (or, for that matter, can be related to all aspects of the city as shown in the boxes related to

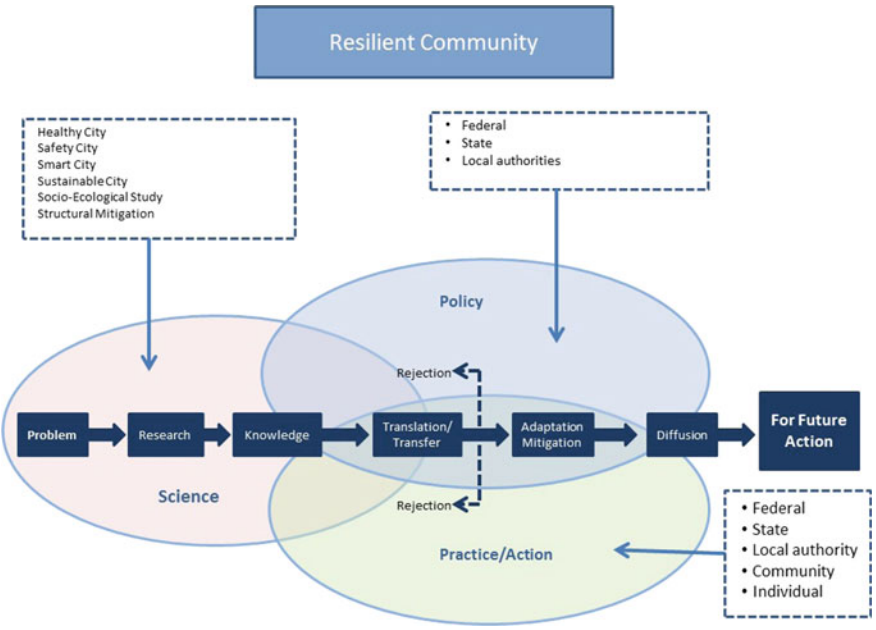

Fig. 9 Science-policy interface addressing environmental awareness in Malaysia

science) and generates knowledge about the actions of the residents in the municipality when coming face to face with the aspect of the environment in their respective neighbourhoods. The complaints can generate new policy matters on which the municipality can take further action. This further action references the specific areas, whether at the federal, state, or local level.

11 Conclusion: Potential and Limit of the Model

We can draw three important conclusions from this study. First, Malaysian urban areas are now more aware of the state of the environment, especially in their neighbourhoods. This is due to the entrance of continuous reminders and urging by several levels of authority through print media and television campaigns about the need to keep the environment clean to avoid the Aedes mosquito and the Zika scare.

The second conclusion is that exposure to information about the impact of the degrading environment must have contributed to the internal behavioural changes among the people of the municipality, eventually resulting in complaints. The majority of complaints seem to have come from the same neighbourhood. Finally, although there is government policy at the local authority level, the action taken is somewhat weak due to the people of the neighbourhood not taking action to redress the complaints. The 'not my backyard' syndrome applies here.

From these observations, we can then comment on the model used earlier. While the model is useful to frame our examination of the complaints by the people in the municipality, a more detailed data set would tell us about the process before the complaints. This may a few concepts in the model such as values from the education systems that need to be further verified. We have made assumptions regarding the process that occurs before the complaints; nonetheless, the model is useful for the purpose at hand.

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Millennium Development Goals in Nigeria: Improving and Sustaining Growth Rate

Wilson Friday Ohioze

Abstract

The augmented Solow human-capital-growth model by Mankiw, Romer and Weil is used to examine the influence of the product of human capital development and labour force and other variables on gross domestic product growth rate in Nigeria, using quarterly time series data between 2000q1 and 2015q4. The study reveal that the lag of gross domestic growth rate, lag of log of the product of human capital development and labour force and that of gross capital formation explained the dependent variable significantly. This is an indication that, the treatment variables are important in improving and sustaining the gross domestic product growth rate in Nigeria irrespective of their signs. The study outcomes further show the existence of long-run relationships among the variables. The study therefore, recommends the need for government and policy makers to give preference to qualitative human capital development. Besides, enabling economic and business environments that would guarantee macro-economic stability should be vigorously pursued. That said foreign investors would be attracted to invest in the nation's economy. Ohioze Wilson Friday is a lecturer in the Department of Economics, Faculty of Social Sciences, National Open University of Nigeria. He is a member of the Nigerian Economic Society (NES). His erudite works have been published in top Nigerian journals. His research interest is in Health and Public Sector Economics with special focus on Healthcare financing.

Keywords

Economic growth · Human capital development · Augmented Solow model · Millennium development goals

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1 Introduction

Most developing nations like Nigeria are still being challenged with lots of socio-economic problems such as poverty and hunger, child labour, discrimination against women, rising children's death, high rate of maternal death, malaria infections and environmental degradations. According to Ajiye (2014), these socio-economic problems are the cankerworms against growth and development. Disturbed by these problems, world leaders and leading development organizations in year 2000 met in, the United State of America (USA) and came-up with a developmental-blueprint (Ajiye 2014) which encompassed how these deplorable situations could be resolved. That meeting led to the birth of "Millennium Development Goals (MDGs)", to advance the growth and development of mankind. That was indeed the world's ever thoughtful and collaborative support towards human progress. Hulme's work (in Ajiye, 2014) describes the summit as the world's biggest promise—a global agreement to reduce poverty and human deprivation at historically unprecedented rate via collaboration.

Nigeria was one of the 189 nations that signed up to the formation of MDGs in the USA. She was committed to the implementation of the eight (8) objectives of the developmental-blueprint. This is evident in term of policy implementations. According to Adawo (2011), Nigeria initiated developmental plans such as National Economic Empowerment and Development Strategy (NEEDS), Subsidy Reinvestment Programme(SURE-P), Vision 2010, and many others, all that was within the framework of MDGs as driving forces to meet the set goals. The implementation of Millennium Development Goals as developmental agenda has since closed. However, reports made available show that Nigeria as a country made marked improvements though, checkered.

In order to improve and sustain the outcomes already achieved, World leaders again meant, and come-up with another developmental agenda now known as Sustainable Development Goals (SDG). The new developmental initiative is to continue and complete the unfinished Business of the now old developmental agenda, MDGs. The scope of the new agenda has been enlarged, and it covers 17 goals. Among these is goal 8, it about increasing the economic growth rate of developing nation to attain a minimum of 7% gross domestic product growth rate per annum. It is important to note that, studies such as Jaiyeoba (2015), Kanayo (2013), Adawo (2011) and many others have investigated economic growth and human capital development, using gross domestic product as a proxy for economic growth. However, researches that have specifically investigated the effect of human capital development on economic growth rate are rare. This study therefore, seeks to appraise the performance of the country's Gross Domestic Product (GDP) growth rate during the last development agenda and examine the effect of Human Capital Development (HCD) on growth rate. To achieve this, the paper is therefore structured thus: Sect. 1 is introduction, Sect. 2 reviews related literature,

theoretical framework is discussed in Sects. 3 and 4 focuses on economic growth rate in Nigeria, human capital development in Nigeria occupy Sect. 5, methodology and estimation procedures are in Sect. 6, results and discussions in Sect. 7 and conclusion in Sect. 8.

2 Review of Related Literature

Basically, the periods during which the MDGs were implemented in Nigeria and how it impacted on Nigeria's economic growth rate form the focus of this study. During this period (i.e. 2000–2015), the level of the nation's economic performance often measured by rate of growth (that is, GDP growth rate) is of primary concern. Of the eight MDGs, goals 2: attain universal primary education by 2015, goal 4: reducing child death, goal 5: improve maternal health and goal 6: combat major diseases such as HIV/AIDS and malaria, were directly linked to the development of human capital. These goals had directly or indirectly influenced the growth rate through the participating countries' productivities (output per input).

The review of scholarly works about economic growth and human capital development has revealed the nexus among the considered economic variables. In fact, a causal relationship exists between economic growth and human capital development. According to Kanayo (2013), two distinct causal chains exist between the two. First, it runs from economic growth to human capital development, that is, financial resources from national income are billed to improve human capital development, second, it runs from human capital development to economic growth. This means that human capital development would aid the rise in the income level of a country. This somehow rubs-on on the individuals' resources. A World Health Organization's report (as cited in Isola and Alani 2012), submits that improved labour productivity contributes positively to per capita income (income that accrues to individuals in a nation from the national income). Also, Rosen (as mentioned in Eigbiremolen and Anaduaka 2014) opines that human capital is the investment on individuals to increase their level of productivity. Synthesizing Rosen and World Health Organization submissions, it can rightly be inferred and declared that growth rate is a function of productivity, and that productivity, in turn, is dependent on the human capital development of any country. Therefore, the rate of growth in terms of GDP of the country is a function of both the productivity level and the human capital development. Kanayo's submission also reveals a bi-directional scenario between growth rate and human capital development, that is, the two variables (GDP growth rate and human capital development) Granger cause one another.

The importance of human capital development in enhancing economic growth in any nation cannot be overemphasized. This is because human capital is an active force in the production process. It coordinates all other resources like finances, raw

materials and the likes that are always passive in the production process to yield the expected output. According to Harbison and Myers (1964), the absence of human capital to coordinate other non-human resources, would lead to non-performance, and economic growth impeded. Economic growth of any country cannot be significant if the human capital is not fully developed. Jaiyeoba (2015) exemplifies that the economies of the Asian tigers (Taiwan and Singapore) improved substantially because of the development or investment in their human capital.

However, scholarly studies such as Caselli et al. (1996) have shown that there are no empirical proofs that human capital development enhances economic growth as revealed. For instance, Pritchett (1996) submits that the educational attainment of the workforce does not positively influence the rate of growth of the worker's output. Pritchett's submission may be right. This is because the quality of education that develops or trains a nation's human resources is dependent on that country's educational system. So, if the quality of a nation's educational system is poor, the human resources that will be produced by such a system may not be able to influence the workers' output. Isola and Alani (2012) declare that there is a differential in the quality of education across nations' boundaries. Nevertheless, the positive association that exists between growth rate and human capital development cannot be down-played. The Chinese experience is a good example. China achieved (that is, rapid economic growth rate) what took some nations several decades to achieve in few years. Between 1978 and 1996, the Chinese growth rate grew from 3.9 to 9.5%. Studies have revealed that the buildup of her human capital was significantly responsible for the leap in China's growth rate.

According to Jhingan (2005), customarily, economic growth can be linked to the accumulation of both physical and human capital. These physical resources are kinds of capital which also is part of production process. However, the human resources on their own are education and health encompassed. Therefore, education and health develop the human resources which help to increase productivity, fitness and others. What Jhingan (2005) opines is that, the association between human capital development and economic growth is not an unusual phenomenon, and that the buildup or accumulation of human resources via health and education would impact on GDP growth rate positively. Corroborating Jhingan's opinion, Lawanson (2009) declares that education and health [as mentioned by Jhingan] are two components which are closely related in the formation of human capital. These (health and education) aid productivity. Education and health complement each other in the process of human resources development. No wonder Ohioze and Uwazie (2016) submit that the issue of health can no longer be relegated to the background when debating human capital development. For any nation to progress in both economic and political fronts, adequate provision for the development of that nation's human resources is very vital. Where this is lacking, such a nation's progress is tantamount to sluggishness. Harbinson (cited in Anyanwu et al. 2015)

observes that a nation that is not able to develop her human resources, and use them effectively in nation building, is not capable of developing any other thing.

Empirically, studies have shown the relationship between human capital development and economic growth. In spite of the methods and models employed in the various analyses, there seems a general agreement that human capital development promotes growth. Kanayo (2013) examines the link between human capital development and economic growth in Nigeria, using the error correction model as an analytical tool. The study outcome reveals that human capital investment in the form of education and capacity building at both primary and secondary levels impact positively on economic growth. However, capital expenditure on education was insignificant to growth. In order words, Kanayo's study reveals that, the influence of capital expenditure on education on economic growth was very minimal during the period considered. Also, Jaiyeoba (2015) investigates the relationship that exists between education, health and economic growth in Nigeria, using time series data which span from 1982 to 2011. The study utilized ordinary least square (OLS) method to analyze the data. The findings show that there exist a long-run relationship between government expenditure on education, health and economic growth.

Isola and Alani (2012) examine the form of association that exists between growth and human capital in Nigeria, using a sample period of 1982–2005. The study employed both descriptive and regression methods to analyze the data. Descriptively, the finding reveals that government over the years committed little funds to health when compared to education. However, the regression result shows that human capital development with the two basic components (education and health) is crucial to growth in Nigeria. Lustig (2006) investigates how related health is to growth in Mexico using data that covered 1970–1995. The study used life expectancy and mortality rates of different age grades as indicators for health. The outcome of the analysis reveals that, in Mexico, one-third of the long-run growth in that economy was caused by health. He concludes that good health is a source of well-being highly valued all over the world. This further confirms Ohioze and Uwazie (2016) submission that, health is a vital component of Human Capital Development (HCD). While Lustig looked at an aspect of HCD which is health, Wilson and Briscoe (2004) considered education and training another component of HCD and productivity. The study shows that increasing investment in education has increased people's productivity and their earnings. The study's outcome also indicated a spillover of education investment to other segments of the economy.

Having appraised related studies, it is discovered that studies that have empirically examined the interactions between GDP growth rate and human capital development in Nigeria are rare. Also, in Nigeria, GDP has often been used to proxy economic performance. This study, therefore, tends to bridge this gap in knowledge in other to make meaningful contribution(s) towards improving and sustaining growth rate in Nigeria.

3 Theoretical Framework

The framework for this study is predicated on the endogenous growth model, often called "new growth theory." The growth model centres on the fact that, a nation's development is propelled by certain factors which are found within the boundaries of a country. This understating tally with the model originators' ideas that, growth rate of GDP is endogenously determined by certain factors found around the economic environment. Among these factors, is the human resources. According to Romer (1994), human capital accumulation in a nation is a necessary factor for continuous economic growth. The suitability of this model for this study is based on the fact that economic growth is human resources determined, and it focuses on investment on human capital in developing nations like Nigeria with lots of available human recourses. The theory reveals that a country with good incentives for her human capital investments would post good GDP growth rate. Todaro and Smith (2003) posit that the theory seeks to explain the factors that determine the magnitude of the rate of growth of the GDP that is not explained by Solow growth model.

Deducing from what endogenous growth model entails as explained above, we, therefore, consider an economy whose economic output is determined by both the human and physical factors. Though, the human resource (active factor) is the focus of this study. According to Harbison and Myers (1964), human resources coordinate the non-human resources (the physical factor), a fraction of the entire human resources. Therefore, in order to fully capture the influence of HCD on the growth rate in the Nigerian economy, this study considers the augmented Solow human-capital-growth model used in Eigbiremolen and Anaduaka (2014), with modifications. The new model (that is, the augmented Solow human-capital-growth) was a contribution to knowledge by the trio of Mankiw et al. (1996). The model incorporated human capital development into the Solow model to show the influence of education and skills on the active factor. This was originally not in the Solow's model.

$$Y = AK^{\alpha}(hL)^{\beta} \tag{1}$$

where: Y, K, A, and L represent growth rate of output; capital stock; total factor productivity; and the work force. The h in the model is human capital development that improves the work force (active factor), α and β are elasticities of both capital and labour inputs with respect to output. The model as it is in Eq. 1 is deterministic, and may not be suitable for any econometric estimation. The model is therefore transformed econometrically to a state of being stochastic. Thus:

$$Y = AK^{\alpha}(hL)^{\beta}e \tag{2}$$

4 GDP Growth Rate in Nigeria

Economic growth is sustained rise in the total output or the supply of goods and services in an economy. It is often represented by the Gross Domestic Product (GDP). However, growth rate is percentage rise in the output or real income of a particular nation. It is commonly measured in 'percentage' (%). In Nigeria, the growth rates in the periods under consideration had checkered outlook, and in most of the years under focus, it was below the Sustainable Development Goals (SDGs) recommended minimum target of 7% (see Table 1). Nonetheless, the GDP growth rates all through the period were positive. For instance, in 2004, the value was 33.74, 10.35% in 2003, 8.21% in 2006 and 7.84% respectively. Outside these years, every other year recorded below 7%. The least value was 3.44% in 2005. In 2016, between the first and the third quarters, the GDP growth rate according to National Bureau of Statistics (NBC) fell below zero. Stable policy implementation and steady inflow of crude oil revenue accounted for the positive GDP growth rate figures recorded between 2000 and 2014. However, the drop in growth rates which occurred in the first three quarter of 2016, was as a result the sudden drop in the price of crude oil in the international market that started mid-2015, and continued all through 2016. As a result of this, the steady inflow of income was no longer

Table 1 GDP growth rate in Nigeria (2000–2014)

Year	GDP growth
2000	5.32
2001	4.41
2002	3.78
2003	10.35
2004	33.74
2005	3.44
2006	8.21
2007	6.83
2008	6.27
2009	6.93
2010	7.84
2011	4.89
2012	4.28
2013	5.39
2014	6.31

Sources (i) World Bank National Accounts Data via www.indexmundi.com
(ii) Central Bank of Nigeria' Statistical Bulletin

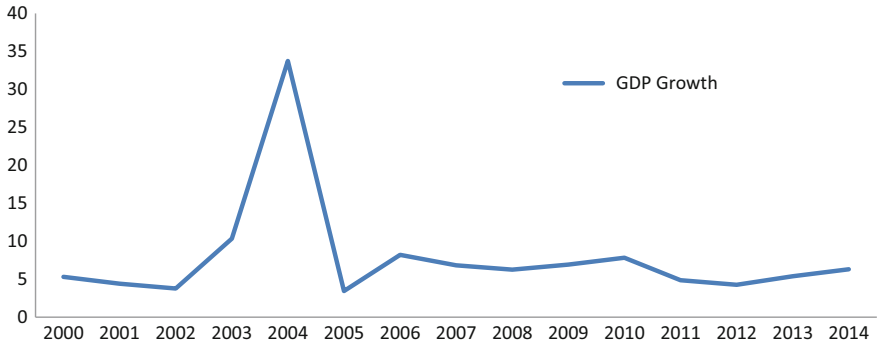

Fig. 1 Graph of GDP growth rate in Nigeria (2000–2014)

guaranteed. To have a vivid understanding of the movement of the GDP growth rate during the reviewed periods, see graph in Fig. 1.

5 Human Capital Development in Nigeria

The level of a nation's human capital formation or development such as Nigeria can be ascertained by the Human Development Index (HDI). The HDI takes into cognizance three basic indicators. These are: life expectancy, educational attainment and standard of living. Development Economists have substituted the 'standard of living' for 'income.' Whichever is preferred, the other two that is, life expectancy and educational attainment still hold sway in HDI estimation. Using HDI to gauge Nigeria's level of HCD, the United Nations Development Programme (UNDP)'s report (2008) reveals that, Nigeria's HCD was low when put side by side with those of other nations in the emerging economies. Also, her HDI global ranking was not encouraging. In 1997, out of 174 nations that were valued and ranked, Nigeria's HDI was ranked 146, 156 in 2011 out of 187 and 153 in 2013 of the 187 countries. Besides, even in the Index of Knowledge Economy (KEI), Nigeria still trails from behind. According to Adawo (2011), Nigeria's rating even among African nations is poor. While South Africa, Mauritius and Tunisia recorded 5.01, 4.32 and 4.11 respectively, Nigeria had 1.55 in 2003 to 2004. These reports about Nigeria's HCD are not cheering. No nation anywhere in the world can grow her economy beyond the level of her HCD. This is because, in production process, qualitative output is always guaranteed by the quality of input engaged. While the human capital/resource serves as the input in the production system called the

Nigerian economy, the economic performance measures in growth rate is the output. In order words, this is a case of input–output scenario.

6 Methodology and Estimation Procedure

For good and reliable result, Eq. 2 specified above is transformed into a log-linear form to make it appropriate for econometric analysis. Thus:

$$\text{Log } Y = \log A + \alpha \log K + \beta \log \text{hL} + e \tag{3}$$

where e_t is the error term, and with the introduction of log notation, the Eq. 1, is now linearized. Output (Y) in the model is captured by GDP growth rate; capital stock (K) is proxy by gross capital formation percentage of GDP; human capital development cum labour force (hL) is measured by the interaction of Human Development Index (HDI) and labour force. However, the fundamental modification in this model is linked with the variable h, the human capital development. This reveals the importance of health in human development (Ohioze and Uwazie 2016). Health was omitted in the augmented Solow human-capital-growth model. Therefore:

$$\begin{aligned}\text{GDP growth rate } &= \mathbf{f}[\text{gross capital formation},\\ &\quad (\text{HDI } \times \text{ labour force}), \text{infrastructural development}]\end{aligned} \tag{4}$$

$$\text{GDPgr } = \alpha_o + \alpha_1 \text{Gcapform } + \alpha_2 \log(\text{hL}) + \alpha_3 \log \text{ infradeve } + e_t \tag{5}$$

$$\begin{aligned}\Delta\text{GDPgr} = {} & \alpha_o + \alpha_1 \Delta\text{GDPgr}_{t-1} + \alpha_2 \Delta\text{Gcapfom}_t + \alpha_3 \Delta\text{Gcapform}_{t-1}\\ & + \alpha_4 \Delta\log(\text{hL}_t) + \alpha_5 \Delta\log(\text{hL}_{t-1}) + \alpha_6 \Delta\log \text{ infradeve}\\ & + \alpha_7 \Delta\log \text{ infradeve}_{t-1} + \delta\text{ECV}\end{aligned} \tag{6}$$

where:

GDPgr = Gross domestic Product growth rate
Gcapform = Gross capital formation (% GDP)
hL = product of human capital development and labour force
Infradeve = Infrastructural development
Log = Natural log (ln)
Δ and δ = Rate of change

Therefore, the a priori expectations are α_1, α_2, α_3, α_4, α_5, α_6, and $\alpha_7 > 0$. It is an indication that, the explanatory variables are expected to be positively related to the outcome variable (GDP growth rate).

Equation 5 is the augmented Solow human-capital-growth model. It shows how GDPgr is influenced by hl (the control variable). The long and short runs effect of the model is investigated using both the Ordinary Lease Square (OLS) and the Co-integration technique. This is underpinned by the fact that, the study is an impact analysis. The scope of the data gathered span across the periods between 2000q1 to 2014q4. These quarterly data were sourced from the Central Bank of Nigeria statistical bulletin, National Bureau of Statistics and the World Bank Index.

7 Result and Discussion

7.1 Interpretation of Regression Outcome

The static OLS regression output in Table 2 shows that the parameters in the model are statistically significant except for the Durbin Watson (DW) test statistic which indicates the presence of serial correlation. But because most macro-economic data are always trending and sometimes non-stationary, interpreting the static OLS result will be misleading and make no economic sense (see Asteriou and Hall 2011). The study therefore, proceeds to it's dynamic analysis (the statonarity analysis).

7.2 Stationarity Test Results

The stationarity or unit root analysis is mainly is examine the time series features of the data such as trend, intercept and the likes. To ascertain this, Augmented Dickey–Fuller (ADF) test is conducted on the macro-economic variables testing their null hypothesis of non-stationarity of the series. The outcome of the unit root test is in Table 3.

Table 2 Ordinary least square output

Variable	Coefficient	Std. error	*t*-statistic	Prob.
Constant	30.96607	24.43422	1.267324	0.2099
Gcapform	−0.656031	0.279238	−2.349358	0.0423
Loginfradev	0.404692	0.065951	6.136117	0.0022
Loghl	−6.859746	2.294618	−2.989494	0.0382
R-squared	0.756646		Akaike info crit	0.631024
Adj. *R*-squared	0.744479		Schw. crit	0.765954
F-statistic	62.18491		Hann–Qui crit	0.684179
Prob (*F*-statistic)	0.000000		Durb–Wat	0.122567

Table 3 Stationarity test result

Variable	ADF@ levels	ADF@ 1st DIFF	Order of integration
GDPGR	−2.022595 1%—3.540198 5%—2.909206	−2.993686 1%—3.540198 5%—2.909206	*I*(1)**
GCAPFOM	−2.173562 1%—3.540198 5%—2.909206	−1.203958 1%—3.540198 5%—2.909206	*I*(2)***
LOGINFRADEV	−2.205524 1%—3.540198 5%—2.909206	−1.959811 1%—3.540198 5%—2.909206	*I*(2)***
LOGHL	−1.881663 1%—3.540198 5%—2.909206	−2.952024 1%—3.540198 5%—2.909206	*I*(1)**

Source Author's computation via E-views
***, ** and * indicate 1, 5 and 10% significant levels respectively

Table 4 The Johansen co-integration test

Hypothesized no. of CE(s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.
None*	0.413882	67.01895	47.85613	0.0003
At most 1*	0.226015	34.43069	29.79707	0.0136
At most 2*	0.201449	18.80232	15.49471	0.0153
At most 3*	0.079905	5.079966	3.841466	0.0242

Trace test indicates 4 co-integrating equations at 0.05 level
*Denotes rejection of the hypothesis at the 0.05 level

7.3 Co-integration Test Results

Having discovered that the variables are stationary at both 1st and 2nd differencing, it is therefore imperative to ascertain the variables' long-run relationship otherwise known as co-integration test. The result as shown in Table 4 is according to Johansen approach. Using Trace test, it reveals that at 5% level of significance, there are four co-integration equations. This means that all the variables in the equation have long-run association at 5% significance level (that is, there is convergence to equilibrium in the long-run).

7.4 Parsimonious *Error Correction Model*

Table 5 shows the outcome of the study's parsimonious error correction model. This is of concern to this study than the over-parameterized model output in the appendix. It is important to understand that, the parsimonious error correction

model is obtained from the over-parameterized error correction output after series of elimination of variables which were not significant using the probability value (pv). The parsimonious result reveals that all the explanatory variables with the exemption of the lag of infrastructural development, have a significant effect on the dependent variable at both 1 and 5% levels of significance.

To consider the statistical significance of the parsimonious model, the adjusted *R*-squared, standard error test, *F*-statistic and the Durbin–Watson test statistic come handy. (i) The value of the R^2 is 98.88%, and indeed very high. This shows that 99% systematic variations in the dependent variable (GDPGR) are accounted for by the explanatory variables. (ii) The *F*-statistics indicates the robustness of the own model. That, at 1% level of significance; the study is 99% confident that the parsimonious model is well specified and appraised. Finally, the Durbin–Watson test statistic is 2.077405, and it is a sign of no traces of serial correlation among the variables.

The parsimonious result also reveals that, while the previous performance of the GDPGR positively influences the outcome of the current GDPGR, the lag of both GCAPFOM and LOGHL are inversely related. This is in-line Caselli et al. (1996) study. The study reveals that human capital development does not support economic growth. This is contrary to the apriori signs. This is because; the available

Table 5 Parsimonious (ECM) output

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	11.17017	3.535301	3.159609	0.0026
GDPGR(-1)	0.865820	0.032628	26.53626	0.0000
D(GDPGR(-1))	0.741590	0.082856	8.950350	0.0000
D(GCAPFOM(-1))	−0.365635	0.085978	−4.252639	0.0158
LOGHL(-1)	−2.432402	0.739027	−3.291356	0.0388
LOGINFRADEV(-1)	−0.187685	0.334529	−0.561043	0.5771
ECV(-1)	−4.947586	1.543300	−3.205849	0.0377
R-squared	0.988786	Mean dependent var	6.837207	
Adjusted *R*-squared	0.987516	S.D. dependent var	0.629620	
S.E. of regression	0.070348	Akaike info criterion	−2.361440	
Sum squared resid	0.262290	Schwarz criterion	−2.117100	
Log likelihood	7 7.84321	Hannan–Quinn criter.	−2.265866	
F-statistic	778.8517	Durbin–Watson stat	2.077405	
Prob (*F*-statistic)	0.000000			

Source Author's computation via E-views

human and material resources in Nigeria have not been fully harnessed and engaged to produce the required outcome. It is also possible that, the nation's HCD is not qualitative enough to support the production process. Where this is lacking, economic growth will be stunted (Harbison 1964). The ECV is speedy of adjustment. It reveals how long it will take to correct the short-run disequilibrium. In this case, it will take 494% adjustment quarterly.

8 Conclusion

The crux of this study is to review the growth rate during the periods of MDGs operations in Nigeria, and see how it could be improved and sustained using HCD. Using the augmented Solow human-capital-growth model by Mankiw et al. (1996), the study examined the interaction of human capital development and labour on growth rate. The Johansen co-integration test shows that four co-integrating equations among the variables engaged. The parsimonious error correction model reveals that the lag of gross domestic growth rate, lag of log of the product of human capital development and labour force and lag of gross capital formation are statistically significant in the determination of the dependent variable. This is an indication that, the variables are important in improving and sustaining gross domestic growth rate in Nigeria. The independent variable with the positive sign shows that, an increase in it, would improve the growth rate of the economy. However, the variables (independent) with negative signs reveal negative influence on the growth rate. Sequel to this findings, the study recommends the need for government and policy makers to urgently to give preference to qualitative human capital development. In addition, enabling economic and business environments that would guarantee macro-economic stability should be pursued. This would attract foreign investors to invest in the economy.

Appendix

Over-Parameterized ECM Output

Dependent variable: GDPGR				
Method: least squares				
Date: 11/16/16 Time: 15:30				
Sample (adjusted): 2001Q1 2015Q4				
Included observations: 60 after adjustments				
Variable	Coefficient	Std. error	*t*-Statistic	Prob.
C	23.06817	10.93274	2.110009	0.0403
GDPGR(-1)	0.874925	0.041687	20.98801	0.0000
D(GDPGR(-1))	0.675645	0.136216	4.960104	0.0000
D(GDPGR(-2))	−0.034490	0.150229	−0.229581	0.8194
GCAPFOM(-1)	0.243645	0.218696	1.114080	0.2710
D(GCAPFOM(-1))	−0.567215	0.704011	−0.805691	0.4246
D(GCAPFOM(-2))	0.169380	0.699395	0.242181	0.8097
LOGHL(-1)	−1.090048	2.858298	−0.381363	0.7047
D(LOGHL(-1))	52.39688	325.1268	0.161158	0.8727
D(LOGHL(-2))	−64.29622	324.7827	−0.197967	0.8439
LOGINFRADEV(-1)	−1.594693	1.322184	−1.206106	0.2339
D(LOGINFRADEV(-1))	0.726971	2.270655	0.320159	0.7503
D(LOGINFRADEV(-2))	1.229616	2.673969	0.459847	0.6478
ECV(-1)	−69.47356	328.5391	−0.211462	0.8335
R-squared	0.989186	Mean dependent var	6.837207	
Adjusted *R*-squared	0.986130	S.D. dependent var	0.629620	
S.E. of regression	0.074151	Akaike info criterion	−2.164475	
Sum squared resid	0.252922	Schwarz criterion	−1.675795	
Log likelihood	78.93426	Hannan–Quinn criter.	−1.973325	
F-statistic	323.6794	Durbin–Watson stat	2.065412	
Prob(*F*-statistic)	0.000000			

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Sustainability at German Universities: The University of Hamburg as a Case Study for Sustainability-Oriented Organizational Development

Claudia T. Schmitt and Sophie Palm

Abstract

The Center for a Sustainable University at the University of Hamburg, Germany (UHH), is an interdisciplinary institution wherein various university stakeholders work together towards creating a "University for a Sustainable Future". Thus, it is an example for addressing processes of sustainable development according to the whole institutional approach outlined by the UNESCO's Global Action Programme on Education for Sustainable Development (ESD). Moreover, the UHH Center for a Sustainable University is a field of application for sustainability-oriented organizational development. In this paper, the UHH Center for a Sustainable University is introduced and serves as a case study: First, a linkage between ESD and innovation processes is drawn and the advantage of organizational development for sustainability as a specific working domain is discussed. Second, barriers for sustainability-orientated transformation at higher education institutions are identified: Different barriers which emerge during the day-to-day business of the Center for a Sustainable University will be examined and deliberated. Finally, particular tools that might help to overcome these barriers are presented. In September 2015 the UN agreed on global goals for sustainable development (United Nations in Transforming our world: The 2030 agenda for sustainable development, 2015), and the UNESCO's roadmap on education for sustainable development highlights the importance of learning and training for transforming our world in a social responsible and sustainable way (UNESCO in UNESCO roadmap for implementing the global action programme on education for sustainable development, 2014). Obviously, the

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awareness for sustainability-related topics increases—in society in general as well as in science and at higher education institutions (cf. Leal Filho and Zint in The contribution of social sciences to sustainable development at universities. Springer, Basel, 2016; Lozano et al. in J Clean Prod 108:1–18, 2015; Schneidewind and Singer-Brodowski in Transformative Wissenschaft: Klimawandel im deutschen Wissenschafts- und Hochschulsystem—Transformative Science—Climate Change in the German scientific and university system. Metropolis, Marburg, 2013). Whereas numerous good practice projects and initiatives have been set up and collected that showcase "green campus development" (e.g. Bellantuono et al. in Introducing the Graphical Assessment of Universities' Sustainable Image (GAUSI) instrument: A marketing tool. Springer, Switzerland, pp. 213–228, 2016; Finlay and Massey in Int J Sustain High Educ 13(2):150–165, 2012; Atherton and Giurco in Int J Sustain High Educ 12(3):269–279, 2011) and the contribution of research and science to various problems that come along with climate change (cf. IPCC in Summary for policymakers. Climate change 2013. Cambridge University Press, Cambridge and New York, 2013; Costanza et al. in Sustainability or collapse?: An integrated history and future of people on earth. MIT Press in cooperation with Dahlem University Press, Cambridge, 2007) the question of how to institutionalize integrated sustainability-related activities at organizations—and especially at universities as "cultural reference points for their communities" (Paleari et al. in J Technol Transf 40(3):369–379, 2015, p. 369)—is addressed only recently. How can structures for sustainable development at higher education institutions (HEIs) be established that incorporate all stakeholders and that help to engage in sustainability-promoting behavior at all levels? Whole-institution approaches (WIAs) are in demand (UNESCO in UNESCO roadmap for implementing the global action programme on education for sustainable development, 2014), yet theoretical and practical frameworks for fostering sustainability-related motivation and behavior in vocational settings at HEIs are sparse. Systematic methods as well as methodologies that can be used to realize WIAs haven't been developed and explored sufficiently so far. Drawing from the experience of the Center for a Sustainable University (KNU) at the University of Hamburg (UHH)—one of Germany's largest Universities with more than 40,000 students and 5000 members of staff (Präsidium der Universität Hamburg 2016)—this paper introduces tools and methods for targeting a whole-institution approach in order to generate and strengthen transformational processes toward sustainability.

Keywords

Sustainable transformation · Sustainability at HEIs · Innovation processes · Organizational development · Organizational change management for sustainability · Barriers to change

1 The UHH Center for a Sustainable University (KNU)

The KNU is an interdisciplinary workforce set up in 2011, dedicated to the advancement of sustainability at the UHH and beyond. It acts as a research network, a think tank for innovation and as an incubator for new approaches, concepts, procedures and methods in the context of sustainable development, thus being an institutionalized network platform that not only deals with research on sustainability-related topics but also represents an applied field of organizational development (OD). Referring to the Brundtland-definition of sustainability (Brundtland 1987), a joint KNU-position paper on the perspective of the University of Hamburg becoming a "University for a Sustainable Future" (Bassen et al. 2016) was created, serving as the foundation for further steps towards implementing structures and guidelines for sustainable development at the UHH. The KNU's activities are systematically related to four dimensions of sustainability that represent fields of actions at the UHH:

(1) The *research dimension*—where questions arise such as: How can sustainable research and research for sustainability-related topics be defined and supported?
(2) The *didactic dimension*—where questions arise such as: What are the characteristics of sustainable education? And how can education for sustainable development (ESD) be facilitated?
(3) The *institutional dimension*—where questions arise such as: What is sustainable governance? How can it be achieved? And how can operations within the institution be shaped in a sustainable way?
(4) The *reflective dimension*, which delineates critical self-reflection as well as reflection on science as a vocational sphere—where questions arise such as: What hinders and fosters sustainability-related behavior? How can sustainable development and sustainability-oriented behavior in science and in HEIs be cultivated?

Research, teaching (didactic) and institutional (governance and operations) are common dimensions of sustainability that are addressed within HEIs (cf. Sassen et al. 2014; Rath and Schmitt, in press). Typical and special for the UHH-context is the reflective dimension. It explicitly outlines the necessity of a benevolently critical perspective on one's own behavior and values for a long-term implementation of transformational processes (cf. Schmitt 2014a, b), emphasizing the impact of social and psychological factors when it comes to adaptation and mitigation as strategies for coping with change (e.g. Levinthal and Marino 2015; Adger 2001) (applied methods and tools for supporting the consideration of this dimension as an equivalent to the other dimensions are exemplified further below).

The University of Hamburg's KNU is a UHH-wide unit that aims at contributing to the development of a socially, economically and ecologically responsible university in all fields of action. By now, the KNU is set up by a steering committee and a main office, both coordinating and integrating the work of several

interdisciplinary KNU-teams that are dealing with specific sustainability-related topics and/or target groups. One of the teams, for example, is dedicated to the advancement of sustainable development in administration. Another team is gathered around student initiatives that engage in "greening" campus activities (e.g. urban gardening projects or debates on corporate social responsibility). Further tangible KNU example projects are: an interdisciplinary research collaboration on multilingualism as a common good and valuable resource (cf. Gogolin et al. 2016), the incitement and supervision of a student-run UHH sustainability report (cf. Palm and Schmitt 2016) and the prototyping of capacity-building workshops for sustainable development (cf. Schmitt 2016a, b). The KNU is also involved in regional projects concerned with the advancement of sustainable development in the city of Hamburg (e.g., it is a partner within the Hamburg HEI alliance for sustainability, collaborating with colleagues from the Hamburg University of Applied Sciences and the Technical University of Hamburg). More detailed information on the KNU, its structure and activities can be retrieved from the KNU-website www.nachhaltige.uni-hamburg.de, (see also Rath and Schmitt, in press). The following sections of this paper will focus on selected conceptual and practical work of the KNU main office: designing tools and methods for sustainability-oriented organizational development.

2 Organizational Development for Sustainability: Linking ESD and Innovation Processes

Seen from the perspective of organizational psychology, organizational development (OD) in general is the systematic endeavor to contribute to working conditions that enhance humanization as well as flexibility and to keep up the individual and collective motivation to adapt to changes (Von Rosenstiel 2003). Thus, OD concepts, tools, and methods that are typically applied in/for business organizations (e.g. see Schültz et al. 2014) might be transferred to the context of HEIs, when system transformations—in this case, a system transformation toward sustainability—needs to be fostered. HEIs are also a kind of entrepreneurs and definitely places of proper work, but it has to be taken into account that HEIs are quite different from business organizations in terms of stakeholders, goals, processes, values, structures and so on. For this reason, a mere endorsement from the business context into the HEI context does not seem to be appropriate. When facing the task of supporting sustainable development at HEIs, however, habits and modes of actions that hinder transformational processes have to be overcome. Ceulemans et al. (2015) point out that organizational change management for sustainability (OCMS) is an emergent field of research and application and call for further work on this topic. This paper seizes the suggestions of Ceulemans et al. (2015) and wants to offer some thoughts on the interrelation of OCMS and ESD (vocational HR-training on SD, respectively) on the one hand and OD for innovation (Schmitt et al. 2013) on the other. Therefore, the authors of this paper propose to (1) consider OD for sustainability,

i.e. OD focusing on the advancement of sustainable development issues, as a specific domain within OCMS, (2) identify obstacles that hinder the implementation of sustainable development by analyzing parallels between innovation processes and sustainability-related processes in organizations and to (3) design and explore tools and methods that help to overcome these obstacles.

2.1 OD for Sustainability as a Specific Domain Within OCMS

The framework on OCMS put forth by Lozano (2013; cf. also Ceulemans et al. 2015) models dynamics of change for corporate sustainability, respectively its orchestration: Corporate sustainability drivers and strategic planning on SD are factors that help to move the organization from a status quo to a more sustainability oriented state if barriers to change are overcome and an institutional guidance is given which orchestrates change processes. The framework-model is a supportive scheme for professionals dealing with OCMS on a managerial basis to better understand progressions and rebounds of (intended) change, yet it does not explicitly address means of implementing SD arrangements within an organization. Given that strategic planning on SD incorporates a systematic implementation of such arrangements—that resemble OD for sustainability—the latter can be seen as a key instrument of OCMS and a relevant field of action within corporate sustainability institutionalization (at universities). OD for sustainability is therefore perceived as a specific professional domain within OCMS (cf. Adams 2011) that designs, explores and evaluates means and methods for facilitating SD processes in organizations. Apart from emergent change that can't be anticipated and channeled by managerial instruments anyway (Liebhart and Lorenzo 2010), planned change directed towards sustainability is likely to profit from genuine measures, e.g., targeted workshops, coachings, vocational trainings and other learning/ESD settings for individual and collective capacity building for transformation (Schmitt 2016a, b).

2.2 Barriers to Change: Parallels Between SD and Innovation Processes

To identify and analyze barriers is an important step for designing appropriate methods and tools for overcoming them (Mirow 2010; Hueske et al. 2015) in order to achieve a more sustainability-oriented state of being. Viewed from an (HRM and OD for) innovation research background (Schmitt 2014a, b, 2016a, b; Laux and Schmitt 2008; Schültz et al. 2014) there are obvious parallels between innovation and SD, because both represent transformational processes (see below); but differences also have to be taken into account, e.g., that the notion of innovation per se does not refer to an integration of social, ecologic, economic (and in addition cultural, c.f. Laszlo and Laszlo 2011) criteria (Hahn et al. 2014) or that an "ethical" or normative dimension of innovation usually isn't considered in mainstream research (cf. Schmitt 2014a, b); in contrast to the notion of sustainability, which per

se is not exclusively directed towards the creation of new features for products, services, etc., as well as toward market success, but also subsumes ideas of conservation, maintainability, and social responsibility. Although findings from business organizations can't be conveyed for HEIs unconditionally and overgeneralizations would be invalid, similarities between innovation processes in business organizations and SD processes in HEIs are illustrated below to serve as a source of inspiration for generating new OD approaches for the implementation of SD.

Which barriers do occur when trying to implement SD at HEIs and which parallels can be drawn between innovation and sustainability processes?[1]

One general problem arising in the course of supporting change processes is a structural one, well known from innovation research (cf. Schueltz et al. 2014): If a designated innovation unit is built up within an organization—which is necessary from a managerial viewpoint in order to be able to address specific challenges related to innovation—it is likely that this unit is perceived to be in charge of this topic exclusively. Other units and departments thus might not feel accountable in this case, arguing that there are others responsible for implementing according actions [in psychological terms, a diffusion of responsibility might occur (Guerin 2003)]. In consequence, the other units—and thus the organization as a whole—won't identify with the topic at stake and a thoroughgoing transformation of culture can't be achieved (cf. Schmitt et al. 2014). For innovation as well as for sustainability related actions, however, it is important that all stakeholders of the organization are involved and held accountable for these topics, so that they can become a long-term characteristic of the organization [*barrier/challenge (a): coping with diffusion of responsibility*]. Therefore, it is suggested to bear in mind the task of coping with diffusion of responsibility when it comes to implement supportive structures for innovation-, respectively, sustainability-oriented behavior.

Another challenge to be dealt with in transformation processes—directed towards innovation as well as sustainability—turns out to be the so called "not invented here-syndrome" (Antons and Piller 2015; Brinkhurst et al. 2011). It describes the fact of new, promising ideas being rejected because they are perceived as not being a genuine contribution of an in-group. As transformation processes are demanded by external stakeholders rather than internal ones, new ideas to address these demands are not easily adopted within the organization. Even if such new ideas would help to solve problems of the organization appropriately, employees will not commit to "external", i.e., "not invented here" solutions [*barrier/challenge (b): not invented here-syndrome*]. Therefore, it is suggested to create settings in

[1]Please note that barriers and parallels identified here are grounded in practical work experiences from the KNU, thus representing a self-report case study; it is recognized that literature, field studies and other case studies on barriers for implementing SD in higher Education do exist (e.g., Holmberg and Samuelson 2006; Lozano 2006; Hammond and Churchman 2008; Dahle and Neumayer 2001; Horhota et al. 2014). In this paper, however, the authors focus mainly on their day-to-day observations within their professions at the UHH KNU as an applied field of expertise for fostering SD at a specific HEI in Germany, and consider those barriers—either seen from innovation—or sustainability-related perspective—as forms of resistance to change in general.

which members of the organization can actively participate in generating new solutions for addressing (sustainability-related) problems at hand. External ideas might be presented as good-practice-examples and stimulate action, but innovation capacity of the organization's members should be triggered and used instead of forcing acceptance for solutions that won't be identified with intrinsically.

One more barrier that can hinder transformational processes is a perceived "opacity of benefits" of sustainable and/or innovative behavior. While some individuals might be motivated to contribute to energy saving, creative green campus development or ESD out of their personal values and conviction, others will not identify with topics like these if a perceived "added value" for them is missing. Especially when it comes to motivate and engage members of the organization who are not involved in sustainability-oriented actions yet, it is important not only to rely on a taken for granted social responsibility for future generations, but also to reveal benefits of individual behavior directed towards sustainability. So questions of how to effectively incentivize sustainability-related actions are crucial to be answered if sustainability of an organization as a whole is to be fostered. However, answers to these questions likely are very target-group specific and presumably can't be generalized for a large extent[2] [*barrier/challenge (c): opacity of benefits*]. It, therefore, is recommended to identify peculiar assets of sustainability-related behavior—for individuals as well as for teams, departments and the organization as a whole—in order to facilitate actions and OD directed towards sustainability.

Moreover, to approach the notion of sustainability in general also incorporates coping with complex, broad and diffuse ideas, and means to ends. Given the situation that, especially at HEIs and administration, clear targeted structures and definitions are preferred and that sustainability is not only a field of theory and research, but also of application, sustainability-related topics are prone to disaffirmation. Although sustainability-related topics and actions are increasingly addressed and integrated into structures and processes, daily experience from the KNU also reveals points of reluctance to those topics because they are considered as not feasible, plain and clear-cut (enough) by some of the stakeholders. Straightforward and effortless solutions are asked for in some cases, which cannot be easily developed, neither for innovation nor sustainability processes. Additionally, communication-related barriers impede the implementation of change towards sustainability: As the notion of sustainability is not only and always referred to in a "scientific way",[3] but also plays a role in day-to-day communication outside the scientific domain, there are a lot of different definitions and interpretations of the notion of sustainability to be found. Various connotations and understandings of

[2]The authors of this paper consider *motivation for sustainability-related behavior* as an own emergent field of (interdisciplinary) research that can't be elaborated on here. If human beings are merely seen under the paradigm of "homo oeconomicus", incentives for sustainability-related behavior have to be identified and set; from a phenomenological point of view, self-efficacy, universal values and individual reflection on one's own social interrelatedness should be (additionally) focused on (cf. Schmitt 2014a, b).

[3]This is not exclusively related to natural sciences, but incorporates the humanities as well as social sciences.

sustainability and sustainability-related behavior have to be distinguished in everyday settings when talking about sustainability at HEIs in order to implement sustainable development [*barrier/challenge (d): "fuzziness" of the notion of sustainability*]. It is necessary to take the "fuzziness" of the notion of sustainability as well as its communication about it into account when it comes to implementing OD for sustainability. It is suggested to offer methods that help generate a shared understanding of sustainability, including a shared view on its diversity and complexity.

There are definitely further barriers to change (cf. Lozano 2006; Dahle and Neumayer 2001; Horhota et al. 2014) that will not be discussed and elaborated on here. More interdisciplinary research seems to be appropriate to address all of the challenges that come along with implementing sustainability-related behavior at HEIs. In the following section, examples for sustainability-centered OD-tools and methods are presented that were designed to overcome the mentioned barriers and to deal with the identified challenges.

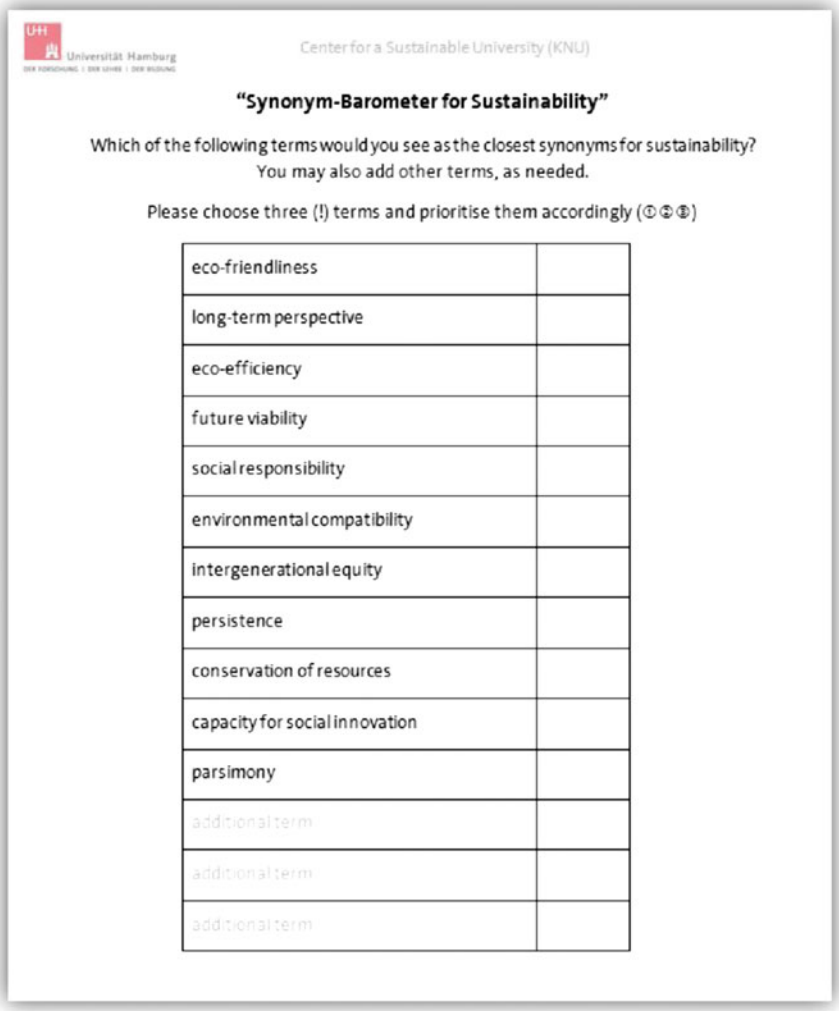
3 Examples of Sustainability-Centered OD-Tools and Methods

How to address the identified challenges? Which tools and methods can help to support the integration of sustainability-related behavior at organizations, especially HEIs, tailored to suit the needs of different target groups? Again, it is referred to the practical experiences gained within the KNU, where instruments to foster sustainable development are designed and explored.

In order to stimulate reflection on the individual as well as shared notions of sustainability in everyday life (cf. the *reflective dimension* introduced in Sect. 1), a so called "*Synonym Barometer*" was created. This Synonym Barometer is depicted in Fig. 1 (Schmitt 2015).

The Synonym Barometer is a collection of ten more or less self-evident synonyms for the term "sustainability" (in German *Nachhaltigkeit*), such as "eco-friendliness", "persistence", "social responsibility", and so on.[4] (These synonyms have not been collected out of a methodological data analysis or from a linguistic viewpoint, because the main purpose was not conducting a research study on it but rather to scrutinize the "barometer method" as an OD for sustainability tool; nevertheless, further research and application of the Synonym Barometer might take into account in-depth linguistic and data-based analysis, preferably as an interdisciplinary study, to originate a more solid selection of words used as equivalents for the term/notion of sustainability.) Moreover, the Synonym Barometer contains blank spaces so that other synonyms and connotations can be

[4]Besides individual interpretation factors, that have to be considered when communicating about sustainability, there also might be cultural, language and translation factors that influence the applicability of the Synonym Barometer or the selected synonyms, respectively; further research on this topic is recommended.



Universität Hamburg

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"Synonym-Barometer for Sustainability"

Which of the following terms would you see as the closest synonyms for sustainability?
You may also add other terms, as needed.

Please choose three (!) terms and prioritise them accordingly (①②③)

eco-friendliness	
long-term perspective	
eco-efficiency	
future viability	
social responsibility	
environmental compatibility	
intergenerational equity	
persistence	
conservation of resources	
capacity for social innovation	
parsimony	
additional term	
additional term	
additional term	

Fig. 1 The "synonym barometer for sustainability"

added according to requirements. It comes along with the task to indicate one's personal three "most favorite" synonyms for the word sustainability. Its aim is to help people reason about their personal day-to-day understanding of sustainability/sustainable development, to sensitize to the various meanings and connotations that need to be differentiated when communicating about sustainability—especially when stakeholders from different disciplines come together or stakeholders that are not dealing with sustainability topics regularly—and to derive a (more) shared conception of the meaning of sustainability.

The Synonym Barometer has been applied in the course of 2015/2016 in several KNU-team sessions as well as in different national and international workshops organized by KNU-members. Together, more than 100 stakeholders from several status groups and different disciplines participated in the exploration of the Synonym Barometer tool. The results of the different application sessions were documented for UHH-intern OD purposes. So far, results display *long-term perspective*, *intergenerational justice* and *future viability* to be the most frequently indicated/selected synonyms for sustainability. However, monitoring of the sessions and workshops shows a clear contingency of the chosen (and added) synonyms subject to particular groups of participants.[5] The Synonym Barometer tool hasn't been evaluated (yet) in terms of meeting its claim to foster a sophisticated understanding of sustainability that—in the long run—leads to correspondent behavior. Evaluation studies are required. Yet, feedback of participants who were involved in the examination of the Synonym Barometer is affirmative for the tool and its impact, because it stimulates thoroughgoing discussions.

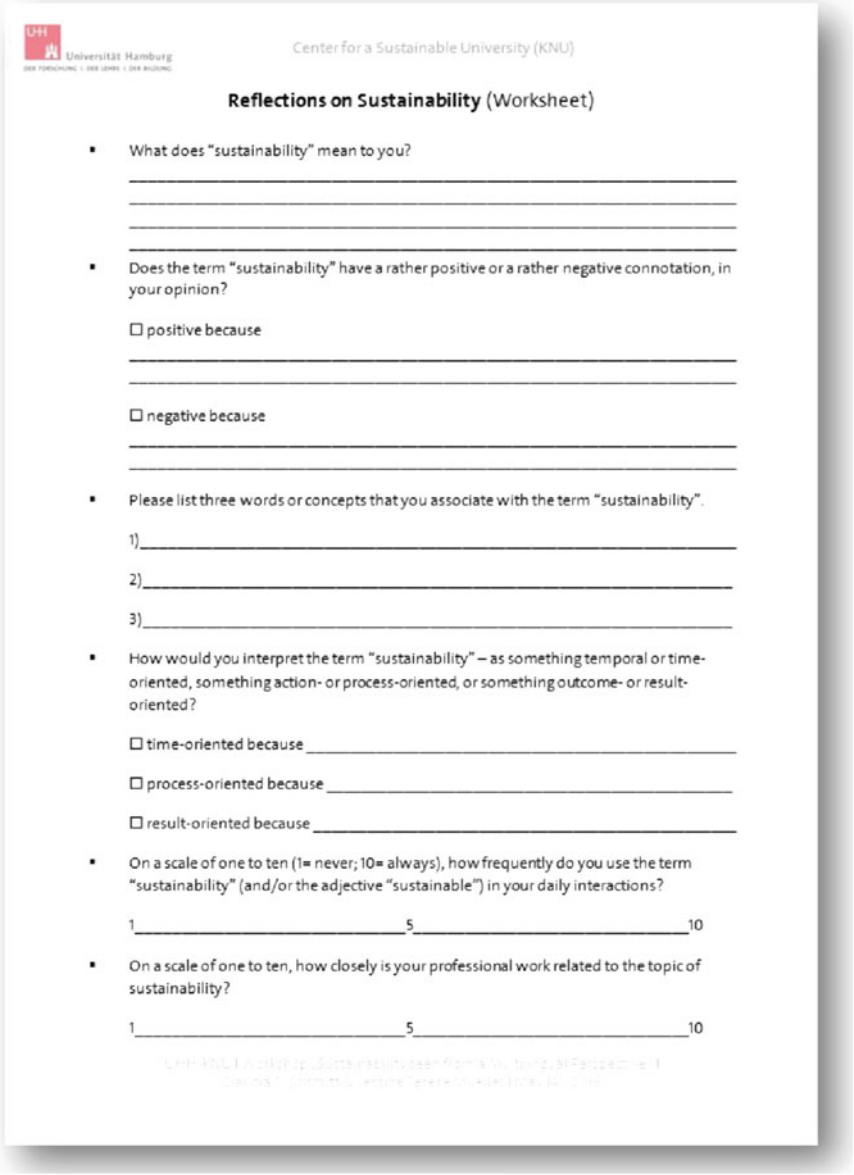
Another instrument to be used for an extensive reflection on the notion of sustainability is a working sheet that offers questions concerned with personal interpretations and viewpoints. The *working sheet* contains questions such as: *What does sustainability mean to you? In your opinion, (why) does the term sustainability have a rather positive or rather negative connotation? On a scale from 1 to 10 (1 = never; 10 = always), how frequently do you use the term sustainability (and/or the adjective sustainable) in your daily interactions?*

These and other questions are presented in KNU-workshops that aim at making people more familiar with topics of sustainability, especially those people that haven't yet been dealing with sustainability topics vocationally. A worksheet with questions like these turns out to be a constructive introduction for capacity building programs, because it encourages individual narratives related to sustainability and allows for discussions as well as shared experiences on the matter. Usually, the worksheet (see Fig. 2) at first is filled out individually, followed by a group discussion on each of the questions (in some settings, it is helpful to explicitly point out that there are no right or wrong answers to these questions). Differences as well as congruences between personal interpretations of the notion of sustainability can be analyzed with this method, in order to derive a joint understanding of corporate sustainability.

A final example for OD-means to support the implementation of sustainability-related behavior in organizations is a scheme of analysis for daily activities and their relation to SD that serves as a framework of orientation. This scheme is called the "*ATIS-Model*"[6] for sustainability-related behavior (Schmitt 2016b) and is depicted in Fig. 3.

[5]Refining as well as using the Synonym Barometer is still work in progress; no detailed results are dispelled here because the data were collected and analyzed for practical reasons, not for conducting a study to be published; for in-depth information on (preliminary) results please contact the authors of this paper.

[6]ATIS is an acronym for the German words ***A**rbeitsplatz* (workplace), ***T**ätigkeit* (task), **I**ndividuum (individual) and **S**oziales/Struktur (social structure), that build the quadrants of the model.



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Reflections on Sustainability (Worksheet)

- What does "sustainability" mean to you?

  _____
  _____
  _____
  _____

- Does the term "sustainability" have a rather positive or a rather negative connotation, in your opinion?

  ☐ positive because

  _____
  _____

  ☐ negative because

  _____
  _____

- Please list three words or concepts that you associate with the term "sustainability".

  1)_____

  2)_____

  3)_____

- How would you interpret the term "sustainability" – as something temporal or time-oriented, something action- or process-oriented, or something outcome- or result-oriented?

  ☐ time-oriented because _____

  ☐ process-oriented because _____

  ☐ result-oriented because _____

- On a scale of one to ten (1= never; 10= always), how frequently do you use the term "sustainability" (and/or the adjective "sustainable") in your daily interactions?

  1_____5_____10

- On a scale of one to ten, how closely is your professional work related to the topic of sustainability?

  1_____5_____10

Fig. 2 KNU-worksheet for reflecting the notion of sustainability

It was created to overcome the "*do's and don'ts are not concrete enough*"-barrier as a part of the fuzziness challenge mentioned above (see Sect. 2.2). To engage people in sustainability topics and direct performances towards social responsible and eco-friendly behavior, intrinsic motivation (Ryan and Deci 2000)

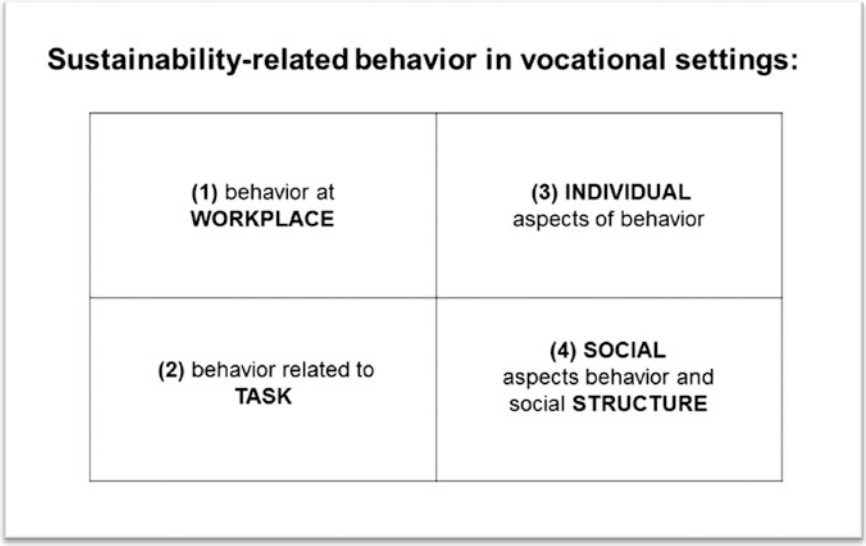

Fig. 3 The "ATIS"-model—different fields of sustainability-related behavior in vocational settings

should be built up. When faced with the task to do so, more often than not stakeholders point out that they do not know what to do and that the demand of sustainability is too complex to grasp and to proceed. When it comes to sustainability-related behavior, specific contexts, situations, and considerations have to be credited, of course. There are no blueprints that comfortably guide behavior in a way that it meets criteria of sustainability on target. So everyone has to learn how to look for options and examples within his or her vocational context to make sustainability happen at an organizational level. The ATIS-model differentiates four quadrants important to consider for practical aspects of sustainability: (1) sustainable behavior at the *workplace*, e.g., actions of energy saving at the office; (2) *task-related behavior* and its relation to sustainability topics, i.e., dependent on the respective job, objectives which integrate sustainability issues into the task content-wise (for researchers this is equivalent to the research dimension mentioned in Sect. 1; for administration contents of this quadrant are different, e.g., in departments for international affairs incorporating ideas on the interrelation of higher education, mobility and ecological footprint and so on; for students, the key question to the task-quadrant would be: in what ways is my study program related to sustainability topics?). These two quadrants show distinctive modes for the incorporation of sustainability-related behavior in vocational settings and allow for the analysis of peculiar options of performance. In contrast, the quadrants 3 and 4 refer to individual and collective determinants of (sustainability-related) behavior: (3) this quadrant reflects *individual aspects of behavior*, thus being focused on personal values, attitudes, etc., and is meant to underline the role of self-efficacy

(Bandura 1977) and proactive approaches to cope with the challenges of transformation (Schmitt 2014a, b). This quadrant reflects social and systemic structures, therefore acknowledging influences of the group and collective level on sustainability processes (e.g., group-think phenomena, Jannis 1972; social loafing, Guerin 2003; the importance of role models for sustainable behavior, Bass and Steidlmeier 1999, etc.). Both quadrants represent distinctive influences on the incorporation of sustainability-related behavior (in vocational settings) and allow for the analysis of peculiar factors that might be changed and/or addressed in vocational trainings.

The ATIS-model functions as a pattern to point out that (a) actual behavior is relevant for the implementation of corporate sustainability (Lozano 2015), (b) to delineate actions for sustainability in vocational settings/at HEIs, different options, and aspects are given, (c) particular practical respects can be analyzed and substantiated against this background. The model was used in singular KNU-settings to offer orientation for further steps of implementing sustainability as an institution-wide guiding principle and is planned to be applied in more KNU-workshops.

4 Summary and Discussion

This paper introduced the University of Hamburg's Center for a Sustainable University (KNU) and described one of its activities in more detail: professionalizing organizational development for sustainability, seen as a specific domain within organizational change management for sustainability (OCMS). Parallels between innovation and sustainability processes were drawn in order to deliberate on barriers to sustainability-oriented change at higher education institutions (HEIs). Identified challenges to be dealt with are: (a) diffusion of responsibility, (b) the "not invented here-syndrome", (c) opacity of benefits of sustainability-related behavior, and (d) "fuzziness" of the notion of sustainability and its communication. Particular tools to foster sustainability-related behavior and reasoning in the sense of a whole institution approach, developed and explored at the KNU to overcome these barriers and to address these challenges, were exemplified: the "Synonym Barometer for sustainability", a worksheet with questions on the individual understanding of sustainability in everyday life and the "ATIS-model" as a scheme of analysis for actions of sustainability in vocational contexts.

The ideas and examples given here are taken from the daily work at the KNU and are displayed mainly from a perspective of applied organizational psychology. These ideas are open to change and development, and still work in progress. The KNU (main office) is not a mere research unit and practical explorations of tools to support sustainability at HEIs/in science are prioritized so far. This is why in-depth data analysis of the reported topics and profound evaluations of the processes and tools presented haven't been conducted yet, but are highly recommended. Additionally questions of proper operationalizations for sustainability—and especially for sustainability-oriented behavior at HEIs—arise, that need to be addressed in order to develop evaluation designs which meet criteria of reliability

and validity. As pointed out in Sect. 3, further interdisciplinary research is also recommended on the topic of sustainability and language as well as intercultural communication (cf. Schmitt et al., in prep.). Because interdisciplinary research on sustainability-related behavior and OD can be seen as a still emergent field of study and application, more approaches, new insights and supportive instruments on these topics are expected and looked forward to.

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Scalability in Systemic Design Approach for Rural Development

Silvia Barbero and Miriam Bicocca

Abstract

Rural Development is a fundamental point in the action plans by the United Nations: the Sustainable Development Goal 2 of the Post-2015 Development Agenda attests the importance of increasing investment and international cooperation to end hunger and achieve food security (https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf). The relevance of this topic makes Scalability and Replicability essential to the successful of the projects that deal with Rural Development. This research is facing the Rural Development through the Systemic Design approach, and its outcomes are models that enable the possibility to replicate projects and processes (Holocombe in Lessons from practice: Assessing scalability. World Bank, Washington, DC, 2012). The concept of Scalability helps to define the boundaries and the limits of the project in order to grow up the benefits for the territory as much as possible, but without exploiting it. The Replicability, defined as the property of an activity, process or test result that allows it to be duplicated at another location or time, it helps to consider the key elements of a project that can have the same role in other contexts. This paper wants to investigate how should Replicability and Scalability become with the application of Systemic Design Approach in a specific context.

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Systemic design · Rural development · Scalability · Replicability · Scale-up · Case studies

1 Background

To reduce poverty in rural areas is necessary to invest in agricultural and rural development.

World Development Report (2008)

The topic of Rural Development (RD) is very relevant because a large part of the population of poor people lives in these territories. Currently over 50% of the world population still directly depends on rural livelihoods that are highly vulnerable to climate change (McIntyre et al. 2009). More than 3 billion people live in rural areas and 1.4 billion people are extremely poor (IFAD 2010). Identification of innovative processes useful for the development of small-scale farmers, therefore, is crucial.

With this paper, we want to emphasize some aspects of scalability of RD projects. Is it always necessary to provide scalability in a project with the aim of RD? If so, what features should it present? What kind of scalability should be?

The concept of scalability it is considered interesting by social business (Bradach 2003) because the scaling process can address very common problems using actions, through replication mechanisms, which have already proven their effectiveness in different geographic areas (Taylor et al. 2002). This is exactly the key issue of the topic: is it necessary and appropriate to require that a Systemic Design (SD) project for the RD is replicable in other geographical areas? To understand the legitimacy of this question it is important to have a clear idea of what SD is and its main features.

2 Methodology

The SD is an approach used in order to:

- sketch and program the flow of matter that runs from one system to another one in a continuous metabolization which decreases the ecological footprint and generates a considerable economic flow;
- organize and optimize all parts within an ecosystem so that everyone can evolve with each other;
- manage, in all development phases of the project, the mutual dialogue between the various actors of this new cultural issue.

The SD approach is based on 5 principles:

- the output of one system becomes the input of another one;
- relations generate an open system;
- open systems sustain and reproduce themselves;
- the context in which the system is built is essential
- the human being must be the centre of the project (Bistagnino 2011).

The central role that local resources and relationships play in the Systemic Design Approach (SDA) makes it a very effective approach to support and encourage RD in a sustainable way. By applying the SDA, it is possible to manage local resources and local products in a way that allows economic strengthening of the farmers and communities that live on the territory.

3 Objectives

The most important issue that we want to investigate with this paper is to understand if an RD project developed with the application of the SD Approach needs to be scalable and replicable. Is it necessary? If so, what kind of scalability is suitable for an SD project?

Hartmann and Linn (2008a) claim that there are some projects of RD that deal with issues of particular importance for the territory and it makes sense to reproduce and scale them, however not all RD project or interventions should be necessary scaled up. For instance, we want to have specific results for the projects under the Millenium Development Goals (8 MDGs). The MDGs are the goals that 191 UN member states agreed to focus on by 2015 in the United Nations Millennium Declaration, signed in September 2000. The 8 MDGs are:

1. to eradicate extreme poverty and hunger;
2. to achieve universal primary education;
3. to promote gender equality and empower women;
4. to reduce child mortality;
5. to improve maternal health;
6. to combat HIV/AIDS, malaria, and other diseases;
7. to ensure environmental sustainability; and
8. to develop a global partnership for development (www.un.org).

To answer to this first issue, we have analysed different case-studies about RD aimed to reach impacts on at least one of the mentioned 8 goals. These cases have been analysed with a specific focus on the scalability of the project.

The second, not less important, objective of the paper is to understand what kind of scalability and replicability the systemic designer must take into account in designing RD projects. To allow the scalability, which characteristics should have

the project? It was very useful for us to compare the cases previously mentioned with a specific SD project. For this purpose, we have considered the Ph.D. research about Rural Development and Sustainable Innovation by M. Bicocca (2016).

4 Scalability and Replicability: Typologies and Characteristics

It is worth mentioning that scalability is not a new concept; this is the reason why it is useful to study and analyse the history and the evolution of the concept, already treated by several authors. Already in the 70s the World Bank, under Robert McNamara's leadership, focused on addressing development challenges in a comprehensive manner and at a large scale (Linn 1983). In recent years many studies have put at the centre and have focused on the concept of scalability and replicability. Scalability can be defined as the ability of a system to change its scale in order to meet growing volumes of demand (Bonnefoy 2008). The concept of replicability defines the capability of a system to be duplicated at another location or time (Sigrist et al. 2016).

Hartmann and Linn (2008a) explain it well in their paper named "A framework and lessons for development effectiveness from literature and practice". A recent popular best-seller, *The Tipping Point*, looks at examples of how some commercial and educational ideas and practices reach the point beyond which they spread "like wildfire" (Gladwell 2006).

A very interesting interpretation of the birth of the concept of scaling up was provided by Ulvan and Miller in the article entitled *Scaling Up: Thinking Through the Issues* (Uvin and Millier 1994). The authors argue that at the beginning of the 1990 s a new organizational model to promote development has emerged. It is a model that wants to bring together the most positive and effective aspects of the previous two models: the top-down model (from 1960s), with the central role of the government and policies, and the bottom-up model (from the second half of the 1980s) in which the most important actor is the community that is committed in the process able to reach development: this is the birth of the *scaling up* model. The objective of this third model is to coordinate the work of small NGOs and communities increasing size, complexity and the impact of their projects. This development model provides that the fallout of the small projects is designed to achieve important results that actually encourage a development process spread globally.

4.1 Different Typologies of Scaling up Process

> Scaling up means expanding, adapting and sustaining successful policies, programs or projects in different places and over time to reach a greater number of people.
>
> World Bank (2008)

> Scaling up brings more quality benefits to more people over a wider geographical area, more quickly, more equitably, and more lastingly.
>
> International Institute of Rural Reconstruction (http://iirr.org/)

> Scaling up as: "to efficiently increase the socioeconomic impact from a small to a large scale of coverage"
>
> Hancock et al. (2003)

One of the most common typologies of scaling up is to be attributed to the USAID (U.S. Agency for International Development) evaluation. This definition refers to the scaling up the process as expansion of the number of members involved in the activities (Ashe 1992).

In the following years, there were many differences between methods to scale up a developed project. Sometimes more oriented to the organizational and managerial aspects of the project, as in the case of Robert Berg (1987) (Messer and Uvin 1995). Sometimes oriented to functionality (Bratton and Hydén 1992): Hyden speaks of functionality when the organization, in the scaling up process, increases the type of activity and the size of these. Clark in 1991 defines *scaling up* in three different kinds of processes. One related to the **project replication**, the second one related to **building grassroots movements** and the last one about **influencing policy reform** (Clark 1991). Such as Clark also other researchers, Korten and Fisher, uphold the concept that *scaling up* has to deal with influencing politics as a very important part of the process.

Messer and Uvin (1995) renews Clark approach and proposes 3 typologies of scaling up (considered as the widening of its scope):

quantitative

In the case of scaling up as "growth" or "expansion", the process is mainly about increasing the membership, the working area or the budget.

functional

According to what Uvin and Miller write, there is another kind of *scaling up* process that deals with the increasing of the topic or the type of the activities in which the organization is committed. In many cases of scaled organization, indeed, it happens that they pass from a productive activity to another.

political an organizational

Under this term, he describes a *scaling up* process, which gets to involve political actors and relations with the state and administrations.

These three categories help us to better understand what kind of *scaling up* process is more suitable to each project, and to each kind of approach that is been

used. Uvin and Miller surely get inspiration from Robert Berg that in 1987 talks about *organizationally* scaling up and *functionally* scaling up.

The first one is simply a growth in size (the same organization, with some goals and a bigger size). The second one is more close to the concept of "intensification" (the same organization increase and diversifies the activities and the products) (Berg 1987).

What emerges from the studies seen so far is that it is not possible to attribute a meaning to the scalability entirely due to an increase in quantity, but rather to the increase of the intensity of innovation. This concept is fundamental if we deal with an SD project. The application of the SD Approach is strictly linked to the local resources and allows reaching important improvements on the quality of the products that derive from the system.

Scaling up is a way to improve the impacts and the effectiveness of a project, particularly in projects focused on RD (Hartmann and Linn 2008b).

Wolfensohn claims: "how to move from our feel-good successes to large scale, how to scale up these initiatives to a depth and breadth where we can really have an impact on poverty, where we can achieve the Millennium Development Goals". In this sense *scaling up* means expanding, adapting, and sustaining successful projects, programs, or policies over time for greater development impact (Wolfensohn 2005).

What we should remember to consider is that scalability is a goal that must be clear from the early stages of the project. Although it is a simple concept to understand, it is not at all obvious to understand how we can help this process in the RD projects.

5 Case-Studies

To achieve the objectives set initially this second part of the paper is based on the comparison of some successful case-studies of social development in marginal or rural areas. This comparison, which emphasizes the aspects related to the scalability and the reproducibility of the project, is particularly interesting and useful to understand what are the necessary characteristics of a social development project. The 7 case-studies are examples of different concepts of scalability, done by different organisations and address different MDGs. The eighth case-study, last one, is especially significant in projects developed with the application of the SD Approach, done by authors directly, and it assumes a new scaling-up model in the field of Rural Development. SD Approach allows to change many aspects of local and social development, this is the reason why is appropriate to refer, within SD projects, to a new kind of scalability, probably more focused on quality than quantity.

The case-studies analysed and mentioned in this paper have been selected paying attention to some issues: they have in common similar contexts (rural or marginal areas), the small size of the "pilot" project, the involvement and the participation of

the end-user, the use, when necessary, of simple technologies and the collaboration between different actors as key subjects of multidisciplinary teams. For each case, we have underlined the country/ies involved, the issue and the objective of the project, how the project deals with scalability and the most important actors involved.

5.1 Cure2Children (C2C) + Grameen Healthcare Trust (Child 4) (Muhammad 2010)

Countries: Kosovo, Pakistan, India, Morocco, Sri Lanka.

Issue: In emerging countries, only a minority of children suffering from these potentially deadly infectious diseases (Non-Communicable Diseases, or NCD) have the ability to access adequate care. India has one of the highest rates of thalassemia in the world with tens of thousands of children suffering and a serious shortage of medical facilities and qualified staff to treat children with this disease.

C2C is an NGO born thanks to Dr. Lawrence Faulkner, oncologist expert in paediatric oncology and haematology, and specifically the treatment of cancer, leukaemia and inherited blood disorders. The interesting aspect of this case is the transition from a normal NGO that thrives on donations to an enterprise for social development adopting a social business scheme.

Objective: to develop models of sustainable health care starting from the children's illnesses as opportunities to develop sustainable health systems locally in developing countries. To create self-sustaining and replicable care programs.

Scalability: local doctors with local funding manage the C2C units. The results are disseminated and validated by submitting to the major professional companies in this field.

The central issue is the sustainability (in terms of skills and economy) of the medical centres. Learning process has a key role. To switch from a normal NGO that thrives on donations to a real company with a social purpose is vital to define a joint venture with Grameen Healthcare Trust. C2C makes the local medical center an economically self-sufficient activity thanks to the *cross-subsidiarity*. The more wealthy households pay a fee for the bone marrow transplant in line with market standards, the poorest pay a reduced rate or, sometimes, nothing. To make this model work is necessary to scale and reach big numbers. The model works, and become self-sustainable only if it is widespread. Only in this way it is possible to get the richest families from neighbouring countries to provide financial support the center. A center in Bangladesh is certainly more convenient for an Asian family that a European center, especially considering the cost of the 45-day recovery period.

Another key point for the success of the project is the very high qualitative parameters. The goal is precisely to attract patients from all over the country and from neighbouring countries. The quality, then, must be at least equal to that of European centres that usually cater the wealthiest families. This is the basis of C2C support.

The crucial factor for the success is the use of information technologies and the fact that the organization is designed as a learning organization. The open-source web platform allows doctors to share data and to create a massive online information store. The joint venture between C2C and Grameen Heathcare Trust thus manages to bring results and effect change on an international scale.

Actors: hospitals and medical centres, C2C team (doctors and nurses).

5.2 Ashoka (Partnership for Development)

Country: 3000 Fellows in 89 countries in every continent.

Issue: as social entrepreneur, Ashoka, founded in 1980 by Bill Drayton, identifies patterns and key levers to help society gain a new framework that enables everyone to become a change-maker. Change-makers are social entrepreneurs, innovators, business leader, policy makers and activists that Ashoka support to succeed. This net has been built from the starting point that world's problems would not be solved by the institutions that created them, but by people who have recognized a problem and have been able to find a solution. The general objective of Ashoka is to find and spread these solutions around the world in order to solve similar problems anywhere.

The Ashoka Fellows network has built a database of social entrepreneurs or Fellows, "providing them with living stipends, professional support, and access to a global network of peers in more than 60 countries" (http://www.ashoka.org).

Objective: to find, select and support the Ashoka Fellows (social entrepreneurs) all around the world and make them become key subjects to foster and support the changing process in order to reach social innovation and development, to define patterns of social development in different topics, and to catalyse social innovation.

Scalability: the Ashoka case-study is fundamental to understand how much is important to build an international and global network in order to transform a small case of social innovation and social businesses into a case of "change-makers". Scalability, defined as the potential of the business model to expand, is a key attribute for Ashoka during the selection of fellows.

Actors: Ashoka Fellows as the leading social entrepreneurs recognized by Ashoka for their innovative solutions to social problems, are his staff members and partners that can collaborate with key partners around the globe. Ashoka involves different types of Fellows at different stages: Ashoka Fellows selected during the launch stage, Senior Fellows such as advanced entrepreneurs and Academy Members from the Global Academy for Social Entrepreneurship.

5.3 Pesinet/Djantoli (http://www.djantoli.org/)

Country: founded in France by Anne Rose-Weil, action countries Mali and Burkina Faso.

Issue: low-cost medical service. By combining micro-insurance, mobile and outreach work of field officers at low cost, it brings health at families and facilitates early access to care.

In sub-Saharan Africa, diseases that can be easily treated are still responsible for 60% of infant deaths. Mali has a very high rate of mortality (one in six children dies before the age of five and mothers are 120 times more at risk than in developed countries).

Objective: to prevent and quickly treat benign disease leading cause of infant and maternal mortality in Saharan Africa. Anne Rose-Weil has created a model to equipping unemployed women with a health training in order to conduct visits in the houses of pregnant women and children under the age of five. They collect data such as weight, temperature and early-sign symptoms, and then send the data to an online platform by using a mobile phone. Local doctors can connect to this platform to review the data collected.

Scalability: the model is important because integrates the service into already existing healthcare centres. Anne has signed a national agreement with the Ministry of Health and the Federation of community-based health centres that will enable her to easily replicate her solution.

Actors: Local doctors, trained women, local primary healthcare organization, National Federation of Community Health Centres (that have signed a national agreement to deploy the service), Franch Red Cross (to diffuse the pilot service), Deloitte (help Pesinet to identify new partners such as mutual insurance companies), private companies, especially in agriculture, that offer services to the employees.

5.4 SISAR (Integrated Rural Water Supply and Sanitation System) (Eneas Da Silva et al. 2013)

Country: Brazil, State of Ceará.

Issue: Sisar is a sustainable management model for small rural decentralized water and wastewater systems in developing countries. The problem to be solved is the lack to the access to water and sanitation.

Objective: the aim of the project is to achieve sustainability in the provision of improved rural sanitation services, through a regional approach. It provides drinking water and sanitation facilities for rural communities. SISAR is a model of participatory management, a federation of different associations created in order to self-managing local systems, in order to manage the rural water supply. In this project is fundamental the support of the State's Water and Sanitation Company (CAGECE).

SISAR is created as an NGO with Local User Groups, each rural community receives a water supply and a waste water system with a defined tariff (business plan), in this way the SISAR operational unit is set up with a Legal Framework that can be implemented and effective.

Scalability: This kind of organization needs more than 50 families to be implemented. This is the reason why it is a good organization to be scaled up. One of the most important characteristics of this organization in the *participatory process*. A positive cash-flow is reinvested in the system with a combination of a Top-Down and Bottom- Up approach (funding and local user group).

Actors: MACS Energy & Water (a German international consulting company that works in infrastructure finance for water and sanitation, and in energy efficiency and renewable energy), local user groups.

5.5 Adding Value to Waste in the Cassava Processing—Goat Keeping Systems (Fuller 2011)

Country: Nigeria.

Issue: Nigeria is the largest producer of cassava (or yuca) in the world (in 2009 Nigeria produced 45 million tonnes of cassava, almost the 19% of the world production) (Adeniji et al. 1997). The cassava waste is usually discarded or burned, producing toxic fumes.

Objective: The goal of this project is to reuse the output of Cassava production. The project is composed of a simple technology (a drying platform for the cassava peels to be used instead of burning the waste), a new product (clean dried cassava peels that can be sold as goat feed), an educational component (a diet prescribed to goat farmers, designed by animal scientists that utilizes cassava peels and maximizes the growth rate and health of the goats), access to credit (facilitating micro-credit loans to build the drying platforms), and a new market mechanism (linking cassava processors and goat keepers).

Scalability: this is an interesting example of how a small project and a simple innovation can be implemented with scaled impacts. The application of this model provides an *economic* benefit to goat farmers and cassava producers of 2$ a day and an e*nvironment* benefit because of the reutilization of the waste as an input and the elimination of toxic fumes.

The project, as it was presented, lacks some indication and suggestion on how to scale up the innovation. This is why it is the important role of the World Bank Country Office to obtain the support of the Federal Government of Nigeria in order to bring the innovation scale.

This case-study is interesting because it is very similar to an SD project, is the definition of a small system that works thanks to the transformation on an output to an input of another system, on the same territory.

Actors: Goat keepers, cassava growers, University of Agriculture in Abeokuta, Nigeria (UNAAB) World Bank Development Marketplace, Federal Government of Nigeria.

5.6 Waste to Wealth by Incubating Mini Cold Storage Technology Ventures (Desai 2011)

Countries: India, Tamil Nadu.

Issue: India produces 63.5 tons of fruit and 125.9 tons of vegetables each year. The 40% of this food becomes a waste because of the insufficiency of cold storage facilities. The post-harvest wastage of vegetables, in India, account nearly for $6 billion annually. The "Waste to Wealth by Incubating Mini Cold Storage Technology Ventures" project aims to reduce post-harvest waste of vegetables and fruits by making possible the access to cold storage for the small farmers.

Objectives:

1. Reducing the vegetable wastage by 50% and more, for farmers, thus increasing their income;
2. Developing a successful business model for faster replication, across the country.

Specific Objectives:

1. Design and installation of mini cold storage systems using latest technology inputs to meet the requirements of different vegetable temperatures, storage quantity, usage, cost and hygiene;
2. Training, Mentoring and Business Development of these micro ventures of youth;
3. Promotion of the model for fast, country-wide, mass replication.

Scalability: World Bank and the Government of Tamil Nadu should meet and discuss ways to expand the project to all 160 farmers' markets in the state. In this case-study is interesting how the aspect of scalability is considered since the first phase of the project. The success of the project is strictly linked to the technology, and also the scaling up depends on it.

Actors: World Bank, Government of Tamil Nadu, vegetable farmers.

5.7 Education with the Participation of Communities (EDUCO) (Hartmann and Linn 2008b)

Country: El Salvador.

Issue: EDUCO project is an example of successful collaboration between community-based organizations and public sector systems. The education system of El Salvador has suffered severe damage during the 80.1 million children were out of school and many teachers abandoned posts. Communities started to establish own community schools. Once the war ended, the government looked as this educational model as a basis of a formal program that would be administratively and financially supported by the government.

Object: The main goal of the project is to restore education system. EDUCO began in 1991 by targeting 78 of the country's poorest municipalities. EDUCO schools are operated by Community Education Associations, an elected committee made up primarily of students' parents. This Committee enters into an agreement with the Ministry of Education. The Community Education Association hires, monitors, retains or dismisses teachers. Parents are taught about school management and how to assist their children at home. Parental involvement is considered key and parents frequently visit classrooms.

Scalability: The scaling up process benefited from the explicit support. As the population met centralized public institutions with deep distrust, the Ministry of Education viewed the parent-organized schools as the only option to reach rural communities (World Bank 2004).

It is an example of how a small innovation can be scaled up to a national level and has a significant impact on national education systems.

Actors: Community Education Associations, Ministry of Education of El Salvador, parents and children involved.

5.8 SD Approach and Rural Development, the Case of Ahuehuetla Coop

Country: Community of Ahuacuotzingo, State of Guerrero, Mexico.

Issue: Revitalization of a Mexican rural area, of the abandoned or underutilized land. This issue has been investigated during the Ph.D. research "Rural development and sustainable innovation. How systemic design approach can contribute to the growth of marginal regions" by the author Bicocca M. (Department of Architecture and Design at Politecnico di Torino).

Objective: The research had two objectives: on one side, the development of the project carried out initially with 6, then with 15, Mexican farmers; on the other side, the definition of models and a framework useful for future projects in similar contexts (rural and marginal areas). Considering the relevance of the RD topic, it is essential that the projects that deal with this issue are designed to be replicated and, possibly, scaled in other similar contexts. This is why one of the most important outcomes of the research has been the definition of 3 models useful for future similar projects: the first one about the actors team involved in the processes, the second one is focused on the 4 steps useful for the implementation of the project; the last one is the framework of the whole project useful for other designers that work in the same issue (Bicocca 2017).

Objectives: the specific objective of the project is to promote diversification in rural economy combining traditional agricultural skills and new technical know-how by the application of the SD Approach. This allows to:

- Improve the quality of life in rural areas;
- Foster the diversification of economic activities;
- Improve the competitiveness (through sustainability) of rural areas;

- Improve the environmental quality, the conservation of biodiversity and to preserve rural countryside heritage;
- Encourage the transfer of knowledge and innovation processes in agriculture in rural areas;
- Encourage the efficient use of local resources.

Scalability: the project has not yet been scaled. The objective of this paper is precisely the definition of the features that should have this project, or projects developed in similar contexts, developed by applying the SD approach, to support and foster the scaling-up process.

The research provides an example of how to create well-being and an important economic flow applying the SD Approach in the small community of Ahuacuotzingo. From the product, the focus moves to flows of materials and energy and to the conversion of waste into useful input for the system. This is a transition able to generate different small business activities.

Actors: the systemic designer, the Ahuehuetla Coop, the connective actor, the 5 farmers (Nacho, Tonio, Josè, Angel and the Cavideco-Centro de Apoyo para el Desarrollo y Vinculación Comunitario, Beto) holding a total of 43 ha, but currently cultivating only 12 ha, 1 group of women that cultivate a greenhouse for the production of organic vegetables, 1 group of women, who have recovered the activity of production of panela which had been abandoned by their father. The actors of the system work as if they were part of the same organism. Each farmer or actor become specialized in one activity in particular. The waste of each activity is used and returned to other productive activities. This allows the generation of new products, which do not exist at the moment.

6 Conclusion

What the scalability of an SD project makes more complex with a focus on the RD, compared to another project, it is the fact that this approach first of all generates relationships. The resulting system is just based on this relational network that is created from the input and output exchanges between the different actors.

The importance of relationships acts, in some sense, as certification and ensuring the quality of products that come out of that same territory. The virtuous cooperation between the actors becomes the system itself. The revitalization of the area, the primary goal when trying to achieve social development in a rural area, with the SD takes place just from the relational network that, itself, allows the creation of new productive activities.

The member that acts as a key player in the system, as is evident from the analysis of the case-study on Ahuehuetla Coop. it is the cooperative of farmers and inhabitants of the Mexican community of Ahuacuotzingo. The characteristics of the environment, a small rural community, make the topics of “dimension” and “scale” very awkward.

From the analysis described in the paper, it is clear that scalability not necessarily needs to be an exponential increase in size, but we can refer also to the increase of the intensity of innovation.

To conclude, we must repeat the categories of scaling up defined by Uvin and Miller (*quantitative, functional* and *political*) adding considerations on how they can be declined within an SD project.

Quantitative: in a project developed with the application of the SD Approach, we must consider acting on the number of the activities, rather than on the size of them. For instance, the cooperative should not become bigger and involve more people. The complexity of the system remain lower if the same cooperative is replicated in the same community first, and then in the nearby communities.

Functional: the relationships between actors on the territory generate new productive processes and, consequently new products. The functional scaling up with the SD approach is the diversification of the production, the scaling of the typologies of production that the output–input flow allows.

Political: within this approach, the concept of scalability and politics is strictly linked. The systemic designer indeed should begin to consider political aspects in relation to scaling up the project, considering always the bottom-up approach and the participatory design phase.

We can, therefore, say that the scale of a project developed by applying the SD approach with the goal of RD, is not necessarily the increase in the reference area size, or in the actors involved in the cooperative, or in the amount of products.

In a fragile area like Ahuacuotzingo, and like most of the rural areas, scalability can be more effectively achieved through the reproduction of the model, rather than increasing the size. On the same territory may arise other cooperatives, similar to Ahuehuetla, which put in place the input–output exchanges, but are also connected with other cooperatives in the territory. The element that needs to be scaled therefore is the relationship network, the system itself, not just one part, one element of it.

The relations, as the network that is created through the exchange of output–input, are the key elements of the system. This is the reason why, when we deal with scalability, this is the element on which we must act: the network of relationships.

Scalability, within the SD Approach for RD, is the strengthening of the connections.

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Participatory Process for Local Development: Sustainability of Water Resources in Rural Communities: Case Manglaralto-Santa Elena, Ecuador

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Abstract

This paper describes the experience of a participatory process that has driven the development of rural communities facing water shortages, demonstrating that collaborative work is key to solve challenges and to achieve a sustainable development. In particular, the paper shows the Manglaralto's participatory process methodology including social, economic, environmental and cultural sustainability areas, and the technical and social adaptations and interactions that have been implemented. The aim of this paper is to describe with facts and events the participatory process and its impact on water management in Manglaralto in order to contribute to the creation of a long-term integrity of natural resources and human well-being. This participatory process has been considered a global example because it was a joint effort between stakeholders, like Manglaralto communities, the Board of Water Regional Manglaralto, International Atomic Energy Agency and the Academic Community-Escuela

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Superior Politécnica del Litoral. The main results of the participatory process have been the water satisfaction for the growing demand, the integration of technical knowledge with ancestral knowledge such as the rescue of ancestral techniques like “tapes” (dykes), the work of the water board at the technical limits of aquifer capacity, avoiding its overexploitation; and the communities’ empowerment in water management.

Keywords
Lack of water · Participatory process · Rural communities · Manglaralto

1 Introduction

It is widely known the document “Transforming our world: the 2030 Agenda for Sustainable Development” so it is considered as a top priority “Ensure availability and sustainable management of water and sanitation for all” (General Assembly 2015).

Water shortage is a major global environmental concern (Hoekstra 2016; Zhou et al. 2016). Nowadays the availability of fresh water resources is a challenge for many communities. Fresh water is becoming a scarce resource that limits the social and economic development in the world (GRID-Arendal et al. 2010; Setegn et al. 2014).

According to Shiklomanov (1998) the surface waters (lakes, rivers and wetlands) represent 0.3% of total freshwater resources on Earth; while groundwaters (aquifers) constitute 30.8%. Groundwaters have an important role in providing water for communities and the functioning of ecosystems (Shrestha et al. 2016). There are 2.5 billion people who rely exclusively on groundwater resources in the world. Also, it is estimated that 20% of worldwide aquifers are being overexploited, so it is reduced reserves of fresh water (United Nations World Water Assessment Programme 2015).

The efficient management of water resources has a major role in social and economic development of Latin America and the Caribbean, because areas with high economic activities are located in areas with low water availability (Peña 2016). At Latin American rural areas the water is supplied fully or partially by groundwater. In addition, it is estimated that there is less amount of water sources in rural areas than in urban areas (Domínguez et al. 2016).

Education and participatory governance are considered two key points for achieving sustainable development in a society. Education is focused on developing communities’ skills that allow them to face and solve their needs, e.g. the preservation of natural resources (Michelsen and Rieckmann 2015). While, the governance facilitates the interaction and negotiation of interests by strengthening the social and political ties to achieve sustainable relations between civil society, public

and private organizations. In addition, the participatory governance is focused on sustainable social and economic development through careful use of natural resources (Jorquera Beas 2011; Leal Filho et al. 2016).

Many participatory processes have been developed as instruments of education and governance for management of natural resources. Participatory processes have shown that for the management and sustainability of water resources, it requires an integrated management of stakeholders such as communities, associations, businesses, governments, NGOs and others actors (Jinapala et al. 1996; Turton 2000; Yavuz and Baycan 2013; Butler and Adamowski 2015).

In rural communities of Latin America and the Caribbean, participatory processes have been developed showing positive results. At the subbasin Toabré river in the Panama Canal a Sustainable Development Program was done through a participatory process. Fifteen participatory workshops were done with the participation of 114 communities (Autoridad del Canal de Panamá et al. 2004).

In the basin of Lake Fúquene in Colombia, Participatory Rural Appraisal Workshops were done using tools such as maps (social, economic, political), matrix ranking (conflicts, benefits, uses) and diagrams (Venn, economic flows, social) which allowed local and regional stakeholders (population, farmers, owners of slaughterhouses, mining awardees, fishermen, craftsmen and others) identify environmental problems, organizational relationships and conflicts generated by access and availability of water resources. Finally, consensual solutions were found through individual and collective actions for watershed management (Maya and Ramos 2005).

There are other cases of participatory processes in watersheds at Latin America and the Caribbean that achieved their objectives, such as the case of the Chira-Piura basin in Peru and the Amarillo-Copán basin in Honduras-Copan, among others (Gobierno Regional de Piura-ANA-GTZ/PDRS 2009; Orellana et al. 2010).

The Manglaralto rural parish is in the Ecuador's coastal region to the north of the Santa Elena province. It is divided into eighteen communities with a total population of 34,457 inhabitants until 2015, according to projections of Instituto Nacional de Estadísticas y Censos (2010). Manglaralto is considered as a tourist sector of Ecuador. Some of the main attractions are beaches, restaurants and handicrafts (Gobierno Autónomo Descentralizado Parroquia Manglaralto 2015). Most of the employed population engages in agriculture, cattle raising, forestry and fishing. On the other hand, it has an unemployment rate of 47.20% and a poverty rate by unsatisfied basic needs of 88.20% (Gobierno Autónomo Descentralizado Parroquia Manglaralto 2011).

In the Manglaralto rural parish, 92.67% of households are supplied with fresh water by wells, 3.34% by the water delivery truck, 2.26% of rain water and 2.26% by albarradas and rivers, in contradistinction to national average in Ecuador, where 45.92% of the rural areas are supplied of fresh water by public water company, 24.87% by rivers, 22.97% by wells (groundwater), 3.16% by albarrada and rain water and 3.08% by the water delivery trucks (Instituto Nacional de Estadísticas y Censos 2010).

It is important to note that there is no public water company in Manglaralto. The main source of water at Manglaralto is groundwater. It is obtained from the coastal aquifer called Manglaralto, administered by the Regional Water Board, Junta Regional de Agua Potable Manglaralto (JRAPM, acronym in Spanish), which provides fresh water to households in Manglaralto through pipe networks (Herrera 2016).

The availability of water in Manglaralto is limited so it is not satisfied the need of water for the population and economic activities (Herrera 2016). In this situation, since 2005 the Escuela Superior Politécnica del Litoral (ESPOL) through the Earth Science Applied Research Center, Centro de Investigación y Proyectos Aplicados a las Ciencias de la Tierra (CIPAT-ESPOL, acronym in Spanish), has generated possible solutions to increase the disponibility of water in Manglaralto; because it has the potential to develop sustainable ways of living and working in communities (Shiela et al. 2016).

The water supply in Manglaralto is a challenge over time. The demand of water of the tourism sector grows, but the warehouse (coastal aquifer) has a storage limit. The technical part alone is unable to solve this situation, so it is important to cover social aspects. Through participatory processes based on participatory action research, changes are generated in management that seeks continuity of water supply. The internal social fabric and strategies born of participatory processes of social interaction allowed the technical issues can be realized, either in an established way or with innovative operations because they are based on ancestral knowledge that is mixed in the daily work or the way of power achieved by hand.

The report of the World Commission on Environment and Development (1987) has stated "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This paper applies the concept of sustainability of the report of the World Commission on Environment and Development, in addition, it brings together four components: social, economic, environmental and cultural.

The paper describes the experience of the Manglaralto's participatory process highlighting activities done and the impact on water management according to techniques of innovation and sustainability used; providing a methodology focused in four areas of sustainability: social, economic, environmental and cultural, that has achieved the increase of availability of water and the empowerment of Manglaralto's communities on water management in order to contribute to the creation of a long-term integrity of natural resources and human well-being.

2 The Manglaralto's Participatory Process Methodology

2.1 Antecedent

Manglaralto rural parish was created in 1861. By that time, the fresh water was distributed by water delivery trucks. In 1970, the price of fresh water fluctuated

between 20,000 and 25,000 sucres per m^3, which currently amount to $0.80 and $1 respectively (Saeteros 2014). It was considered as a high price according to the socioeconomic conditions of the sector.

The government created the Water boards management Law in 1979, that allowed to parishes to create communal water boards. Thus, Manglaralto population was organized to the creation of a water board and to manage the water resources of the Manglaralto coastal aquifer at Manglaralto basin. The basin has 13.238 ha of extension, while the coastal aquifer has an area of 508 has (Herrera 2016).

The Manglaralto Regional Drinking Water Board or Junta Regional de Agua Potable Manglaralto (JRAPM, acronym in Spanish) was created thanks to the encouragement of the parish's Father, Stäheli Othmar (Swiss priest) and the support of all communities. The water board was legalized by the Ministerio de Desarrollo Urbano y Vivienda (MIDUVI) of Ecuador in 1980. Then, they have legalized The Olón Regional Drinking Water Board in 1982 and The Valdivia Regional Drinking Water Board in 1987; so the Manglaralto rural parish has a total of three water boards currently.

The JRAPM is in charge of the distribution, control and collection of water resources for the inhabitants of five communities of the Manglaralto Parish: Montañita, Cadeate, Liberator Bolívar, Río Chico, San Antonio and to the parochial head. Currently, the JRAPM is composed of six members, three men and three women. Each member represents to each community linked to the water board. It is important to highlight that the water board members are democratically elected.

2.2 Stages of Participatory Process

The Manglaralto's participatory process was made during the years 2005–2015 through action-participatory research methodology with reference from studies of

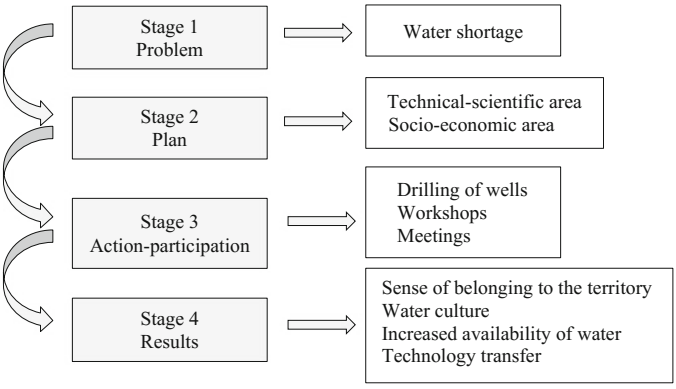

Fig. 1 Stages of the Manglaralto's participatory process. *Source* the authors

Bonilla et al. (1972), Fals Borda (1981), López Cabanas and Chacón (1999) and Becerra and Moya (2008). It was composed by four stages as it is shown in Fig. 1.

2.2.1 Stage 1: Problem

Manglaralto's population had availability of water for 8 h per day in 2005, about from 6:00 a.m. to 10:00 a.m. and 2:00 p.m. to 6:00 p.m. This did not satisfy the need of water of the population. Also it was evident an increase of business and tourists at the parish, who also had demand the water resource.

Some people bought water from water delivery trucks. However, the water price of delivery trucks was very costly. As a result, water demand was not fully covered so population did not have water for their basic needs.

But the problem was not only the lack of water, but the administration of the water board. The water board had reached 25 years of management and they were continuing at the same way management. Although JRAPM work was excellent in those years because they managed the water with limited resources, they needed new techniques to distribution, control and collection of water resources, i.e. new technologies.

2.2.2 Stage 2: Plan

Academic researchers of CIPAT-ESPOL proposed the development of a project to characterize coastal aquifers in Santa Elena. It would be a starting point to drill water wells for exploitation in order to satisfy the water needs.

National and international support was requested to carry out the project. Given the efficient efforts of CIPAT-ESPOL and JRAPM, they got support from the International Atomic Energy Agency (IAEA) of the United Nations. Since 2006, the IAEA sponsored two projects called Characterization of Coastal Aquifers on Provincia of Santa Elena ECU/8/02 and Application of Isotopic Tools for Integrated Management of Coastal Aquifers RLA/8/041.

Activities were concentrated in social, economic, environmental and cultural areas; based on two objectives principally: increasing the availability of water and empowering communities in water management. Figure 2 shows some activities of the participatory process according to sustainability pillars.

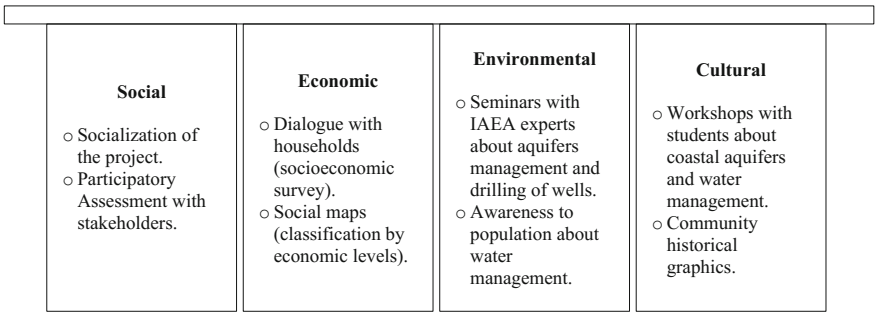

Fig. 2 Activities planned at Manglaralto's participatory process. *Source* the authors

2.2.3 Stage 3: Action-Participation

The process participatory has included a broad kind of stakeholders, such as the population of rural communities, technicians water board, researchers, professors, students, NGOs and government. Figure 3 shows the relation between stakeholders and the way how they are involved in the process.

Manglaralto communities, CIPAT-ESPOL and JRAPM were the managers of the process, the responsibles of organizing and controlling the activities. The Center for Applied Social Development of Escuela Superior Politécnica del Litoral (CEDESA-ESPOL by its acronym in Spanish) and students of ESPOL University were collaborators of the process. They support in different activities like socializations, awareness campaigns, techniques studies at coastal aquifer, and others.

The IAEA was the sponsor, which had provided resources for the execution of projects. Also, it was the in charge to control the activities and to do visits with technical experts that gave advices in order to reach projects goals. The Undersecretary of Control and Nuclear Applications, the official organization in charge of management of activities linked to radioactivity at Ecuador, was a consultant actor.

The participatory action research (PAR) methodology was focused principally on action for social intervention by the enabling dialogue and mediation on the management of coastal aquifer between different stakeholders, encouraging the participation of the most sensitive and disadvantaged groups in decision-making.

Various activities of participatory action research like meetings, round tables, seminars, workshops, awareness campaigns, courses, briefings, lectures, open houses, theater plays, gradual evaluations by the community were developed. Workshops about water management and Manglaralto coastal aquifer were developed at communities as a source of information and participation for improving the water management. Activities of participatory action was a joint work of IAEA, CIPAT-ESPOL, JRAPM, CEDESA-ESPOL and communities. In addition, some training workshops for projects staff (CIPAT-ESPOL and JRAPM) were developed by IAEA for integrating knowledge about aquifers management, drilling of wells and other techniques. Table 1 shows some events of the participatory process, like workshops, conferences, courses, trainings and socializations.

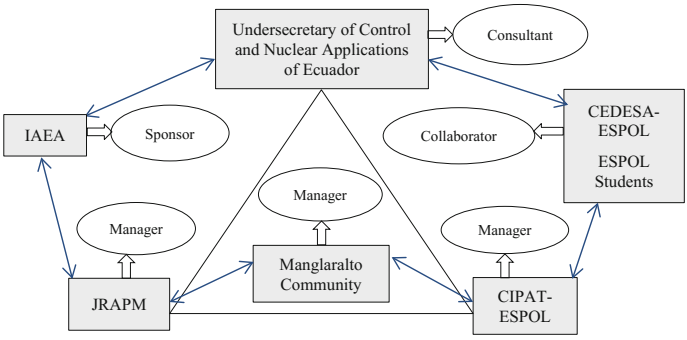

Fig. 3 Stakeholders in the Manglaralto's participatory process. *Source* the authors

Table 1 Events developed

Year	Activities of participatory action	Description
2007	Technical visit	Technical coordination workshop for the Regional Project RLA/8/041 "Development of tools for the integrated management of coastal aquifers. Phase I"
2007	Conference	Ibero-American conferences on desertification and sustainable use of water in drylands. Cartagena de Indias-Colombia
2007	Workshop	The importance of the management of the Water Resource in the Peninsula of Santa Elena
2008	Training	Surface and underground water balance and isotopes in the National Electric Energy Company (ENNE). Honduras
2008	Training	Training in the groundwater area. Ibero-American Center for Industrial Development (CIDIAT, by its acronym in Spanish). Mérida-Venezuela
2008	Course	Chemical and isotopic characterization of groundwater and its application in the study of aquifers
2009	Socialization	Contribution to environmental services. Socialization to publicize ECU/8/02 and RLA/8/041 project activities
2009	Course	International Course on Underground Hydrology in Coastal Areas
2010	Technical visit	Mr. Raúl Ramírez, Technical Officer for Latin America of IAEA
2011	Socialization	Scientific forum-water matters: making a difference with Nuclear Techniques
2013	Course	The use of isotopes as tracers in the water cycle, from the atmosphere to aquifers
2014	Lecture	Isotopes in the water cycle
2015	Workshop	Hydrogeology and integrated management of coastal aquifers

Source Herrera (2016)

Awareness campaigns were developed at schools primarily because children have the power for reaching the water sustainability so they were a key actor at participatory process. Awareness campaigns were organized by CIPAT-ESPOL in collaboration with JRAPM and CEDESA-ESPOL. Each one lasted approximately 3–4 h. Table 2 shows some of the schools and communities where the awareness campaigns were developed.

2.3 Stage 4: Results

One of the main results of the participatory process is the strengthening of the sense of belonging to the territory. The project was an initiative for that the community feels identified with its environment and committed to finding solutions to solve the problems afflicting it in their daily lives.

Table 2 Awareness campaigns developed

Year	Community	School	Participants	
			Adults	Children
2010	Manglaralto	Alfredo Sanz Rivera	45	275
2011	Cadeate	Franz Wasarva	110	67
2011	Libertador Bolívar	Casa Comunal	95	38
2011	Río Chico	Dionicio Gonzabay	25	56
2012	San Antonio	Vicente Rocafuerte	24	247
2012	Manglaralto	Colegio Manglaralto	53	321
2013	San Antonio	Vicente Rocafuerte	29	156
2013	Montañita	José Mejía Lequerica	37	88
2014	Cadeate	Franz Wasarva	17	155
2014	Sitio Nuevo	Eloy Alfaro No16	21	67

Source Herrera (2016)

Manglaralto communities were self-advocates of the project, providing a constant participation during the process. In addition, the efficiency of community-technical relationship enabled the successful performance of planned activities.

Another very important result is the acquired water culture. Manglaralto communities created and developed attitudes and skills for efficient management of water resources. They improved their actions regarding the management of water in their daily activities.

It has increased in more than twenty-one thousand users of water in 10 years as shown in Table 3. Also, there is an increase in the availability of water through the drilling of new wells. Currently, there are thirteen wells in Manglaralto as shown in Fig. 4, which has promoted the access to quality water for the population.

Experts of IAEA, CIPAT-ESPOL research team and JRAPM developed techniques to improve management of Manglaralto coastal aquifer by transferring technology. Ten training workshops were provided by the IAEA to projects staff and there were 12 visits of technical experts for giving advices and reviewing the project. In addition, the participatory process included 15 events, 12 socializations and 15 awareness campaigns aimed to the community of Manglaralto, primarily students in schools and colleges in order to expand and expose the facts of water management and the coastal aquifer.

On the 3rd of July, 2011, Yukiya Amano, Director of the IAEA, made the official visit of the project and congratulated to the project managers for the results

Table 3 Evolution of water users and number of wells in Manglaralto

Year	Users	Wells
2005	2000	2
2010	17,587	9
2015	23,586	13

Source Herrera (2016)

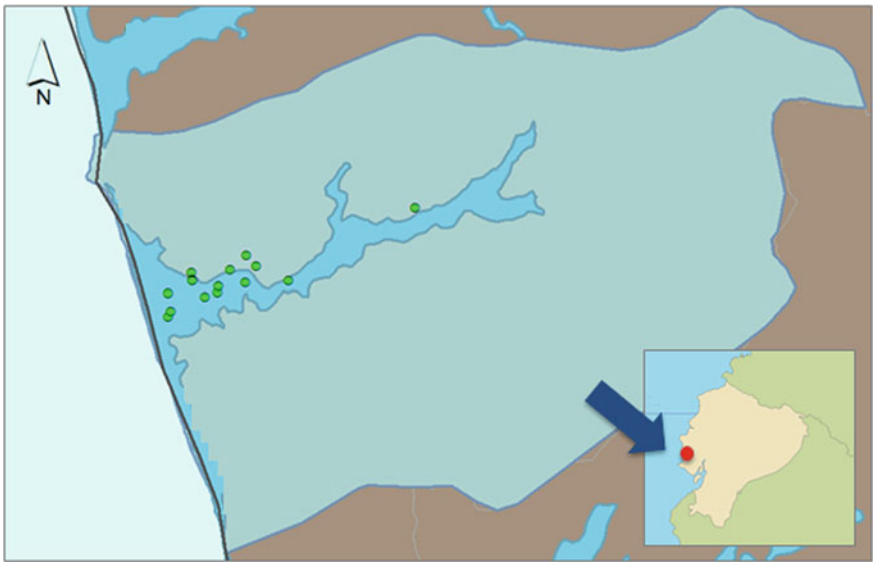

Fig. 4 Location of Manglaralto basin at Ecuador. *Source* the authors

obtained. On the 21st of September, 2011 the Manglaralto project was presented in Scientific Water Forum "Water Matters" where Manglaralto case was considered a world example (Macneill 2011; Herrera 2016).

After the success of projects in Manglaralto there are an increased number of candidates who compete for managerial positions in JRAPM. So people are most involved in water management and the coastal aquifer issues.

Manglaralto communities are in search of the collaboration of public and private entities in activities for the development of their community. Universities and research centers, as CIPAT-ESPOL, have developed projects in Manglaralto, not only focused on water resources management. As a result, there are relevant academic contributions, such as fourteen undergraduate, master and doctoral theses and twenty-seven publications (Herrera 2016).

2.4 Limitations

When people face water scarcity, the dialogue becomes difficult. There are demonstrations on public roads to protest, there are closed roads, and population is suspicious and incredulous when someone discussed them a project that can contribute to the solution of the problem, so they do not lend their support to the fullest. However, in most cases when the dialogue begins and communities work together to face water scarcity an agreement is reached, needs for water are satisfied and improves water management.

The quantity of events, socializations and awareness campaigns developed was a limitation. More educational workshops for the entire province, not only the communities where JRAPM provide water, are required; considering that it is a community resource and its poor management affects all population.

JRAPM is who takes decision and the work is done by consensus, but the decision has the risk of being policy or conjunctive. So the PAR methodology has the limitation of not representing all stakeholders. In general, the methodology leads to consensus, but the water board representative could do what he considered as correct at any time.

The water board improves its technical facilities with the monthly charge to water users. There are users who do not pay the bills of water on time and the board does not deny them water use. However, water cannot be free for the population, it is necessary to pay for it to appreciate its value. In addition, paying for the water service becomes a key element of sustainability, as the managing board maintains its self-management and services based on this payment. The community also maintains its active participation when services are maintained.

3 Conclusion

The Manglaralto participatory process demonstrated that the integration of labor between government-university-industry-community with the assistance of international cooperation led the satisfaction of water needs of communities through sustainable use of water resources, contributing to the creation of a long-term integrity of natural resources and human well-being.

Collaborative work among stakeholders through participatory action research methodology is a key to solve environmental challenges. The methodology is adaptable and change according to the dynamics of people and resources, so stakeholders were incorporated in decision making and activities developed. As resulting the water satisfaction for growing demand was achieved by the increase of the number of wells from two to thirteen wells in 10 years, the integration of technical knowledge with local knowledge allowed the rescue of ancestral techniques like “tapes” (dykes) so in Manglaralto communities have been made artesian tapes, and communities’ empowerment in efficient water management.

The number of users of water resources in Manglaralto is increasing. It is important to highlight that the increase is not only in population but in facilities, condominiums, hotels, hostels, restaurants, shops and businesses in general. Future researches will be necessary to develop a better management of Manglaralto coastal aquifer, being the coastal aquifer system is working at the technical limits of its capacity. The thirteen wells are a limit for Manglaralto coastal aquifer. No more wells can be made.

The main study that needs to be done for sustainability is about recharge. All this requires that participatory processes continue as a driving symbol that generates adaptations and solutions. The recharge is an urgent measure, so the tapes "dykes" become an important strategy.

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The Role of Systems Thinking in the Practice of Implementing Sustainable Development Goals

Martin Reynolds, Christine Blackmore, Ray Ison, Rupesh Shah and Elaine Wedlock

Abstract

Implementing the sustainable development goals (SDGs) adopted at the UN Summit in September 2015 specifically invites the creation of "an integrated, holistic, multi-stakeholder approach". This implies the need for systems thinking in practice, a tradition that draws on systems theories, tools and techniques able to facilitate better conversation and cooperation between agencies. As an approach it goes beyond development of competencies through formal education programmes. This paper focuses on SDG 17—the means of implementation—and the role of systems thinking in practice for supporting both competence and SDG implementation capability. Two inter-linked initiatives led by systems thinking practitioners in the field of sustainability science are reported; one is an action research inquiry exploring the praxis (theory-informed-action) challenges of applying systems thinking in practice in contemporary workplaces ranging from in-field development projects to government administrations and business ventures, and another which built on the findings from this inquiry—a proposal for developing an action-learning platform for SDG implementation. Experience suggests that implementing SDGs requires not only competence in systems

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thinking but a capability of putting systems thinking into practice in a dynamic way, as praxis. The proposed action-learning platform can also be regarded as a learning laboratory in the sense that it will offer learning support and a chance to collaborate and experiment. This platform aims to be co-designed with multi-agency practitioners from international development, government planning, business/social enterprise and NGOs. The proposed platform draws on open-source resources, and ideas of social learning, developmental evaluation and systems thinking in practice traditions.

Keywords
Competency framework · Capability approach · Developmental evaluation · Integration · Learning laboratory · Praxis · Sustainable development goals · Systemic sensibility · Systems thinking · Systems thinking in practice

1 Introduction

Well before the launch of the (2015–2030) sustainable development goals (SDGs) at the UN Summit in September 2015 there have been concerted international efforts towards establishing sustainability science in higher education institutions as a means of nurturing requisite competency in managing sustainability (cf. Kajikawa 2008; Lang et al. 2012; Yarime et al. 2012). A core focus in these endeavours has been transitioning sustainability science from an interdisciplinary pursuit—speaking to and integrating with other relevant academic disciplines—to a transdisciplinary pursuit—enabling active collaboration with stakeholders comprising wider civil society. Agreement on the 17 goals and 169 targets at the UN, now focusses attention on the implementation of the Goals. Goal 17 specifically addresses the challenge of implementation. The key word for effective implementation is *integration*—developing the capacity for reaching beyond the silo-thinking and fragmented practices that arguably impoverished progress in implementing the preceding (2000–2015) millennium development goals (MDGs). 'Integration' is a slippery concept; some call for 'a systems view' in the better supporting implementation of SDGs and strengthening sustainability science (Le Blanc 2015; Oldekop et al. 2016; Stafford-Smith et al. 2016; Abson et al. 2017). Moreover, the need for a system's thinking competency in the context of Higher Education for Sustainable Development (HESD) has been established though variously expressed (Barth et al. 2016).[1] But what is the nature of a systems view and how might it

[1]For particular references see for example the following chapters: Chapter 2, Learning for Walking the Change: Eco-Social Innovation through Sustainability-oriented Higher Education *Arjen E. J. Wals, Valentina C. Tassone, Gary P. Hampson and Jonathan Reams*; Chapter 6. Understanding Approaches to ESD Research on Teaching and Learning in Higher Education *Stephen Sterling, Paul Warwick and Lynne Wyness*; Chapter 16, Operationalising Competencies in Higher

grapple with the messy task of actually implementing SDGs? How might systems thinking *in practice* be mobilised for supporting SDGs?

Systems thinking and systems thinking in practice (STiP)[2] pedagogy in relation to sustainable development has a long tradition at The Open University (UK), beginning with programmes of undergraduate systems education in the 1970s (Blackmore and Ison 1995). More recently in relation to the postgraduate programme in systems thinking in practice (STiP), the relationship and relevance of STiP to sustainability science have been highlighted (Blackmore et al. 2014, 2015). The focus of this paper is not so much on issues of competency generated through *learning* about systems thinking in practice, but rather the wider real-world issues of capability—*enacting* the learning. Whereas 'competency' refers more to acquiring a literacy about practice, the notion of 'capability' is used here with reference to ideas of praxis (theory-informed-action)—applying competencies to particular situations. Praxis captures the actual experiences of mature-age part-time students having undertaken core modules of the OU STiP programme and encountering the challenges of enacting STiP with stakeholders from different organisational backgrounds.

The paper first summarises the context of core competences associated with the postgraduate STiP programme, before going on to describe an action research project involving OU STiP alumni and employers which aimed to track the problems associated with applying STiP in the workplace. Two strands of work-in-progress emerging from this project are then briefly summarised in relation to challenges of implementing SDGs. One strand focuses on competency, and the need for developing some variant of a competency framework for STiP practitioners and their employers, in order to have some mutual benchmark reference as a move towards more institutionalised professional recognition of STiP. Having wider professional recognition of STiP can enhance the relevance of STiP for SDG implementation, and can make it possible for improved investment towards promoting STiP capabilities. A second strand focuses on capability, and specifically on moves towards piloting new platforms of pedagogic design and engagement. The term 'platforms' is used here to refer to an interactive space, either physical, virtual or both, that would enhance the conversations to be had between STiP practitioners and workplace colleagues in order to enhance the concerted action, especially in SDG-enactment-related contexts. Such platforms might be referred to as 'learning' or 'systemic innovation' laboratories. The preliminary contours of this second strand of development—nurturing a platform of action learning—are outlined, as praxis support is needed for those engaging on the front line of implementing SDGs.

Education for Sustainable Development *Arnim Wiek, Michael J. Bernstein, Rider Foley, Matthew Cohen, Nigel Forrest, Christopher Kuzdas, Braden Kay and Lauren Withycombe Keeler*; and Chapter 17, Individual Change: Researching Educational Outcomes Achieved by Higher Education for Sustainable Development *Kerry Shephard*.

[2]STiP is the namesake of a Postgraduate suite of qualifications (Certificate, Diploma, and Masters) offered to part-time students at the UK-based Open University. The acronym as used in this manuscript refers to both the postgraduate programme and the wider praxis notion of systems thinking.

2 Systems Thinking 'Competency' for Sustainability

There is a compelling and intuitive notion that children generally have good systemic sensibilities. Through their early year's education and/or perhaps more inherently, children are able to appreciate the interconnectedness of all things. Children are generally competent in asking purposeful questions—"why?"… and "why?", "but why?"—and so on, at successive levels of recursion and open-ended inquiry. The notion is disturbing when we consider how often such inquiries are met with irritation from adults. It is even more disturbing when considering how mainstream post-early years education actively diminishes such competences through rigidly dividing up curricula into disciplines, coupled with a focus on summative assessments to test retention of bits of knowledge at the expense of providing space for open inquiry and conversation. Education for sustainability might be ideally seen as a means of readjusting the emphasis towards fostering systemic sensibilities.

Ray Ison uses the idea of systemic sensibilities as a baseline transition point for envisioning the role of a 'systems thinking in practice' curriculum for enabling a better response to the sustainability challenges of the Anthropocene (Ison and Shelley 2016). Ison and Shelly make a useful distinction between systemic sensibility, systems literacy, and systems thinking in practice capability; regarding STiP capability as a sub-system of systems literacy, which itself is a sub-system of systemic sensibility. In commenting on the challenge of retrieving and building on systemic sensibilities, Ison and Shelly state:

> What is missing … are the contexts for a systemic sensibility to flourish, to be recovered and/or fostered. Investment in systems literacy and then systems thinking in practice capability is missing in education as well as organizational life. The shift from sensibility to capability is needed if purposeful action is to be pursued with some prospect of altering the current and anticipated human condition, our co-evolutionary trajectory with the biophysical world, with other species, and with each other. This is the challenge of 'Governing the Anthropocene' which, as a profoundly existential crisis, is also the greatest challenge for systems thinking in practice… (*ibid* p. 589)

Figure 1 is an adaptation of a systems map image of transition from systemic sensibility to systems thinking in practice capability. For the purpose of this paper, the term 'systems literacy' is substituted with 'systems thinking (in practice) competency'.

Formal curricula in higher education institutions (HEIs) have a good record of encouraging a range of different competencies to support sustainable development (Leal Filho 2011; Disterheft et al. 2013; Barth et al. 2016), including a range of interdisciplinary and transdisciplinary skills. Competencies associated with systems thinking are particularly relevant to education for sustainability (Sterling 2004; Martin et al. 2005; Stibbe 2009).

STiP competency might be summarised in terms of fulfilling three key activities (Reynolds and Holwell 2010; Reynolds 2011, 2013, 2014):

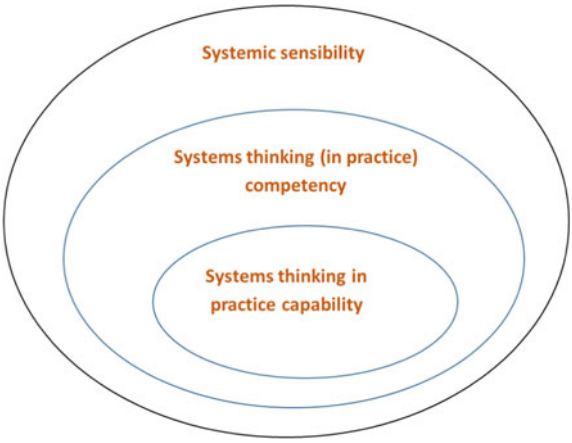

Fig. 1 The nested (systemic) relationship between systemic sensibility, systems thinking (in practice) competency (or systems literacy) and systems thinking in practice capability. *Source* Adapted from Ison and Shelley (2016, Fig. 1, p. 589)

1. Understanding inter-relationships
2. Engaging with multiple perspectives
3. Reflecting on boundary judgements.

Although competency is something that HEIs may teach formally in the curriculum as a means of encouraging praxis, a curriculum in itself cannot guarantee capability of praxis. Hence, Fig. 1 retains parentheses with 'systems thinking (in practice) competency'. Being competent in appreciating systems thinking in practice is different from being capable of actually applying systems thinking in practice, for example, in particular circumstances of supporting sustainability.

Since 2010, postgraduate STiP studies at the OU have focussed on developing competency skills in systems thinking in practice (Blackmore et al. 2015). Two core 30 credit modules (each requiring 6 months part-time study) are associated with the programme:

- Thinking strategically: system tools for managing change (TU811) and
- Managing systemic change: inquiry, action, and interaction (TU812).[3]

The following three key features of pedagogy roughly correspond with each of the competencies above, and are shared by the two core STiP modules (Blackmore et al. 2014).

(i) Epistemic understanding. 'Systems' are used as conceptual models, as epistemological devices rather than ontological realities (understanding inter-relationships).
(ii) Active pedagogy. Students use their learning context in creative combination with tutors and module designers (engaging with multiple perspectives).

[3]Content details of the two modules (OU codes TU811 and TU812, respectively) can be found on The Open University website http://www.open.ac.uk/choose/ou/systemsthinking.

(iii) Design praxis. Students develop projects using systems concepts in a constructive, reflexive, design-mode manner favouring formative over summative evaluation (reflecting on boundary judgements).

All three features offer pedagogic opportunities and challenges in fostering systems literacy and enhancing systems thinking competence relevant to SDG implementation. So, firstly, appreciating epistemic understanding of 'systems' prompts an opportunity of using systems of interest innovatively but remains a major challenge given the prevailing ontological understanding and use of systems as being direct representations of the reality; for example, in reference to 'ecosystems', or 'the' health system, 'the' economic system, and so on. One liberating example of this challenge is in viewing interventions (projects, programmes, policies, etc.) associated with, say, implementing SDGs, as themselves 'systems of interest'. This is different from, though complementary to, seeing such interventions as serving particular formalised 'systems' (as perceived in the real world—for example, the health system or the economic system, etc.).

Secondly, active pedagogy provides the opportunity to actually practice ideas of STiP in the workplace as a learning context thereby bringing out the relevance of teaching material. The traditional divide between learning and practice is challenged in the core modules through carefully orchestrated activities that enable students to engage purposefully with their own contexts of practice—often, though not exclusively, contexts associated with students' own workplaces. STiP students actively working in areas of SDG implementation, for example, are thus required to grapple with their own particular roles with implementing SDGs using STiP ideas during their studies.

Thirdly, in relation to design praxis, STiP students generally appreciate the opportunity of an end-of-module project assessment where they can develop their own 'systems of interest' as a means of either proposing strategic improvements (TU811) or constructing a briefing paper relevant to a systemic change situation (TU812). In viewing and appreciating systems as designed constructs for learning and implementation, there is a deeper appreciation of challenges associated with (i) the provisional nature of 'systems' (systems as fallible constructs), (ii) the interchangeable use of systems as both ontological and epistemological devices, and (iii) the overall essential transformative drive of STiP—systems *for* sustainability and systems *for education* as against, for example, 'sustainable systems' or 'education systems'.

Moving from teaching and learning 'competencies' towards nurturing 'capabilities' requires more attention to the context in which (for example, systems thinking in) practice is actually practiced. For example, enabling an 'integrated, holistic, multi-stakeholder approach' towards implementing SDGs (as expressed in SDG 17) requires not just being equipped with tools and ideas from, say, systems thinking traditions, but an awareness of, and an ability to work constructively with, constraints and opportunities presented by institutional and cultural contexts in which practitioners involved with SDG implementation actually work. Ray Ison describes the usefulness of systems thinking in making such transitions in terms of

taking a 'design turn': "…ways to improve practice at the same time as striving to transform their contexts of practice through systemic design" (Ison 2016, p. 47). The following section reports briefly on an action research inquiry undertaken by members of the Applied Systems Thinking in Practice group at the OU which explored some of the challenges amongst STiP alumni in making this design turn, challenges that will have to be met in the implementation of SDG 17 in a given context.

3 Systems Thinking in Practice 'Capability' for Sustainability

The STiP core modules at the OU attracts students from a wide range of public and private sector professional backgrounds including public health, countryside planning, landscape design, project management, engineering, energy industries, community development, and social work. Students have worked for councils, business, industry, and non-governmental organisations. Academic backgrounds range from information systems to engineering to health and social care to environmental sciences to development studies. There is perhaps an assumption in a postgraduate provision that PG qualified students have the capabilities of applying their PG skills to their workplace. The assumption can sometimes be reinforced at HEIs where PG learners might tend to be mature-age and part-time and considered more adept at transferring competencies into capabilities. From the standpoint of many PG students who are work-based whilst studying, the divide between the two worlds can, however, often be experienced as an 'either/or' dualism—*either* they are studying *or* they are working—with there being a clear perceived boundary between the two worlds. For others, the two worlds might more helpfully be experienced as an interactive duality. Here, the learning activities are in continual interaction with workplace activities, where changes emerging in one world inform changes to the other world through a virtuous feedback pathway. Such interactive processes might be regarded as constituting praxis (theory-informed-action, or thinking-in-practice).

Pedagogic models of design and delivery of learning often reinforce a dualism rather than promoting the duality of praxis. Since the first presentation of core modules in 2010, the STiP programme has endeavoured to address this pedagogic dilemma through enabling students to practice their learning through workplace-oriented activities and assessments, and through reflective conversations amongst students sharing experiences of using module materials in their activities and assessments through vibrant student forums. The STiP programme has registered significant success in achieving praxis during core module presentations, but there remain challenges in bridging the divide between STiP study experiences and post-study workplace experiences.

Competencies associated with developing epistemic understandings, encouraging active pedagogy, and promoting design praxis, need translating into capabilities.

Evidence from past students of their experiences of the STiP modules was gathered as part of an 18-month action research inquiry—*Enhancing Systems Thinking in Practice at the Workplace*—initiated by the OU STiP team in 2014 with the active involvement of OU STiP alumni (Reynolds et al. 2016a). The inquiry was funded by eSTEeM—the OU Centre for promoting STEM (science, technology, engineering, and maths) pedagogy.

The primary aim of the eSTEeM inquiry was to seek ways of bridging the gap between the largely 'conceptual' world of distance teaching and learning at post-graduate level, and the more 'practical' world of applying learning experiences in the workplace. In short, the inquiry was aimed towards shifting attention from enhancing levels of *competence* in systems thinking (in practice) to enabling *capability* for systems thinking in practice. The overall approach was to evaluate experiences of students, alumni, OU tutors—Associate Lecturers (ALs)—and employers, all associated with the STiP programme in order to support systems thinking in practice at the workplace (Fig. 2).

The research was carried out using the principle of a co-inquiry platform—researching *with* people rather than *on* people—through a series of structured conversations including interviews, follow-up online discussion and a workshop event. The research was done in three phases involving the appointment of two experienced ALs from the STiP programme (Rupesh Shah and Elaine Wedlock).

Phase 1 semi-structured interviews with (i) existing STiP students and (ii) ALs associated with core modules of the STiP programme. The results of this first phase were used to inform the second phase.

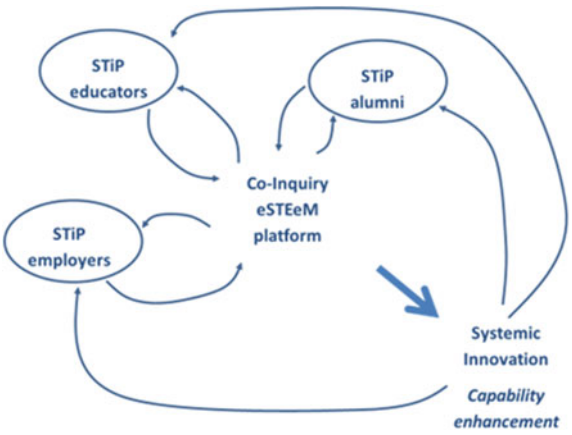

Fig. 2 eSTEeM–The Open University Centre for promoting science, technology, engineering and maths (STEM) pedagogy—project approach to enhance capacity for systems thinking in practice (STiP) in the workplace. *Source* Reynolds et al. (2016a). © 2016 The Open University

Phase 2 semi-structured interviews involving: 16 interviews conducted by the two AL consultants with STiP alumni active in the OU alumni LinkedIn community and an employer and/or manager they nominated (i.e. eight interviews with alumni and eight interviews with employer-partners of alumni).

Both phases 1 and 2 involved writing summary reports in order to; (a) feedback to interviewees and elicit further conversation and stakeholding engagement, and (b) provide the basis for a working paper, to be developed as a refereed journal article.

Phase 3 seminar and workshop events: Central to this phase was the preparation and delivery of a 1-day workshop in London. The workshop involved representatives from all stakeholder groups including all interviewees from phases 1 and 2, other employer representatives and specially invited alumni. The workshop brought together STiP alumni, educators and employers to engage in a short collaborative inquiry designed as a system of collaborative inquiry around the dynamic of 'post-study systems thinking in the workplace' (Fig. 3).

After an initial cycle of inquiry around the general experience of being a systems practitioner, the inquiry was structured around a further three cycles each focusing on the experience from a particular perspective (doing systems practice—as part of being a practitioner, educating systems practice, and employing systems practice—Fig. 3).

STiP alumni registered challenges in applying learning experiences from the core modules to post-study workplace situations. Some core challenges can be briefly summarised. First, in using epistemic understandings of systems, the capability challenge is recognising where the ontological and epistemological use of systems is appropriate or relevant. This includes working with particular

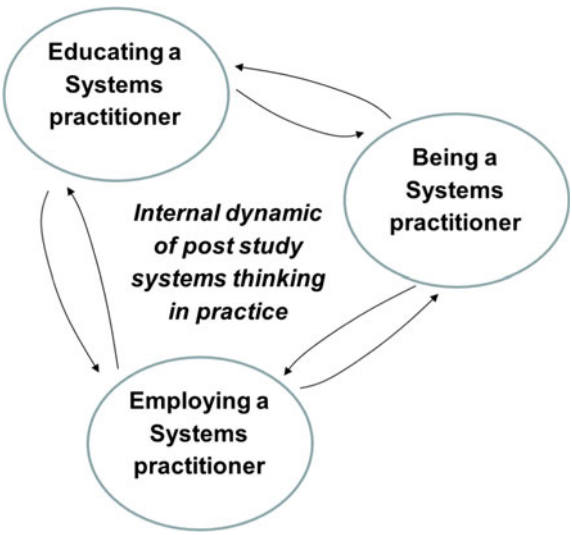

Fig. 3 Systems thinking in the workplace dynamics: May 2015 workshop collaborative inquiry framed around three sets of conversations. *Source* adapted from Reynolds et al. (2016a)

stakeholders—colleagues and employers—many of whom are likely to be less appreciative of the epistemological use of systems.

Second, whilst individually valuing and appreciating the relevance of systems ideas and tools for the workplace, some STiP alumni in their workplace situations have difficulties relaying the usefulness of these ideas to colleagues. Often, ideas associated with STiP are introduced by alumni 'under the radar' as a form of silent practice in order to avoid the risk of seemingly threatening entrenched ways of thinking and practicing in the workplace, or seemingly introducing language which might be regarded as alien or foreign, or worse, simply shallow and 'faddish'.

Third, applying the craft skill of 'design praxis'—using systems as experimental (ontological and epistemological) devices for transforming situations—requires creative space. Such 'space' in many workplaces is limited by a culture that is sometimes fixed on rigid performance measures and standards that do not allow for adaptability. For enabling STiP endeavours to thrive, a culture of safe-fail (spaces of 'caring', for failing safely with imperatives towards learning…) needs to replace prevailing cultures of fail-safe (spaces of 'accountability', with imperatives towards taking—often punitive—corrective action).[4]

The challenges associated with developing STiP capability are thus more associated with cultivating cultures that enable STiP competencies to flourish. Some of these were articulated at the eSTEeM workshop and bear relevance to supporting institutional practices of SDG implementation.

4 Praxis Support for Implementing SDGs

The implementation challenges summarised below are phrased in terms of the necessary praxis support needed to counter prevailing dualisms associated with affecting each of the three sources of STiP competence:

(i) Dualisms of systemic versus systematic (understanding inter-relationships),
(ii) Practice versus understanding (engaging with multiple perspectives), and
(iii) Formative versus summative evaluation (reflecting on boundary judgements).

- *Systemic and Systematic* (understanding inter-relationships and developing epistemic understanding). Having some systemic sensibility about the integral nature of the SDGs is one thing. Actually integrating SDGs is something quite

[4]'You Can't Grow Roses in Concrete' is the title of an action research report using systems thinking ideas on organisational reform to support high quality safe practice for child care services in UK (Munro et al. 2016). The title epitomises the need for focussing on developing appropriate institutional creative space. In my reading of the report, the 'roses' can refer immediately to the Children of child care services and to the multitude of professionals responsible in different ways to support the children. Nurturing a culture of care is as relevant for professionals as those for whom professionals may serve.

different. Whereas the former may involve a *systemic* understanding, the latter inevitable involves some *systematic* engagement. The challenge is not to dismiss one for the other but rather to keep both in conversation with each other through continual creative tension. The tension here is one that is replicated in any intervention, including pedagogic design. Course design and all associated institutional processes and practices are inherently systematic. The challenge for developing a postgraduate course on STiP involves translating a systemic subject matter into a pedagogy which is largely and necessarily systematic (with formal linear progression through materials, cut-of-dates for assessments, within a fixed time period of six months per module, etc.). In the design of the two core STiP modules, the tension is in-part retained through recurring reference in the course to particular metaphors. Metaphors of bricolage (for TU811; see Reynolds 2015) and juggling (for TU812; see Ison 2010) are helpful devices for capturing the praxis tension between being systemic and being systematic. In the realities of implementing SDGs, notions of being 'systemic' (holistic, 'getting the bigger picture', 'seeing the forest for the trees'…) are often regarded as being good in theory but difficult to translate into (necessarily systematic) practice. Support is needed for enabling appropriate translation at appropriate times from one to the other; from being systemically aware to doing practice systematically.

- *Practice and Understanding* (engaging with multiple perspectives and developing active pedagogy). The second challenge involves using the workplace as a resource for developing systemic practice. Stakeholders involved with implementing SDGs supported by systems thinking may feel a sense of despair with yet more additional demands on learning new tools and techniques. However, much of the learning experienced through STiP is undertaken by actively practicing ideas using existing techniques but in an adaptable manner. Conventionally, formalised learning is framed in terms of first 'understanding' followed then by 'practice', with the premium given to 'understanding'. Retaining the tension and actually privileging practice over understanding (cf. Cook and Wagenaar 2012) provides a means of enabling praxis support. The capability to do this may be undermined by conventional prevailing practices that reinforce formal certification (proof of 'learning') associated with existing professional practices. STiP pedagogy can help to counter such practices. For example, TU812 uses the notions of social learning, landscapes of practice and communities of practice (Blackmore 2010), whereas TU811 emphasises the notion of reflective practice in relation to learning from the application of systems ideas in a work context (Reynolds and Holwell 2010; Reynolds 2011). However, as evidenced through the eSTEeM inquiry, learning from the work experiences may have unintended consequences on work relations. Practicing new ideas without due concern for the cultural context can have an alienating effect with work colleagues. Is there perhaps an ethical imperative in providing health warnings of potential disruptive consequences around performing new practices in work situations, particularly workplace situations associated with implementing SDGs where there is already likely to be considerable tensions

given the tasks at hand? What wider professional guidance might be offered to nurture better understanding amongst work colleagues?

- *Formative and Summative evaluation* (reflecting on boundary judgements and developing design praxis). The third challenge constitutes the evaluation of learning in relation to what Ison refers to as 'the design turn' (Ison 2010, 2016). Traditionally, evaluation is regarded as an activity to do after implementation of an intervention—summative evaluation. A conventional systems-based approach to implementing SDGs might use 'systems' as an ontological device—a benchmark—for measuring the performance of an intervention. The 'Goals' associated with SDGs would be seen as providing the measurable outputs or outcomes from existing 'systems'. So for example, SDGs associated with healthcare may be associated simply with national health systems, or SDGs associated with food security may be similarly associated with national agriculture systems, etc. Whilst this is often a helpful (systematic) use of systems thinking, it may also lead to frustration. Practitioners can often despair with what regularly comes over as free-thinking, open inquiry initiatives proffered by external advisors/consultants/educators, only to be frustrated by the realities of having to address existing agendas, targets, 'goals', fixed by prevailing institutions (norms, rules) in the workplace.

The praxis challenge here is in shifting the use of the systems idea to one of formative 'design' mode rather than purely summative 'diagnostic' mode. An alternative might be to regard the SDGs not as fixed measures of some pre-existing system of either UN global intervention or existing national 'systems', but rather as one set of components in the continual flux of events, people, and ideas (cf. Geoffrey Vickers, in Ramage and Shipp 2009a) that makes up the mess (cf. Russell Ackoff in Ramage and Shipp 2009b) or (super) wicked problems (cf. Lazarus 2008) to which SDG interventions are addressed. It may then be possible to utilise the systems idea in design mode; as a purposeful means of structuring SDG interventions in order to address systemic sensibilities associated with the need for integrating SDGs. Such a 'design' shift involves moving from using systems for summative to more formative forms of evaluation and, moreover, appreciating the integral play of both types of evaluation throughout an intervention. Drawing on ideas from developmental evaluation (Patton 2011), ideas for using STiP to integrate formative and summative evaluation have been described in terms of systemic evaluation (Reynolds et al. 2016b). Navigating the tension between formative and summative evaluation is likewise evident in any intervention, including pedagogic design for the STiP modules at OU. Developmental evaluation requires some form of formative evaluation in a way which benefits students as well as their employers. This raises some issues in relation to the institutional validity (at the University and in other workplaces) of formative evaluation compared with mainstream demands for summative evaluation (e.g. performance indicators).[5]

[5]An example of a design turn was evident at the eSTEeM workshop in London, 2015. At one stage the conversation was reframed by participants from one which focuses on how the OU could improve its offering for students to instead focus on the question of how the OU can support alumni and employers to develop systems practice in their own context, building self-sustaining communities of practice.

Two strands of further inquiry evolved from the eSTEeM project; each regarded as endeavours towards promoting purposeful systemic design—design praxis. One strand focuses on developing a competency framework for STiP and another strand focuses on generating multi-stakeholder spaces for STiP explorations. These are both works in progress and are briefly described below in relation to their potential relevance to supporting SDG implementation.

5 Emergent Inquiries in Developing STiP Capabilities

Figure 4 illustrates two emergent strands of inquiry associated with the STiP eSTEeM project. Both strands of inquiry support capability enhancement. Both strands also provide feedback loops to the improvement of STiP competency and the ongoing development of the OU STiP postgraduate curriculum. Core to this development is the wider involvement of STiP alumni, employers, along with academics (Associate Lecturers and central academics).

One strand of inquiry is exploring the task of formulating some kind of competency framework for STiP; one that serves the professional interest in promoting STiP in Higher Education Institutions as well as professional bodies and employers. A core challenge of such a framework is to remain true to STiP as praxis; a framework continually adaptive to changing circumstances (events) as well as responsive to diverse and changing users (people) and associated systems of interest (ideas). Such a framework can potentially offer more security amongst practitioners in the field of sustainable development to experiment safely with systems ideas in their workplaces. An appropriate STiP 'competency framework' provides a step towards offering professional legitimacy to practice systems thinking, thus generating a more enabling context for STiP.

The second strand of post-eSTEeM activity is one that has more direct potential for supporting SDG implementation. The general endeavour here is one of action research and outreach; an endeavour that builds on OU 'third mission' traditions in more directly serving wider social and community development (in addition to traditional 'missions' of research and teaching associated with conventional HEIs). A series of interventions are underway involving ASTiP[6] colleagues at the OU in facilitating the framing of public policy issues regarded as being wicked problems (in areas of health, education, agriculture, and environment) with participants from relevant sectors. These ASTiP activities have been ongoing outside of the eSTEeM project, particularly in areas of water governance (Foster et al. 2016), environmental governance (Ison et al. 2015), and indigenous community development (Berardi et al. 2015). The eSTEeM inquiry has given impetus to a more concerted strategy of mobilising STiP expertise, including STiP alumni, alongside colleagues at the workplace.

[6]Applied Systems Thinking in Practice Group.

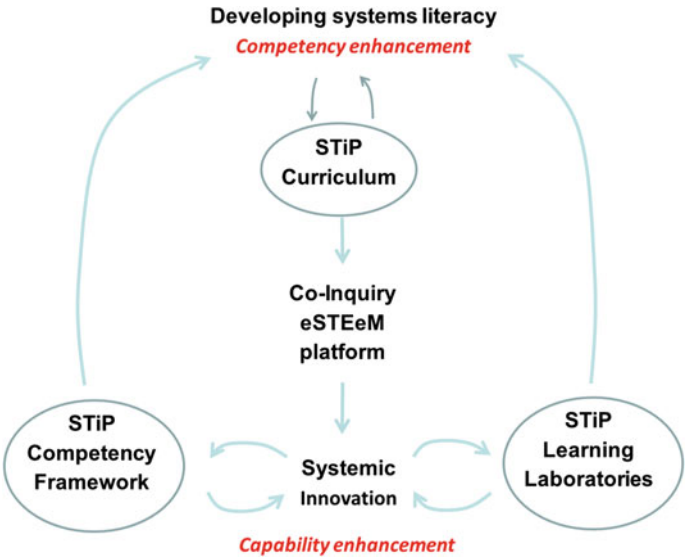

Fig. 4 Two strands of inquiry—competency framework and learning laboratories—emerging from an initial co-inquiry exploring capability enhancement of systems thinking in practice (STiP) sponsored by eSTEeM—The Open University Centre for promoting science, technology, engineering and maths (STEM) pedagogy.

Drawing on ideas of co-learning initiatives from Ha et al. (2016) third mission endeavours based on mobilising STiP competencies with multiple stakeholders might collectively be termed as constituting learning laboratories. Ison et al. (2016) at Monash University in Australia used the notion of a learning laboratory to envisage a transformation of the University to meet the challenges of SDGs.[7] The purpose of the learning laboratory is seen as providing "support (tools, concepts, methods, experiences) and facilitation in framing public policy issues and devising action strategies for research, education and decision-making… [helping] participants experience a transformation from the current situation of policy inertia to one where learning through complex situations result in practical action" (*ibid*).

The learning laboratory as envisioned by Ison and colleagues provides a site for transformational change. Figure 5 depicts the change in terms of two simple systems; one a system as it is currently perceived, and another as an idealised system. Both systems of interest are delineated by three generic questions regarding; (i) what the system does (purpose), (ii) why the system works as it does (worldview or rationale underpinning the system) and (iii) how the system operates (core system activities).

[7]The proposal was to view the University as constituting three pillars of activity—(i) designing and implementing inter- and transdisciplinary research with academics, (ii) building capacity of Monash students in addressing sustainability challenges, and (iii) support for the public and private sectors in 'silo busting' for improved governance (Ison et al. 2016).

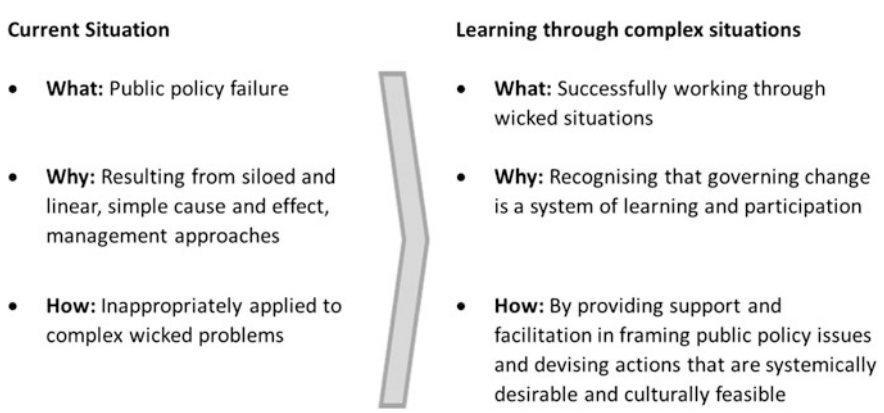

Fig. 5 Transformational change that could be supported by the design of 'systemic learning laboratories' combining both material and virtual elements. *Source* Ison et al. (2016)

The purpose of a learning laboratory is to engage stakeholders associated with particular wicked problems in different domains, through processes of systemic co-inquiry based on principles of STiP. Such initiatives are currently being explored and developed with ASTiP colleagues in areas of, for example, systems for Health, systems for evaluating Social Enterprise Impact Hubs, systems for Conservation, systems for Food Security, and systems for implementing SDGs. The remainder of this section briefly describes this latter initiative—a proposed learning laboratory developing a multi-stakeholder platform for integrated SDG implementation based on STiP.

Developing STiP capability—praxis support—for integrated implementation of SDGs is a particular concern for the United Nations Development Programme (UNDP). In response to alumni contacts with UN personnel, enquiries with ASTiP are being progressed with the view of setting up a learning platform utilising OU expertise from the Development Policy and Practice (DPP) research group, along with ASTiP group members and associates, including ALs and STiP alumni. The working title for this initiative is 'Facilitating effective implementation of Global Goals for Sustainable Development through Applied Systems Thinking'. In addition to support from UNDP, ASTiP and DPP colleagues, and the International Development Office at The Open University, the OU is also able to provide technical support for enabling a learning laboratory through its online platforms of FutureLearn and OpenLearn Works, with the in-house Open Media Unit (Scanlon et al. 2015; Law and Jelfs 2016).

The proposed learning laboratory initiative is built around praxis principles of 'conversation'; a conversation between thinking and practice. Three orders of conversation underpinning systems thinking in practice (Reynolds 2014) dovetail with the three competencies of STiP—understanding inter-relationships (1st order), engaging with perspectives (second-order) and reflecting on boundary judgements (third-order). The three orders of conversation are mediated through the lens of

developmental evaluation—a practice orientated means of coupling formative with summative evaluation drawing on ideas from complexity science and systems thinking. Drawing on a recent expression of developmental evaluation in terms of systemic evaluation (Reynolds et al. 2016b), three principals of capability are used to guide systemic interventions based on implementing SDGs—humility in appreciating that systems of interest inevitably exclude factors and actors, empathy in appreciating the need to engage with perspectives that may not conform with existing value judgements, and inevitable fallibility, in appreciating that systems design around interventions are never fail-safe given the prevailing uncertainties, and hence need a safe-fail context of ongoing experimentation.

The overall objective of this initiative is to develop an ongoing learning system as a platform to promote and enable more effective implementation of SDGs. The aim is to enhance the governance and effectiveness of inter-sectoral development initiatives at local, national and international levels. This will be achieved by means of facilitated purposeful inquiry and interaction amongst key stakeholder groups (representatives from government, business, expert bodies, and civil society) based on systems thinking in practice. The proposed learning system will be co-designed amongst stakeholders with the core project team, particularly drawing on existing Open University open learning platforms (FutureLearn and OpenLearnWorks), existing open-source resources associated with OU STiP pedagogy, and sources of expertise including distance learning support and media development, in addition to externally sourced internationally acclaimed academic expertise in systems thinking and development management theory and practice. Specific components are outlined below.

A core objective is to initiate new institutional arrangements for coordinating the implementation of the SDGs. Two component parts of the initiative are outlined below and can be collectively referred to as a "MOOC-plus" intervention, where a MOOC is a Massive Open Online Course.

Component 1: MOOC-core: Co-design and development of an initial MOOC specific for the needs of UNDP and other key stakeholders/sponsors, with the provisional title 'Implementing SDGs through Systems Thinking'. The MOOC will be designed around core principles of STiP and systemic evaluation and will reach a geographically dispersed group of stakeholders with an interest in the integrated implementation of SDGs. FutureLearn is the platform to be used for the delivery of the MOOC.[8]

Component 2: MOOC-wrap around: Several pilot additional and more specific ('closed') learning supported journeys will be co-designed and developed for more bespoke variations of the FutureLearn MOOC. These MOOC-wrap around products will enable engagement of perspectives amongst representatives from specified stakeholder groups (including government policy and analytics professions, business sector partners, independent expert consultants, NGOs and INGOs)

[8]Owned by The Open University and launched in December 2012, FutureLearn is an internationally recognised social learning platform, designed to deliver academic courses with conversation between learners core to the experience. It delivers courses with over 50 partner universities.

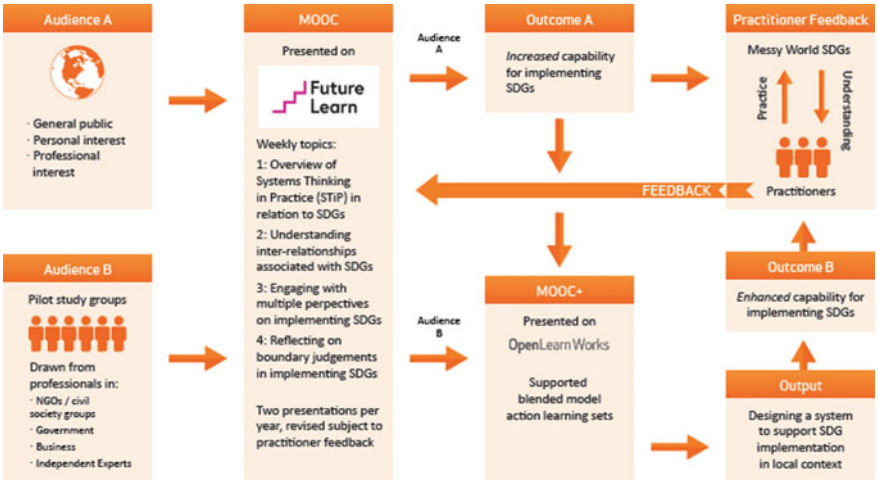

Fig. 6 Praxis support for implementing sustainable development goals (SDGs) based on systems thinking in practice at The Open University. *Source* Reynolds et al. (2017). © 2017 The Open University

responsible for implementing SDGs. These will foster 'multi-stakeholder partnerships' (in line with SDG 17) and will be enacted both online and through face-to-face workshops facilitated by experienced ASTiP practitioners. The MOOC-wrap around will be based on the more interactive OpenLearnWorks platform provided by the OU.

Other objectives associated with the proposal include, firstly, encouraging the application of systems thinking (ST) among SDG stakeholders, and secondly, encouraging the application of institutional development approaches, focused on the creation of new frameworks for policy and practice and on the building of the inter-organisational relationships through which those new frameworks are created. An integral aspect of this is the development of the 'critically reflective practitioner' with the capability to examine 'how we do things' and explore 'how we might do things differently'—a capacity crucial for the effective implementation of the SDGs.

MOOC-core involves individual sense making of SDG interventions, and so is aligned more with first-order conversation in STiP. MOOC-wrap around involves active collaborative partnerships facilitated by experienced STiP practitioners and is more aligned with second-order STiP conversations. Third-order conversations—reflection on learning—is encouraged throughout the two components of the proposed initiative. Figure 6 provides a sketch of the proposed intervention.

A supplementary objective is to raise awareness and offer opportunities amongst participants for further more formal individual study for further professional development on associated and accredited postgraduate qualifications—particularly associated with STiP and/or DPP—at the OU.[9]

6 Conclusion

"…[H]umanity remains on largely unsustainable development trajectories. Partly, this is due to the failure of sustainability science to engage with the root causes of unsustainability […] We propose a research agenda inspired by systems thinking that focuses on transformational 'sustainability interventions'" (Abson et al. 2017 p. 30). The 'learning laboratory' initiative outlined in the preceding section provides a contribution towards such an agenda. There is no quick-fix to the challenge of integrating SDGs—the particular concern of SDG 17. Acknowledging the need for developing 'an integrated, holistic, multi-stakeholder' approach is an expression of systemic sensibility; an appreciation that implementing any one of the SDGs will have effects on other SDGs. Traditions of systems thinking are particularly relevant to the task given the intuitive ideas relating to 'getting the bigger picture' (holistic thinking) and encouraging 'joined-up practice' (pluralistic thinking). But is it enough for higher education institutions to help develop systems thinking in practice (STiP) skills and competencies? As evidenced by the eSTEeM project, outcomes reported in this paper, Introducing and cultivating STiP competencies in (i) understanding inter-relationships, (ii) engaging with multiple perspectives, and (iii) reflecting on boundary judgements, are not in themselves guarantors for enabling capability.

The challenges in moving from developing competencies in a curriculum to nurturing capabilities in work situations require grappling with issues of praxis. For cultivating STiP capability, these challenges can be understood in terms of enabling 'conversations' of praxis—conversations that bring into play the dualities (as against either/or dualisms) between systemic and systematic endeavours, between practice with understanding, and evaluating formatively alongside making summative judgements.

More specifically, cultivating STiP capability for implementing SDGs requires developing a constructive safe space in which practitioners from different sectors may 'experiment' with other stakeholders in creatively applying ideas of STiP with a praxis sense of humility, empathy, and inevitable fallibility. The proposed creation of a learning platform laboratory reported here is one example of the type of

[9]Participants can join existing cohorts of OU students for assessed 30 credit modules, each lasting 6 months of part-time study (approx. 10 h/week). It may also be possible to make specified groupings of students in tutor groups so that they can share particular conversations around SDG implementation on a virtual basis during the module presentation. The 30 postgraduate credits of each module can count towards accredited UK postgraduate qualifications at Certificate (60 credit), Diploma (120 credit) or Masters (180 credit) levels.

praxis that might be envisioned. Such endeavours more generally require HEIs to refocus investment strategies from traditional 'teaching' and 'research' towards a process—intrinsically political—of building new relationships, new understandings and new institutions: in short, a process of learning to do things differently.

Acknowledgements Appreciation is given to copyright owner The Open University (UK) for permission to reproduce Figs. 2, 3 and 6

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Creating Circular, Efficient and Symbiotic Cities: And How Higher Education Should Contribute to Create the Solutions that are Required

Karel Mulder

Abstract

The 'Grand Challenges' of our times, like climate change, resource depletion, global inequity and the destruction of wildlife and biodiversity can only be addressed by innovating cities. This paper will analyse major options for innovating cities, main barriers for these innovations that are rooted in the paradigms of the experts running urban systems and educational reforms that might contribute overcoming these barriers.

Keywords

Urban innovation · Urban systems · Engineering paradigms · Paradigmatic change · Engineering education

Despite the options of tele-working, tele-trading and tele-amusing, that allow people to participate in ever more activities, wherever they are, people are resettling in cities at an unprecedented speed. The 'rurification' of society, that was forecasted based on the development of tele-working, did not occur.

Cities are potentially far more resource efficient than rural areas. In a city transport, distances are shorter, infrastructures can be applied to provide for

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essential services in a more efficient way and symbiosis might be developed between various infrastructures.

However, in practice, urban infrastructures are not more efficient than rural infrastructures. This paper digs into the reasons why the symbiotic options that are available in cities are not (sufficiently) utilised. The main reason for this is not of an economic nature: Infrastructure organisations are run by experts who are part of a strong paradigmatic community. Dependence on other organisations is regarded as limiting the infrastructure organisation's freedom of action to achieve its own goals. Expert cultures are transferred in education, professional associations and institutional arrangements.

By three concrete examples of urban systems, the paper will analyse how various paradigms of experts co-evolved with evolving systems. The paper reflects on recent studies that identified professional education as the initiation into such expert paradigms. It will thereby relate the lack of urban innovation to the monodisciplinary education of experts and the strong institutionalised character of expertise.

1 Introduction, the Importance of Focussing on the Environmental Efficiency of Cities

The 'Grand Challenges' of our times, like climate change, resource depletion, inequity in a global community, and the destruction of wildlife and biodiversity require drastic measures. Marginal improvements that diminish resource consumption (and therefore also waste generation) by only a few percent, are very important, but by themselves insufficient to create the leaps in resource efficiency that are required. Radical innovations are important (Moors and Mulder 2002; Mulder 2007; Weaver et al. 2000) as well as processes of more encompassing societal change (Geels 2002; Rotmans et al. 2001; Grin et al. 2010).[1]

In this paper, the argument will be made that the dominant global trend of urbanisation should be made into an ally for Sustainable Development. The paper explores the potential of cities to become far more efficient in their metabolism. Such improvements cannot be achieved by the ordinary modes of innovation aimed at optimisation of existing systems. This paper will analyse barriers prohibiting sustainable innovations in cities. The expert communities that are running urban systems are identified as the main barrier to change: In three case studies, it is analysed how these communities developed institutionalised paradigms that prohibited innovations that exceed their systems. The paper reflects on changes in the education system to facilitate these innovations.

[1]This paper results from a more encompassing project at THUAS regarding the Urban Metabolism.

2 Cities as a Key Challenge

2.1 Urbanisation

Throughout the world, people that live in rural communities are moving to large cities. In 1900, about 200 million people were living in metropolitan areas. Nowadays, this number has risen to more than 3.5 billion. It is expected that by 2050, there will be about 6.5 billion people living in metropolitan areas (UN Department of Economic and Social Affairs Population Division 2014). This urbanisation is far greater than the growth of world population.

This massive migration is in part determined by economic factors. Income is higher in cities and there are more opportunities for receiving education and health care. As consumption in cities is higher than in rural areas, this migration creates more resource consumption and more pollution.

This phenomenon is not just occurring in developing nations: It is not just a phenomenon of turning a resource driven (agricultural, mining) economy into an industrialised economy; the transition of industrialised economies into service and knowledge driven economies also fuels urbanisation. In 2050, more than 80% of the Europeans will live in cities, as compared to 70% today (UN Department of Economic and Social Affairs Population Division 2012).

This phenomenon is interesting as technological innovation plays a major role in it: Until about 10 years ago, many proponents of the information society claimed that the future would be purification or dis-urbanisation (Muhammad et al. 2008). The internet would imply that far more people would start tele-working, city cinemas and theatres were not needed anymore as one could watch movies and performances from the living room. Traffic jams would vanish and most people could enjoy the pleasures of a serene rural life. Reality unfolded differently….

This history is an interesting example of how technological communities 'sell' their new technologies: with attractive promises (van Lente 1993) that disregard the social embedding of technological practices. Telecommuting failed to realise its high ambitions by a disregard for the social aspects of working in an organisation, and the pleasure of going out cannot be replaced by watching a screen (Hynes 2014).

Urbanisation is driven on the one hand by the social practices by which labour as well as private lives are organised, and on the other hand the physical space that is needed for livelihood and/or well-being. The growing amount of social interaction involved in modern labour (e.g. knowledge society requiring more education and more team-work) as well as the growing amounts of capital accumulated in production and R&D facilities as well as the declining agricultural labour force explains the current urbanisation trends quite well (Primdahl et al. 2013).

2.2 Urban Systems and Urban Symbiosis as an Interesting Option

The densely populated urban areas create nodes of infrastructures that provide for important physical needs and services of the inhabitants:

- motorways, railways, (air-)ports, as well as undergrounds, tramways, busses, private cars and maintenance firms, provide transport
- district heating systems, gas grids, electricity grids, gasoline logistic systems, provide energy
- drinking water-, sewage-, MSW collection systems provide sanitation
- communication systems like fixed telephone lines, mobile telephone, Wi-Fi, cable tv, radio and tv broadcasting, provide communication
- and many more systems….

These systems are vital for urban life. A power black-out can threaten social order, and communications break down can have huge economic impacts (Takanashi et al. 1988; Schewe 2007; Frum 2000). These systems all have their own background and history. Many of them have a public utility character, which implies that their operation is often under public control.

Nowadays, as these systems are so densely present, the symbiosis between these systems can often be developed as follows:

– heat might be produced by heat pumps using drinking water wells, increasing the quality of the drinking water and providing heat.
– heat might be produced using the road surface, cooling the road; the same system might heat the road a bit in winter, preventing frost damage to the road and accidents.
– Sewage treatment systems might produce biogas for the gas grid, thereby decreasing the amount of residual sewage sludge.
– Electricity transformer stations might be cooled by heating (tap-) water
– Etc. (Cf. Mulder 2016b).

These options are only scarcely used, even if their commercial prospects appear bright. Sometimes it is argued that developing such symbiosis might create barriers for future innovation:

> If systems are combined/entangled, they are harder to adapt than the stand-alone systems. Symbiotic relations between systems might require more costs for future change, re-establishing the relation between systems and renegotiating mutual compensation, which might be blocked by a partner (Boons and Berends 2001).

However, it appears that developing symbiosis between systems also creates new options for innovation. The increased efficiency of symbiotic systems might enable the systems to fulfil additional tasks or develop additional improvements (Vernay 2013).

Hence, it seems that there are additional reasons that symbiosis between systems is not developed. In the remainder of this paper I will make the point that the disciplinary cultures of the experts running the infra systems play an important role. Experts controlling infrastructures rarely initiate any activity in regard to developing symbiotic relations with other systems. In fact, they prefer not to attract any attention from their controlling political authorities, except for some attention for the problem that their infrastructure solves. Civil engineers running Dutch coastal defences sometimes jokingly remarked "O Lord, give us our daily bread and every now and then a flood", as this would guarantee political support for their work for another decade. However, politicians were to be kept out of the decision-making regarding their systems. As a civil engineering professor once stated to his students: "you are rational, politicians are only out for re-election. Pay due attention to them and then neglect their words". This characterises very much the infrastructure operators—Operate the system rational. However, what does their rationality imply? What is rational depends on the goals that are to be achieved, and these should be set by the public authorities or managers that control the system. However, the controlling engineers have their own 'rationality'.

2.3 A Systems Culture of Autonomy

The emergence and growth of infra systems has been the subject of several studies after the ground breaking work of Hughes (1985). In their emergence and growth the organisations that built new systems, develop a strong inside–outside perspective. Hughes uses the military frontline as a model for the dynamics of a system —the system has to deal with external threats and barriers that prohibit the advance of the frontline. The systems are therefore aimed at annihilating 'reverse salients', i.e. removing the hostile strongholds that prohibit the growth of the system or create a threat to its continuity.

A system's culture emphasising autonomy can be recognised in many organisations that operate urban systems. It is generally reinforced by the institutional structure of such systems (being monopolistic entities) and the development of a professional culture for the experts that design, maintain and operate these systems.

3 Case Studies

3.1 Method

By the example of the electricity system, Hughes has analysed the dynamics of large (urban) systems and how these systems were institutionalised and were embedded in society. For the aim of this paper, it is important to understand, how the paradigms of the experts designing, running and maintaining these urban systems were created, transferred and institutionalised. This will be done using three

historic case studies that will sketch the history of a type of urban system in combination with the history of paradigmatic community running this system.

3.2 Electricity Grids and Power Engineering

Power engineering is the discipline that deals with electric power networks. The specialists that operate these systems are generally educated as electrical engineers.

After Thomas Edison created the first electricity systems, the tremendous growth of electricity networks created a strong need for efficient electricity transmission, and for efficient electricity generation. As transmission of electricity could be carried out very efficiently by applying high voltages, power stations could become more efficient by becoming extremely large. Interconnections between power stations increased the reliability of the system and allowed for planned maintenance of power stations. These developments created large-scale centralised electricity systems that had a hierarchic nature. The paradigm of the experts that controlled these systems reflected this hierarchy:

Electrical engineering as a discipline emerged between 1890 and 1910 and was initially a homogeneous discipline, microelectronics did not exist and the extremely high voltages utilised in power engineering were still rather limited. As consumer electronics and microelectronics emerged, power engineering became one of the major sub-disciplines of electrical engineering. Power engineering now often is a special track of electrical engineering after engineering students master the basic science and mathematics of electricity. Power engineering has its own professional associations, its own standards and liabilities. Employers of power engineers are generally utilities, power stations, suppliers of equipment for the electricity grid and power stations, and related research institutes. Power engineering is an internationalised discipline with IEEE-Power and Energy being the main international professional body.[2]

In the 1970s and 1980s, power engineers were often fiercely resisting the introduction of renewable electricity generation by PV and wind turbines. The main argument for this position was that these sources of power could not be controlled by the grid operators. Thereby, the supply of this power to the grid would be out of tune with the 'alternating currents in the grid', or in electrical engineering terms, it would generate a lower power factor in the grid (i.e. increasing electricity losses). Central control for optimal grid performance was a key element of the power engineering's paradigm (Hughes 1985).

However, there is no compelling need to turn to hierarchy: reaching efficient decentralised power generation can be defined as a challenge for further innovation. But in practice, the power factor argument was turned into an argument not to move in the direction of renewable power generation. This was often combined with other

[2] http://www.ieee-pes.org/.

professional prejudices, i.e. that windmills were a relic of the past. The paradigmatic change occurred, (towards a more 'market type' model of electricity production and consumption) but the change of paradigm is far from being completed.

3.3 Sewage Systems and Sanitary/Wastewater Engineering

Nineteenth-century cities were dirty places. Drinking water was often taken from waters that also were used to drain excrements from cities, or it was taken from wells that could be contaminated (e.g. by the content of cess pits). In the nineteenth century, various excrement collection systems were introduced for sanitation purposes: barrel-collection, vacuum systems and flushing systems. In the early twentieth century, the flushing system became dominant. In a flushing system, both sewage and the precipitation that have to be drained from the city, are both removed by the same pipes and released in open waters. This implied that the use of human excrements in agriculture was impossible. Imports of cheap fertiliser from South America, and the development of synthetic fertiliser had terminated the need for human excrements as fertiliser.

Sanitary engineering emerged as a new sub-discipline of civil engineering, and it was focussed on urban sanitary conditions. Hydrology and urban planning were created as the conceptual base of sanitary engineering. The robustness of the system became a cornerstone of its design, as any change of the system was complicated, risky and expensive.

Sewage systems greatly contributed to public health. However, sewage outlets created tremendous water pollution problems, especially if no sea coast or large river was present. But even cities at the sea coast had large problems. In nineteenth century, The Hague, for example, emitted its sewage in front of its beaches which was devastating for tourism. The outlet was two times shifted further offshore. The city's engineers who had been raised in the paradigm of cheaply removing dirt from the city removed it ever further. Finally, it led to a conflict between cost efficiency and environmental performance: an elementary form of sewage treatment was introduced in 1960. In the 1980s, full treatment was introduced by national legislation (Mulder 2016a). This marked a change in paradigm, from cost effective sanitation, to cost effective destruction of urban dirt.

From the 1990s, sanitation engineers were confronted with demands to recover energy and raw materials from sewage. As this often implied dealing with other systems (energy systems, resource users) there was not always much enthusiasm. Moreover, the sector was still struggling with a problem of the past. The double function of sewage systems, both removing excrements and precipitation, made waste water treatment inefficient. The waste water treatment plants were often cleaning rainwater, while in cases of extreme rainfall the treatment plants could not cope with it and emitted raw sewage to open water. As in the course of time, rainwater was increasingly removed separately, sewage treatment had the prospect

of growing to overcapacity. So, the 'load factor' of these systems would decrease, which implied that every experiment would be a further threat to the existing system.

The paradigm of the sanitation engineers emphasised preventing system disturbances, as this created the main threat to a politically controlled monopolistic organisation. Environmental performance of the system was generally less important. In fact, sanitation engineers did a proper job when nobody noticed their system. Innovation occurred mainly if it diminished risks of system failure (e.g. quality of piping, etc.). Novelty implied risk and it was therefore avoided. Changes and extensions of the system were extensively planned.

3.4 Drinking Water Production and Distribution

Drinking water was first supplied by pipeline grids in antiquity. However, modern drinking water systems started in seventeenth-century London (Tomory 2015). Various other cities started their own drinking water supply networks in the eighteenth and nineteenth centuries. Drinking water networks were sometimes needed to supply sufficient water to cities, but more often, their 'raison d'etre' was the insanitary condition of most cities. Drinking water supplies were needed to deal with health risks. For example, during a large cholera epidemic in the Netherlands in 1866, it was discovered that the larger cities with a reliable drinking water supply suffered relatively few victims (Departement van Binnenlandse Zaken 1872). This created a strong incentive for creating drinking water supply systems. Over 200 local drinking water systems emerged in the Netherlands, some were private, but most of them were controlled by (combinations of) municipalities.

In the twentieth century, population growth and increased per capita water consumption created a need for large-scale drinking water grids and additional raw water sources. But the main challenge for drinking water engineers was not in their systems as such but in the threat to the systems raw material—the growing pollution of surface and ground water. This often necessitated to take water from more distant raw water sources: Besides enlarging their drinking water production systems, Amsterdam, Rotterdam and The Hague each had to invest in new water intake stations at the Rhine and Meuse rivers together with pipelines and large reservoirs (to be used in periods of drought and in case of industrial spills). New forms of pollution often threatened drinking water supply and many efforts were required for maintaining quality. This led to an 'almost natural' paradigm for drinking water engineering: increasing the scale of the systems, by which the costs of reaching more remote safe water sources could be shared. Moreover, drinking water systems had to be reactive in regard to new cases of pollution.

Drinking water engineers were hardly organised as an international discipline: the basic technologies were well understood, and the main challenges of drinking water systems were to react to new local challenges. The basic features of drinking water systems (centrally controlled water intake, purification and distribution) were

never challenged. Drinking water was cheap, which implied that there was no stimulus for risky innovation.

This unchallenged position of the core elements of the drinking water systems' paradigm created certain openness for societal issues. For example, drinking water companies organised advertising campaigns to reduce water consumption.

An interesting example is the joint creation of a district heating company in the town of Culemborg, in the Netherlands. The local drinking water company created a joint venture with the new inhabitants of an eco-neighbourhood. This joint venture installed a heat pump at the water company's water wells that supplied heat to 230 dwellings. However, there was a different counterforce in this case. For a long time, many municipalities had aimed at integrating their utilities, mainly to increase administrative efficiency. However, the neo-liberal wind of the 1980/90s led to privatisations. In this political climate hesitatingly developed entrepreneurial plans for diversification of drinking water companies were often shelved (Vernay and Mulder 2015) in the wave of privatisation and mergers. Drinking water companies had to focus on core business and strengthen their performance in order to prevail in this turbulence.

4 Conclusions

4.1 Systems, Paradigms and Change

Change in dominant features of systems is both risky and can often only be carried out gradually. Hence all professional groups controlling urban systems developed a strong paradigm that aimed at controlling and preserving their system. Central control of the system was seen as the best way to make the systems' operations predictable and prevent disastrous systems failure by overload, etc. Central control was a means to prevent systems failure, but often became the core element of the paradigm of the systems' operators and designers.

Paradigmatic resistance against societal demands is not irrational; in all argumentations, the paradigm of the professional group emphasises specific values, like avoiding risk or the necessity of systems control. Risk avoidance and systems control might appear as universal values for technological systems development but so is the value of improving a system, or altering it to accommodate new societal requirements. Semi-rational arguments often occurred as follows:

- The argument that something 'is impossible' can never be proven, as history have shown so often that nothing can be absolutely excluded in the future.
- A serious argument against urban symbiosis measures is the 'load factor' of current systems: as current systems are often 'under used', why to introduce a new alternative system that will even increase the overcapacity of the existing system?

– Every change of system will lead to a destruction of existing assets, know-how and experience, i.e. the system is locked in.

Executing control seems to be the dominant feature of all the engineering paradigms. It is what Habermas called the ideological nature of science and technology (Habermas 1968).

4.2 Bridging Disciplines, Creating Solutions

It is often claimed that the challenges of Sustainable Development necessitate inter- and transdisciplinary research and design. But this applies not only to SD challenges. Engineering disciplines can do a better job if their control paradigm is loosened; instead of harnessing nature (an expression introduced by Mao Tse Tung) (Shapiro 2001), the engineers that control urban systems should learn to work with nature, and with others, by which more (and probably better) solutions might come in reach. Better solutions require thinking across the dividing lines of current systems, and thinking long term (Mulder 2014, 2017). That requires a great change, in engineering paradigms, in professional culture and in engineering education. But that will contribute to better solutions, not only for the grand challenges for which Sustainable Development is the answer but also for the challenges of the past for which various urban systems were the answer.

Such changes will not be accomplished overnight, they will take probably at least a generation as paradigmatic change is generally not a process by which individuals switch to new ideas, but a process by which a new generation, with new ideas, takes over (Kuhn 1962). But this implies that education has a crucial role to break the transfer of the old paradigm to new generations and to create openness to new challenges. Although it might be argued that a paradigm shift is required in a more general sense, this research specifically identifies the need for paradigmatic change among the experts that design and run urban infrastructures. That might change today's strong trend towards urbanisation into a force supporting Sustainable Development.

It might also be important that more people engage regarding the challenges of sustainabilising urban infrastructures. These invisible structures are generally taken for granted by the public, which implies that they are also of no interest to politicians. How the 'invisibles of the city' can be turned into objects of citizen engagement is an issue for further research.

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Sustainable Diets: The Gulf Between Management Strategies and the Nutritional Demand for Fish

Andrew Hollingsworth

Abstract

Fish, the largest source of animal protein in the world, has long been one of the most important foods in the history of humanity. Its contribution to nutritional, economic and social well-being has been a pivotal factor in facilitating population growth over many hundreds of millennia. With population growth predicted to exceed 9 billion by 2050, its continued availability will be essential in taking humanity forwards. As far as sustainable development is concerned, a significant number of studies have suggested the more recent history of fishing is one of over-exploitation, pollution, nutritional inconsistency, depletion, local extinctions and imminent crisis. The incentive-driven free market for fish has encouraged efficiency and industrial scale production. Calculations of fish stocks are mostly based on United Nations data, but the accuracy of this data has also been called into question. As international and national governance failed to deliver effective fisheries management, these have largely been replaced by a proliferation of market-based certification schemes. This paper explores the more recent evidence in order to understand the key challenges of producing fish sustainably. The purpose is to understand how sustainable fish consumption is today. Specifically, it will attempt to investigate the scope and size of the challenges facing the sector, and critically appraise the management strategies currently in place to ensure that the Sustainable Development Goal is met. It will then assess the effectiveness of those organisations charged with governing the sector and attempt to ascertain the extent to which the consumer is aware of the challenges and how this influences seafood purchasing behaviour.

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1 Introduction

Fish has long been one of the most important foods in the history of humanity. Its contribution to nutritional, economic and social well-being has been a pivotal factor in facilitating population growth over many hundreds of millennia. As populations grew, the availability of fish helped shape human geography and influence settlement patterns. Many towns grew up around these natural food sources; Cape Cod, for example, is named after one of the best-known New England fishing grounds. Today, fish is the largest source of protein in the world, the consumption of which is greater than that of beef, sheep, poultry and eggs combined (FAO 2016). With the human population predicted to grow towards a figure in excess of 9 billion by 2050, clearly, the continued availability of fish to meet this growth in demand will be absolutely essential in taking humanity forwards.

Given the relative importance of fish, it is hardly surprising to find a plethora of research in the academic and scientific literature. It appears under a number of disciplines including anthropology/ethnography, aquatic sciences, biology, economics/development, environmental science, ethics, geography, health policy & education, natural sciences, politics/political science, but some observe that the literature is all too often unconnected whereas sustainability requires a more holistic framework (Sovacool 2009). The literature also illustrates the wide range of views that permeate such a complex, global food sector. An overwhelming number of studies would seem to suggest that the more recent history of fishing is one of over-exploitation, pollution, habitat loss, depletion, local extinctions, and imminent crisis (Delgado et al. 2003; Greenberg 2010; Sumaila et al. 2010; Ye et al. 2013; Kalfagianni and Pattberg 2013; Hallstein and Villas-Boas 2013; The Economist 2014; Pitcher and Lam 2015). Early work by Carson (1951) commented on the irony that the sea, from which life first arose, should now be threatened by the activities of one form of that life, seeing the ultimate threat to life itself.

Sovacool (2009), for example, suggests more than 70% of global fisheries have already surpassed their sustainable limits, whereas just four years later Kalfagianni and Pattberg (2013) propose this figure is nearer to 80%. Even the omnipresent Cape Cod fishing ground was forced to close to commercial fishing in 1994. A number of studies suggest both the continued removal of more fish than can be replaced by natural processes and the trend of placing political drivers above scientific ones as being the main contributory causes. Many studies promote the obvious advantages of the rapidly growing trend in aquaculture but, at the same time, others (see, for example, Thurstan and Roberts 2014) suggest that this growth only serves to shield consumers from the consequences that our dependency on fish

continues to cause. Further sustainability concerns are raised with the inherent imbalances in global supply and demand, especially with western consumers aspiring to eat more fish as part of a healthier diet in the world full of undernourished people who depend on fish as the main protein staple in their diet. At the same time, industry bodies such as the *International Fishmeal and Fish Oil Organisation* (IFFO) make statements in the media about harvesting fish stocks sustainably is very much in their members' commercial interest (IFFO 2016).

This paper will explore the more recent evidence in order to better understand the key challenges of producing fish sustainably, with a specific focus on The UN's Sustainable Development Goal 14, which is designed to conserve and sustainably use the oceans, seas and marine resources, all of which are seen as being essential in ensuring a sustainable future. It explores the more recent evidence in order to understand the key challenges of producing fish sustainably with the purpose of understanding how sustainable fish consumption is today. The literature review examines 53 recent peer-reviewed and industry journals covering the technological, scientific, economic, politico-legal, social and governance challenges. Every aspect of the world's oceans, temperature, chemistry, currents and life drive the systems that make the Earth habitable for humans. This includes rainwater, drinking water, weather, climate, coastlines, much of our food, and even the oxygen in the air we breathe, which are all ultimately provided and regulated by the sea (UN 2015). Specifically, it will attempt to investigate the scope and size of the challenges facing the sector, and critically appraise the management strategies currently in place to ensure future sustainability. It will then assess the effectiveness of those organisations charged with governing the sector and attempt to ascertain the extent to which the consumer is aware of the challenges and how this understanding influences their seafood purchasing behaviour.

2 How Sustainable Is Fish Today?

The need to ensure the sustainability of fish stocks has long been a feature of fishing history. Not only is fishing a major source of food for humanity, it also provides employment and economic benefits to the two-thirds of world's population who inhabit coastal areas and depend on coastal environments for their livelihood (Sovacool 2009). It is perhaps for this reason that the literature contains many examples of measures to sustain stocks. Pitcher and Lam (2015), for example, cite the year 1357 when laws were passed to protect herring fisheries in East Anglia. The *Food and Agriculture Organization of the United Nations* (FAO) biennial assessment of the market (FAO 2016) has frequently reinforced the view that all aquatic resources, although renewable, are finite and need to be properly managed rather than being seen as an unlimited gift of nature or, as Probyn (2016) recently described, the anthropogenic threats facing the world's oceans. The generally poor state of global fisheries increasingly reported in both the media and literature alike

has led many observers to suggest such efforts have not resulted in effective measures for controlling fishing (Ye et al. 2013).

There have been many attempts to define the sustainability of fish. For the purpose of this study, the UK's Department for Environment, Food and Rural Affairs (Defra 2011) definition is particularly useful from a consumer perspective:

> Sustainably sourced fish is key to ensuring that stocks do not decline to dangerously low levels and that the ecosystem upon which the fishery depends is maintained. Fish species, fishing method and location of fishing all contribute to whether a fish is from sustainable stock.

Similarly, the FAO (2016, iii) outlines the significant role that fish continues to play in eliminating hunger, promoting health and reducing poverty, and claiming that '*never before have people consumed so much fish or depended so greatly on the sector for their well-being*'. The report goes onto highlight the need to look beyond the economics in order to ensure that environmental well-being is compatible with human well-being if long-term sustainability is to be a reality for all, concluding that promoting responsible and sustainable fish consumption is central to its work and purpose.

Most academic literature cites the FAO data for estimates of global fish consumption. The latest estimates this to be around 158 million tonnes (see Fig. 1), which equates to an average per capita consumption of 19.4 kg and significantly increased from an average of 9.9 kg in the 1960s. Other analyses provide further detail to the picture. Thurstan and Roberts (2014) report the supply of wild capture fish supply has declined by 32% since 1970, with the shortfall being kept in check by the rapid growth in aquaculture during this time. Aquaculture also serves to distort the picture, given the quantities of wild fish caught for the fish-feed industry.

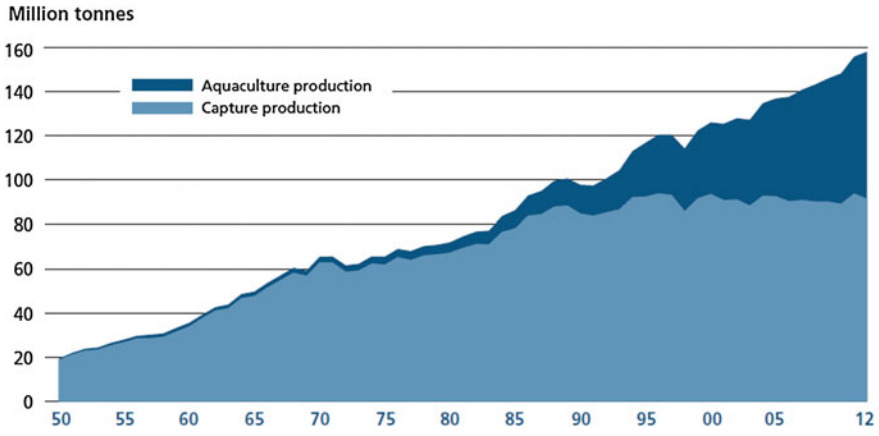

Fig. 1 World capture fisheries and aquaculture production. *Source* FAO (2016)

So, given the long understanding of the need for sustainable fish production and a relatively clear grasp of how much fish is being consumed, why are there so many claims of a sector heading towards crisis? An analysis of the literature suggests a wide variety of challenges that broadly fall into technological, scientific, economic, legal, social, and political, each of which warrants further discussion.

3 Technological Challenges

Since the 1880s, a succession of new technologies has essentially meant greater productivity for the fishing industry. Some of these are best described as indirect to the industry, such as steam-powered, then diesel-powered vessels, developing railway infrastructures and cold storage. Other, more direct advances helped improve the efficiency of capture, including larger drift nets, motorised net drums, freezer trawlers (introduced during the 1960s), and mechanised purse seine vessels (introduced during the 1970s) which enable entire herring shoals to be caught. Further innovations were designed specifically to make it difficult for fish to escape predation, including sonar to track aggregations of fish, radar for navigation, and Global Positioning System to mark specific locations of fish. In the North Sea, for example, Pitcher and Lam (2015) found that herring was rapidly overfished almost to the point of extinction, with catches exceeding by a factor of ten what had previously proved sustainable. This picture was repeated in many of the world's oceans across a number of fish species.

Seemingly unperturbed by both overfishing and destruction of fish stocks and habitats, further technological developments during the 1980s enabled fishing to ever-increasing ocean depths. And with these new depths came a new set of challenges. A study by Villasante et al. (2012) estimated the mean longevity of species increased with depth, from about 13 years for shallow water species to about 25 years for intermediate species and about 60 years for deep-sea species. This is a concern, not only because so little is known about the ecosystem effects of deep-sea fisheries, but also because further studies (Sumaila et al. 2010; Pitcher and Lam 2015) have concluded that the slow-growing, long-lived fish are buffered against climate fluctuations. So, the more the older fish are taken, the more fragile and less resilient these fish populations become, as it takes a long time for the fish to replace what is removed by fishing. Clover (2012) cites North Sea sole maturing at half the body weight they did in the 1950s, and cod reproducing at the age of four where they used to wait until six or seven to reach maturity 40 years ago. Furthermore, Villasante et al. (2012) argue where these stocks were managed under scientifically proposed Total Allowable Catch (TAC) schemes, these levels were not respected in about 60% of the cases investigated. In the European Union, for example, the agreed quotas were exceeded in about 50% of the cases during 2002–2011.

Many of these technological developments helped fish become an international commodity market. By the late 1980s, claimed the FAO (2000), fishing could no longer sustain such rapid and often uncontrolled exploitation and development. The introduction of frozen blocks of seafood commodities helped fuel the demand for consumer food products like 'TV dinners' (Pitcher and Lam 2015). A number of studies have suggested that even with all this expensive modern technology, the amount of cod, haddock and halibut landed in the UK is only 6% of the figure caught with sailing boats in the 1880s (Clover 2012). This was further aggravated by the amount of unregulated fishing on the high seas, in many cases involving straddling and highly migratory fish species (FAO 2000). Hardly surprising then, that many of the world's fish stocks are now seen as overexploited and some are close to collapse (The Economist 2014).

4 Scientific Challenges

The scientific challenges identified from the literature demonstrate an all too common similarity, one when the political and economic factors invariably take precedence over scientific factors. When viewed on a species by species, the pattern is all too similar: Herring is again overfished and showing signs of decline (Pitcher and Lam 2015); many Hake fisheries in both northern and southern hemispheres have collapsed in the past 20 years (Pitcher and Lam 2015); stocks of Bluefin Tuna, following the rapid increase in the global demand for sushi, is estimated at fewer than 10% of its 1970s population and has now imploded beyond recovery (Greenberg 2010); migratory fish such as wild salmon that migrate between the sea and fresh water are especially vulnerable, running a gauntlet of fishing gear as they enter rivers and lakes Pitcher and Lam (2015); North Sea cod stocks, however, may soon be certified sustainable by the Marine Stewardship Council (MSC) after many years of declining fish stocks (Gosden 2016). Overall, the problem seems so acute that Ye et al. (2013) suggest that restoring all overfished stocks may not result in Maximum Sustainable Yield (MSY) for all stocks, owing to the relationships between species and the dynamic nature of ecosystems. Dueri et al. (2016) also found such strategies complex, requiring regular review and updating, with the most appropriate management strategies changing as environmental and socio-economic conditions evolve.

5 Economic Challenges

The economic challenges also present a complex and multi-faceted set of inter-related variables. Sovacool (2009) argues that the behaviour of most fishing activity can be understood, rather obviously perhaps, as a simple economic optimisation. Clover (2012) cites World Bank estimates that fish contributes

£177 billion (EUR 219 billion) to the global economy. However, fishing less would allow stocks to recover and they estimate this would produce 40% more fish very quickly, adding £30 billion a year to the global economy. Also using World Bank data, Anticamara et al. (2011) estimate that the depletion of fish stocks causes economic losses of $50 billion annually, although The Economist (2014) argue that the full cost of damaging the system is not borne by those doing the damage. Earlier work by Sumaila et al. (2007) estimates fishing subsidies at 25% of the total landed value and profits normally not more than 10%. This has led some (Veldhuizen et al. 2015a) to predict that fuel subsidies may prove to be the Achilles' heel of some fishing fleets. The FAO (2016) raises concern by the inherent imbalances in supply and demand for fish, and the social problems that this imbalance causes. Sovacool (2009) highlights the relationship between free markets and the 'tragedy of the commons', especially where property rights are not clearly defined and when the commodity being protected is a particular living organism or part of an ecosystem. The Economist (2014) goes further to suggest that governance of fishing meets none of the essential criteria required.

6 Legal Challenges

Garcia and Rosenberg (2010) estimate that Illegal, Unreported and Unregulated (IUU) fishing, is a major source of undocumented catches, and it varies between 11 and 26 million tonnes and is worth $10–20 billion annually. IUU has long been seen as a cause of depleted fish stocks, destroying habitats, distorting competition, disadvantaging legal fisheries, and weakening fishing communities. With the potential to affect both the unregulated high seas and exclusive economic zones where state control is ineffective, it undermines efforts to conserve and manage fish stocks and inhibits progress towards achieving sustainability. The Economist (2014) argues that: most regional fishery bodies have too little money to combat illegal fishing; there is no register of estimated 4 million fishing vessels operating globally; rules only apply to members with 'outsiders' breaking them with impunity; and over half the countries said they could not even control vessels sailing under their own flags. Work by Veldhuizen et al. (2015b), however, is a little more optimistic, concluding that some of these issues have been partially tackled by policy responses such as TACs, individual transferable quotas, marine protected areas and effort restrictions.

7 Social Challenges

The social challenges are also inter-related variables that, very often, are shielded by governments reluctant to make unpopular decisions which may put pressure on society. Ye et al. (2013), for example, refer to an unwillingness or inability to

accept the short-term socio-economic consequences as hindering progress in rebuilding many fisheries. Thurstan and Roberts (2014) call for commonality to redress the wide discrepancies (ranging from 97 to 550 g) between the various national and international bodies on how much fish consumers should eat to achieve the desired health benefits (see Table. 1).

Other studies (Pitcher and Lam 2015) call for '*decommoditization*' strategies that sustain human and ecosystem relationships with fish beyond their commodity value in order to sustain global fisheries. The argument is that severely depleted fish stocks reflect global markets that value fish as just another consumptive commodity. Recovery of these depleted stocks could take years or even decades. This implies significant immediate and sustained cost, the impacts of which will be painful and felt by society as a whole. Once again, those sectors most dependent on fish for their livelihoods, especially those in the developing world would be particularly affected (Table 1).

Table 1 National dietary guidelines for fish consumption

Country	National guidelines	Recommended amount (g wk^{-1})	Source
United Kingdom	2 portions (140 g each) per week, one of which should be oily	280	Food Standards Agency (2010)
United States	2 average meals (6 oz each) per week, not including species high in mercury	340	U.S. Food and Drug Administration (2014)
Australia	2–3 servings per week (150 g each) not including species high in mercury	375	Food Standards Australia New Zealand (2013)
New Zealand	2–3 servings per week (150 g each) not including species high in mercury	375	Food Standards Australia New Zealand (2013)
Canada	At least 150 g each week	150	Health Canada (2011)
Denmark	200–300 g fish per week	250	WHO (2003)
Iceland	300 g fish per week	300	Gunnarsdottir et al. (2009)
Austria	1–2 portions per week (total 150 g)	150	WHO (2003)
Germany[a]	1 portion of seafood per week	100	WHO (2003)
Greece[a]	5–6 servings per week	550	WHO (2003)
Georgia	12.8–15 g fish per day	97	WHO (2003)
Ukraine	20 g fish per day	140	WHO (2003)
Estonia	2–3 servings per week (50 g each)	125	WHO (2003)
Armenia	30 g fish per day	210	WHO (2003)

Source Thurstan and Roberts (2013)

[a]Specific portion size not provided, it is assumed that one portion equals 100 g

8 Political Challenges

The political challenges discussed in the literature mostly relate to short-termism, the accuracy of reporting and engagement with international treaties. Ye et al. (2013) found governmental reluctance to make unpopular decisions, especially for long-term benefits where they may not gain much credit. Also, there are often limited resources available to implement management plans, particularly during recessionary times. The propensity to sign-up to international treaties is frequently seen as demonstrating a common desire for the goals of the treaties, but it does not always mean that implementation will follow. The accuracy of reporting catch data can also be an issue, especially with a tendency to under-report due to a lack of oversight and/or where high levels of subsistence fishing exist, but new technologies (e.g. Google Earth) are providing opportunities to minimise this (Trujillo et al. 2012).

9 Is Aquaculture the Saviour for the Overburdened Wild Fisheries Sector and an Important New Source of Food?

Aquaculture currently accounts for about half of all of the fish consumed, and it remains one of the fastest-growing food producing sectors (FAO 2016). While there seems little to doubt that aquaculture has great potential to expand and intensify sustainably, the sector has its own set of technological, scientific, economic, legal, social and political challenges. Many studies highlight the unsustainability of current practises (Delgado et al. 2003; Vassallo et al. 2007; Greenberg 2010; Volpe et al. 2013; Kalfagianni and Pattberg 2013; Thurstan and Roberts 2014; The Economist 2014; Hadjimichael et al. 2014; Byelashov and Griffin 2014; Edwards 2015; Alexander et al. 2016), especially the environmental concerns, although the proponents of newer, smarter methods of aquaculture suggest these concerns can be overcome (Earle 2013; Hallstein and Villas-Boas 2013; Thurstan and Roberts 2014). Pollution issues seem particularly challenging (Georgakopoulos and Thomson 2005; Alexander et al. 2016), especially health concerns surrounding the toxin polychlorinated biphenyls (PCBs) and the wide range of chemicals used to treat diseases such as sea lice. The field trials using Wrasse, a native UK fish species and natural predator to lice seem to show considerable promise. The dependency on wild fish for feed is well documented, particularly the projected increases that may require more wild fish for feed (Olsen and Hasan 2012). At the same time, however, research into new and sustainable sources of fish feed such as the genetically modified Camelina trials at Rothamsted would seem to offer real solutions (Hixson et al. 2014). Consumer pressure group Greenpeace (2013), however, argues that

aquaculture is exacerbating the pressures placed on overexploited marine ecosystems. This concern continues to influence consumer behaviour especially in the salmon industry (Whitmarsh and Palmieri 2011).

10 Who is Governing the Fish Market to Ensure Consumer Demand is Met?

The effective governance of a natural resource at a global level is bound to be a monumental challenge. The growing need for healthy food will invariably increase the demand for fish, a sector whose productivity is already highly stressed by excessive fishing pressure, pollution and climate change (Miller et al. 2013; Havice and Iles 2015). How can fisheries governance ensure a sustainable product, without depleting the environment, and adapt to climate change in order to meet this growing challenge? Sovacool (2009) suggests there are currently 22 international treaties in existence, all aiming to protect fish stocks globally. This is in addition to 18 regional fisheries management organisations and a plethora of regional agreements that attempt to regulate the fishing in every region of the world (see Appendix two for examples). Hazen et al. (2016) analyse how fisheries management agencies around the world are shifting from single species approaches towards ecosystem-based management implementation. Certainly, the continued reliance on controls and restrictions seem insufficient to protect global fish reserves. The alternative would be measured to reduce the demand for fish: Ye et al. (2013) for example, recommend a reduction in global fishing capacity of 36–43%, resulting in the loss of employment of 12–15 million fishing jobs and cost $96–358 billion. Kalfagianni and Pattberg (2013) advocate merging standards to bring about sustainability benefits, as standards converge towards higher stringency and strictness. Such a meta-governance system, however, seems unlikely in the foreseeable future. Stoll and Johnson (2015) investigate how non-governmental organisations and the private sector are increasingly using market strategies to drive governance, which they claim both bypasses formal government processes and weakens the power of policy-makers. Martinet et al. (2016) recommend multicriteria evaluation methods that take account of uncertainty be used to rank potential management strategies when there are conflicting economic, ecological and social objectives at stake. The current governance challenge is an increasingly complex one and many of the latest studies suggest the current forms of governance could quickly become obsolete should less traditional and potentially more severe measures, such as closed fisheries, long-term spatial closures or ecosystem approaches be applied (Steadman et al. 2014; Vázquez and González 2015; Yamazakia 2015; Elefterie 2016).

11 Identifying and Addressing the Main Consumer Concerns About Fish Sustainability

Consumers ultimately hold the key to driving the demand for sustainable fish. But, in order to do this, they must first be aware of the multiplicity of issues surrounding sustainability and then be prepared to selectively seek out appropriate products. A number of studies attempt to ascertain both this awareness and willingness to purchase. Verbeke et al. (2007) found the perceived importance of sustainable products was neither correlated with fish consumption frequency nor with general attitude toward eating fish. Defra (2011) found that although seventy per cent of shoppers claimed it was important that their fish came from a sustainable source, sixteen percent of these shoppers did not actually understand what sustainable fishing was. A further study by Clonan et al. (2012) found the number of consumers purchasing fish for health reasons was more than those seeking sustainably sourced fish and concluded that clearer advice should enable consumers to meet nutritional needs while protecting fish stocks. This study also identified not only a lack of awareness but also confusion relating to the MSC label for sustainable fish. Kalfagianni and Pattberg (2013) argue that although there have been some successes with these standards, few measurable environmental improvements have been seen to date. Perhaps the clearest consumer information comes from Greenpeace (2013), who recommend asking questions about where fish comes from in order to send a clear message to the supply chain intermediaries. This advice goes onto include seeking good alternatives, choosing line-caught fish wherever possible, reducing consumption, and sourcing from small local UK fisheries preferably in the south-west UK. But, with over 400 similar standards, certifications and labels related to wild fisheries and aquaculture, it remains an empirical and unresolved question whether such labels actually affect consumer behaviour (Hallstein and Villas-Boas 2013). In addition, there is some evidence to suggest that many retailers are falling behind on the amount of sustainable fish products they stock, despite having the opportunity to remodel supply chains and influence consumers (Greenpeace 2013; Chkanikova and Lehner 2015).

12 Conclusion

The overwhelming impression from studying the recent literature is one of an increasingly important food sector which is far from sustainable. It is clear that sustainability can only be achieved if all the aforementioned challenges are addressed in an integrated way. The need for a multidisciplinary approach to risk assessment and analysis identified within the literature remains an urgent one. The

challenges that the sector faces as it moves toward 2050 are both huge and highly complex; addressing them will require concerted and determined efforts by all the stakeholders concerned. There are, however, many strategic responses that collectively the industry can adopt such as adapting technologies to reflect the changing resources. The problems would seem especially problematic on the high seas, where over-exploitation is often double that of waters under national control. Those countries signing up to bilateral and multilateral agreements to increase the mobility of fishing are showing promising results, as witnessed with arctic cod between Norway and Russia (Veldhuizen et al. 2015a), so more are needed. Management measures need to be more flexible, especially those relating to fishing rights and closing vulnerable seas. More responsive and proactive legal frameworks are needed, ones that incorporate monitoring and early warning systems. This should be coupled with the elimination of harmful subsidies, replacing them instead with economic and social incentives.

Excessive fishing capacity must be reduced and the sector must contribute more to ecological services. All sectors of the industry must become more environmentally friendly and adopt adaptive livelihood strategies. Aquaculture must grow in ways that mitigate against environmental damage by choosing the right species and environments in which to grow them. Improved fishery management and aquaculture technology offer significant scope to improve fish consumption. Market-based initiatives aimed at the consumer have to be clearer and the message consistent across the many standards and certifications. On this latter issue, the move to national rather than global certifications would seem to offer significant benefits, e.g. GlobalGAP benchmarked national Good Agricultural Practice programmes, but the success of such systems is dependent on global agreement on safe fishing levels. Fish has to be taken out of the commodity market, where all stocks are seen as being equal, and the consumer educated accordingly. Good governance will be essential in helping to ensure that future demand for fish is met in an environmentally sustainable way, while at the same time reducing food insecurity and poverty. Further interdisciplinary research is needed because the challenges of fish sustainability intricately affect a diverse range of stakeholders and institutions. The significant variance between the largely optimistic view of fish sustainability published by FAO compared with the majority of more pessimistic academic studies requires further investigation.

The UN's Sustainable Development Goal 14 (to conserve and sustainably use the oceans, seas and marine resources) may provide an opportunity to step up action on the individual ocean-related issues set out in MDG 7 and contribute to the post-2015 development agenda. As one of the criticisms of MDG 7 was that individual communities approached it in isolation, we must assume that for SDG 14 to be successful, it must both have the right targets and be systematically interconnected to the other 16 goals. Further research is needed to ensure fish sustainability be fully realised; it must, therefore, bring together the science, decision-making and institutional structures involved in the implementation of the SDGs.

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A Framework to Conceptualize Sustainable Development Goals for Fishing Gear Resource Management

Paritosh C. Deshpande and Dina Margrethe Aspen

Abstract

In response to the growing concerns of global environmental damage and resource depletion, UN launched the Sustainable Development Goals (SDGs) in 2015. Using SDGs to develop sustainable systems and practices requires tools that link goals and actions. This study provides a systems engineering framework to operationalize SDGs and develop strategies to attain goals and targets. The approach is based on a multidisciplinary process initiated by system and stakeholder analysis before developing sustainability goals, targets and indicators. These are used to identify and analyze strategies for system improvement. A case study using SDGs to improve fishing gear resource management (FGRM) is provided to illustrate the framework. The study shows that the proposed framework may assist decision-makers in translating SDGs to improved practices in a consistent, traceable and transparent manner.

Keywords

SDGs · Systems engineering · Industrial ecology · MFA · Recycling and reuse · Fishing gear

List of symbols

ALDFG	Abandoned, Lost or otherwise discarded fishing gear
EOL	End-of-life

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EU	European Union
FGRM	Fishing gear resource management
IA	Impact assessment
IE	Industrial ecology
IO	Input–output analysis
LCA	Life cycle assessment
MCDA	Multi criteria decision analysis
MDG	Millennium development goals
MFA	Material flow analysis
NPA	Northern periphery arctic region
SDG	Sustainable development goals
SE	Systems engineering

1 Introduction

Policies and programmes for sustainable development have undergone significant shifts in focus since its introduction at the first global conference on the environment in Stockholm in 1972 (Ryan 2004). With prospects of a rising global population, accelerating global development and the associated increase in resource use and environmental impacts, the definition of sustainability has broadened from mere concern of pollution and biodiversity, to the promotion of eco-efficiency, reduced energy use and, lately, to sustainable circular business models (Stø et al. 2008). In order to meet these needs for transformation, on September 2015, the UN launched the '*2030 Agenda for Sustainable Development*' that includes a set of 17 ambitious and elaborate Sustainable Development Goals (SDGs) and 169 targets. The SDGs, also known as the Global Goals, extend the Millennium Development Goals (MDGs) by providing a unified framework, and mobilize global efforts around a common set of goals and targets (Griggs et al. 2014). While the goals themselves will be universal, it will be left to countries to select national targets and ultimately determine their own priorities and level of ambition related to the scale and pace of transformation (Allen et al. 2016). Compared with the MDGs, the SDGs represent a far broader, more integrated and challenging agenda for both developing and developed countries. The underlying targets of the SDGs also invite companies everywhere to advance sustainable development through the investments they make, the solutions they develop, and the practices they adopt (GRI 2015). In doing so, the goals encourage companies to reduce their negative impacts while enhancing their positive contribution to the sustainable development agenda across their supply and value chains (GRI 2015).

Accumulating research on the SDGs and sustainability highlights that translating the SDGs in societal or organizational practice calls for the development of new metrics, indicators and data collections methods (Lu et al. 2015). In addition to coining new methods, efforts are needed to find innovative new ways to use existing monitoring methods and evaluation procedures to measure progress towards the targets. This monitoring must take place on local, national, regional and global levels and across sectors (Costanza et al. 2016). Several modelling approaches are available to understand synergies and trade-offs among the social, environmental and economic aspects of sustainability. Allen et al. (2016) highlights the strengths and weaknesses of such contemporary modelling tools in the context of national development planning for the SDGs and concludes that systems-based macro-framework hybrid models are most relevant in translating the SDGs at the national scale.

In this article, we propose a stepwise framework to enable and realize relevant SDGs based on systems engineering principles. The framework builds on integrated systems- and life cycle thinking and highlights the multidisciplinary efforts needed to synthesize, analyze and monitor strategies that help attain the SDGs. Embedded in the systems engineering discipline, the framework utilizes models to help build consistent, traceable and transparent links between SDGs, targets, improvement strategies and decisions. Contemporary models from industrial ecology (IE) are used to identify the complex socio-technical problems and interactions among different systems and stakeholders to facilitate sustainable development.

Figure 1 illustrates the link between the various levels of societal organization, the SDGs and the role of frameworks and models to enable desirable transitions as manifested in SDGs. In our study, the systemic framework is applied to a case of

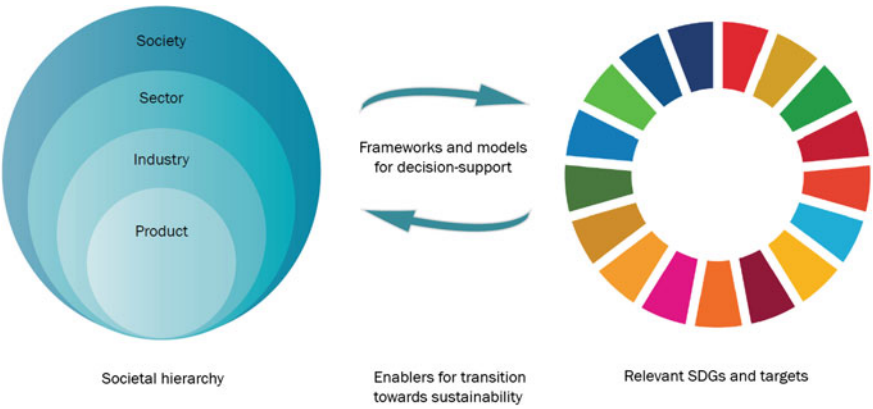

Fig. 1 Models and frameworks as enablers for SDGs

fishing gear resource management (FGRM) with the aim to develop strategies for the sustainable handling of fishing gear resources using the SDGs and relevant targets.

2 Background

Marine littering defined as solid refuse introduced into the marine environment through human activity poses a major threat to the ocean environment and is a growing concern for authorities. The consequences of intentional and accidental release of marine debris have come under greater scrutiny in recent years, and efforts to properly measure and mitigate these impacts are a political priority. The scientific reviews conducted by Gregory and Ryan (1997) highlighted the clear predominance of plastics amongst the marine litter with plastic contributing 60–80% of the total marine debris around the globe. More recent efforts by Derraik (2002) and Macfadyen et al. (2009) confirms the similar findings and reported a significant amount of plastic waste in marine litter. Moreover, plastics have a long life in marine ecosystem and hence it is imperative to take severe measures to address the problem at both international and national levels (Derraik 2002).

One particularly troublesome fraction of marine plastic waste is fishing gear. *Abandoned, Lost or otherwise Discarded Fishing Gear* (ALDFG) from capture fisheries, as well as the aquaculture industry, may adversely impact marine organisms, coastal communities and society at large (Macfadyen et al. 2009). A study by Wilcox et al. (2016) ranked fishing gear as the deadliest waste fraction for marine organisms based on expert judgements. ALDFG continues to fish, often referred to as "ghost fishing", and has damaging impacts on fish as well as marine birds and mammals (Macfadyen et al. 2009). Studies of drift fishing gear show that nets may continue to ghost fish for years after their release into the ocean (Tschernij and Larsson 2003). Other impacts from drift nets include entanglement and ingestion, new habitat provision, alien invasions and assemblage level effects (Gall and Thompson 2015). In addition to the threat to marine ecology, the loss of fish stocks due to ghost fishing and the expanded cost of valuable resources on lost or abandoned fishing gear also possess significant economic setbacks.

The Norwegian Directorate of Fisheries currently undertakes annual clean-ups to recover and register derelict fishing gear and gear components. Reports from the period 1983–2012 shows that over 16,000 fishnets and significant amounts of other types of gear were retrieved from the Norwegian coast. Ghost fishing estimates of gear retrieved in 2011 and 2012 were 14 (Langedal 2011) and 6 tonnes (Langedal 2012) respectively. Furthermore, almost 12,000 kg of crabs were caught from 1100 derelict gill nets and crab-traps in 2011 alone (Langedal 2011). As these records show, it is imperative to recover and manage the waste generated from ALDFG and to investigate alternative sustainable strategies for fishing gear resource management. This paper presents and applies a systems engineering approach to develop indicators and strategies to solve this problem based on SDGs.

3 Methods

To address the need for sustainable fishing gear resource management (FGRM), a combination of qualitative and quantitative research methods is required. Kates et al. (2001) advocate for the need to foster problem-driven interdisciplinary research in order to comprehend the dimensions of sustainability for the given challenge at hand. This interdisciplinary approach can be achieved through building capacity for research questions, creating coherent systems of research planning, operational monitoring, assessment, and application (Kates et al. 2001). Research methods employed in this study are discussed briefly and chosen due to their ability to structure and scope complex interdisciplinary research problems.

3.1 Systems Engineering Methods

Systems engineering (SE) is defined by the International Council on Systems Engineering as, "an interdisciplinary approach and means to enable the realization of successful systems" (INCOSE 2011). Systems engineering deals with analysis and design, operation, and maintenance of large integrated systems in a total life cycle perspective (Blanchard et al. 1990), and helps to maintain the scope and boundaries of a multidisciplinary research problem. SE involves identifying interconnections between technology, management, legal aspects, environmental and social issues, finances and corporate strategies for the system under study (Asbjørnsen 1992). At the heart of any system is the system's engineering process, which is a holistic and systematic approach that facilitates problem-solving. The process is executed in a stepwise manner moving from the origins of the problem to the systems within which it exists, the nature and properties of the system, and potential solutions and decision-making (Fet 1997).

3.2 Industrial Ecology Methods

Industrial ecology (IE) is the study of flows of materials and energy in and between industrial and natural systems (Allenby and Richards 1994) with the aim of identifying pathways to sustainable growth. System analysis tools for impact assessment (IA) are a central feature of the IE discipline to model, measure and monitor production and consumption activities. Examples of such IE tools/models are life cycle assessment (LCA), material flow analysis (MFA), input–output analysis (IO) and other analytical approaches. The combination of industrial ecology and systems engineering have been demonstrated in several studies, e.g. (Bringezu 2006; Fet 1997; Haskins 2006; Skaar 2013). These methods and their applications are further elaborated in Sect. 4.4.

4 Application of Systems Engineering to Fishing Gear Resource Management

The systems engineering process is iterative and expands on the common sense strategy of understanding a problem before solving it, examining alternative solutions and verifying that the chosen solution is correct before implementing it (INCOSE 2011). The use of this top-down and iterative systemic model is successfully demonstrated by Fet et al. (2010) in developing a decision-support framework for complex environmental analyses of fish food production systems and Utne (2006) who demonstrated the use of the SE process in fisheries management. The framework developed for the sustainable management of fishing gear resources is depicted in Fig. 2. This framework is motivated by the iterative systemic frameworks developed by Blanchard et al. (1990) and Fet (1997) and can be used to analyze as well as improve the performance practices of FGRM through the development of sustainable strategies. The presented framework is applied and illustrated through a case study for FGRM in the Northern Periphery Arctic (NPA) region.

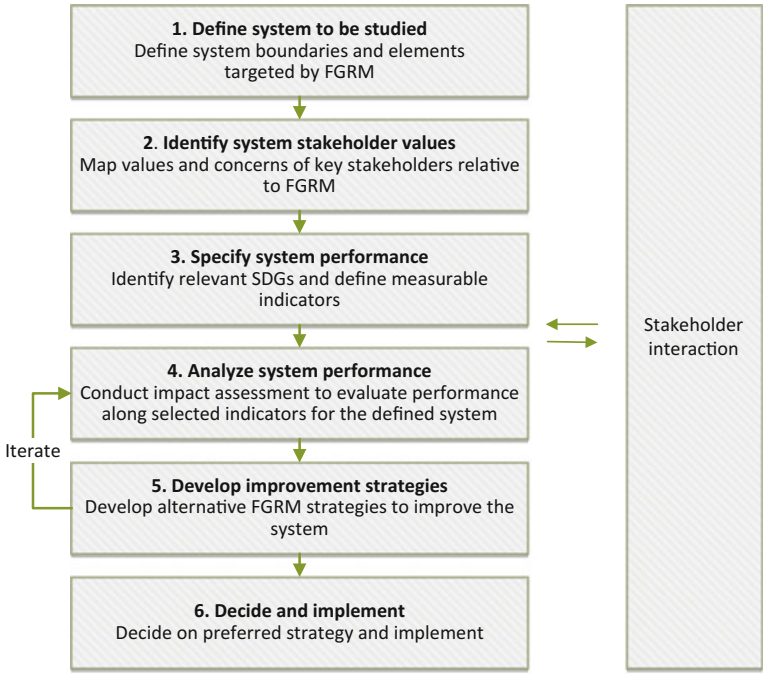

Fig. 2 Stepwise systemic framework for fishing gear resource management (FGRM)

4.1 Step 1: Define System to Be Studied

The stepwise process is initiated by defining the system boundaries of the problem to be solved. A rigorous system description facilitates understanding the baseline conditions of the system. Defining system boundaries is also essential to limit the complexity and highlight the scope of the system under consideration. The system boundaries may be related to geographic boundaries, the kind of processes utilized, for example, extraction of resources, the types of by-products and emissions, and determination of which interrelated systems belong to the system under study (Fet 1997).

The system under study for our illustrative case example covers the life cycle of fishing gear. This encompasses the natural system, including the ocean and land, and industrial systems for gear production, fisheries and aquaculture, and waste management. This could also be geographically limited to a single region or country in the NPA region, for example, Norway. Figure 3 depicts the life cycle of

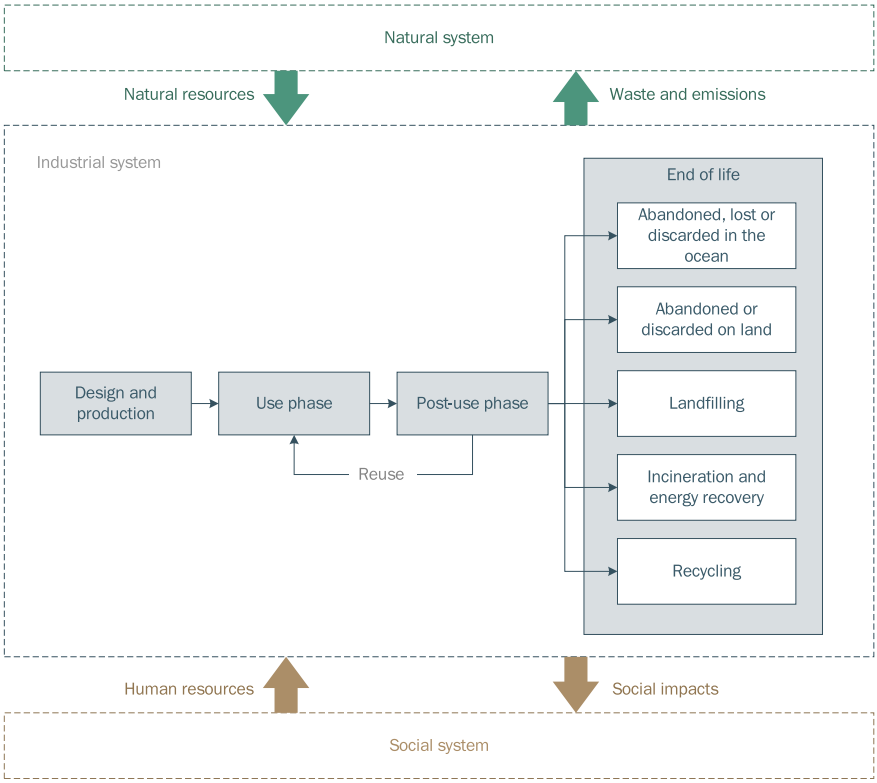

Fig. 3 System life cycle diagram for fishing gear resource management

fishing gear to improve FGRM; all phases must be targeted and improved with policies, strategies and technologies. The flows within the industrial system, as well as its interactions with the natural system, must be modelled, analysed and evaluated.

The motivation to study this system is to develop FGRM improvement strategies that help mitigate environmental problems that result from existing practices in the system across all life cycle phases. The main issues to consider are (i) reducing impacts from ALDFG on the environment, communities and economy, and (ii) realizing value creation and circular business opportunities from better waste management and recycling practices.

4.2 Step 2: Identify System Stakeholder Values

In this step, stakeholders, their values and concerns are identified and mapped. According to Freeman (2010), a stakeholder may be any person, group or organization that influences or is influenced by a decision. Identification of specific groups of actors who are stakeholders in the issue of FGRM is important when considering how to target solutions. The classification and mapping of stakeholders have been carried out in several different ways based on the applicability and relevance to the problem. Mikalsen and Jentoft (2001), for example, classify stakeholders based on their influential power to control or affect the system while (Clarkson 1995) maps them between primary and secondary stakeholders based on their relationship to the area at stake. According to Clarkson (1995), a primary stakeholder is one who is directly dependent on the system while a secondary stakeholder is influenced by the system indirectly. Samoura et al. (2007) distinguish and map the needs of stakeholders in terms of their economic, social, regulatory and political interests associated with the system. For this study, key stakeholder groups are identified and their interests categorized in terms of economic, social and regulatory aspects. While mapping the stakeholders as shown in Table 1, the following criteria are taken into account:

- Their relationship to the issue of handling and managing fishing gear resources;
- The potential impact of the group on the issue (either positive or negative, or both); and
- Their influence in affecting and supporting change/action that addresses the issue of FGRM.

As shown in Table 1, stakeholders that influence the category of economic actors are those who directly or indirectly share economic interests related to fishing gear and its End of Life (EOL) processes. This corresponds to entities that operate in the industrial domain in Fig. 3.

Fishnets and fishing gears are made of various types of plastics such as polyamide, polypropylene, polyester, polyethylene and PVC (Klust 1982). Consequently, fishnet producers and suppliers followed by waste collection, transport and

Table 1 Categorization and mapping of stakeholders of fishing gear sector

Stakeholders	Economic	Social	Regulatory	Environmental
Gear producers and suppliers	x		x	
Fishermen	x	x		x
Port authorities			x	x
Waste management companies	x			x
Waste gear collectors and transporters	x			x
Recycling companies	x		x	
Business enterprises	x			
NGO's		x		x
Local communities		x		x
Marine wild life				x
Fishery directorate			x	x
Environment directorate			x	x
Ecolabel schemes	x	x	x	x

management companies responsible for recovery and recycling of these plastic types are listed under the category of stakeholders sharing economic interests. Moreover, this recycled plastic material potentially attracts new business entities that are interested in recycling the material from waste fishnets, which is in-line with the principles of circular economy, where waste from one sector can be reused as an input to another (EU 2014).

Efficient handling of ALFDG will result in improving the economic efficiency of fishing activities. Furthermore, recovery of derelict fishing gears will prevent the ghost fishing resulting in better yield from fishery; hence, sustainable FGRM will bring the overall wellbeing for stakeholder groups such as fishermen and local communities. Marine wildlife is another key stakeholder under the social and environmental categories, as better recovery practices may reduce the occurrence of drift nets and abandoned gear and thereby ghost fishing and other adverse impacts.

The local/regional fishery, environmental directorate, port and municipal authorities are labelled as actors influencing the regulatory and environmental categories. Sustainable FGRM will reduce marine waste thereby protecting marine ecosystems, which are important interests of regulatory agencies. Moreover, being signatories to the Paris Convention, satisfying targets set forth by SDGs is among the essential interests of regulatory actors. Certain regulatory and social organizations (NGOs) also possess interests in protecting the marine environment from the ALDFG and are, therefore, classified under the environmental category.

4.3 Step 3: Specify System Performance

After identifying stakeholder values and concerns, performance requirements must be established. In this step, specifications that describe how the system is supposed

to function are defined (Asbjørnsen 1992). According to Fet (1997), these are functional, operational, and physical performance requirements with respect to the system under consideration. Identifying relevant SDGs and underlying targets is a first step in specifying performance requirements as not all SDGs and targets are pertinent for the system under consideration. For FGRM, covering all areas of concern for stakeholders is necessary to synthesize the performance measures against which alternative sustainable strategies will be tested and evaluated. Table 2 lists relevant SDGs for the case of FGRM, mapping them onto the systems to be considered as well as stakeholder interests.

After system requirements are defined through selection of relevant SDGs and underlying targets, they must be translated into system performance specifications. These specifications are definable and provide measurable performance criteria for the total system and subsystems (Fet 1997). This can be achieved by defining indicators capable of assessing the performance of the fishing gear sector. According to Azapagic and Perdan (2000), selecting appropriate indicators is an important step in determining the effectiveness of the assessment. It is also an important tool to help manage resources to attain the SDGs (Hák et al. 2016). The quality of indicators should be assessed according to their properties to ensure that

Table 2 Relevancy of selected SDGs

SDG	Relevancy
8: Decent work and economic growth	Sustainable economic growth and employment are important aspects of the interaction between the industrial and social system as depicted in Fig. 3. Strategies for FGRM must be developed considering these links. Further specification of targets and indicators should cover the values of stakeholders with economic and social interests in FGRM
9: Industry, innovation and infrastructure	FGRM strategies and practices will require supporting infrastructure and innovation. The workings of the industrial system throughout the life cycle of fishing gear determine the success of achieving sustainable FGRM. The goal reflects interests of industrial actors who have strong economic stakes relative to FGRM
12: Responsible consumption and production	Minimizing the impacts from interactions between the industrial and natural system is an important goal for sustainable FGRM. In addition to avoiding natural deterioration through dealing with ALDFG, the impacts from inputs and outputs from FGRM processes must be considered. The goal also covers human health and local development, mapping on to environmental, economic and social stakeholder interests
14: Life below water	Resource management practices that deal with ALDFG aim to reduce impacts gear encounters in the oceanic environment. However, potential adverse effects from gear collection, as well as alternative gear and usage, must also be considered. The goal covers both economic and environmental interests of stakeholders

they are both scientifically valid and practical. According to ISO 14031, which details requirements of environmental performance indicators, it is important to ensure that indicators are (i) relevant and understandable to internal and external parties, (ii) useful for measuring performance against objectives, (iii) obtainable in a cost-effective and timely manner, and (iv) sensitive to change (ISO-14031:2013 2013).

Indicator sets may furthermore be classified according to various typologies. For instance, they could be divided into leading and lagging indicators to distinguish whether they measure causes or effects (Kumar et al. 2013). The DPSIR system is a more comprehensive version of such, where indicators measure drivers, pressures, state, impacts or response in a system (UNEP 2007). Furthermore, strategies and practices may also be evaluated by targeting managerial, operational or other aspects of the effort itself, as suggested in ISO 14031 (ISO-14031:2013 2013). The illustrative example provided in this paper does not make any such distinction but recommends identifying potentially appropriate typologies for system improvement based on the SDGs.

Figure 4 illustrates indicators based on the SDGs. The figure shows the traceability from the overall objective (sustainable FGRM) to the SDGs, and their underlying targets and example indicators, as enabled by the systems engineering framework.

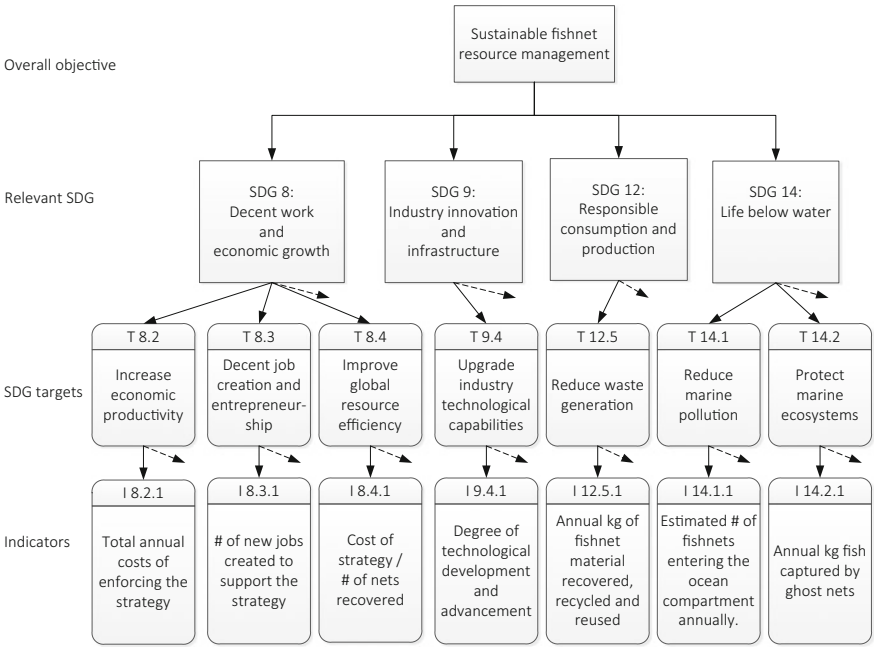

Fig. 4 Indicator traceability model

4.4 Step 4: Analyze System Performance

The performance indicators selected in step 3 are further analysed using impact assessment methods and other various tools. Tools frequently used to assess the performance of sustainability indicators are life cycle assessment (LCA) and material flow analysis (MFA) (Valenzuela-Venegas et al. 2016). LCA is an analytical tool for systematically evaluating environmental impacts associated with a product (or service) over its entire life cycle (Curran 1996). The method computes impacts across a range of environmental categories, enabling decision-makers to evaluate critical processes over the product life cycle, as well as a means for comparing alternative products and services in meeting a functional need. MFA traces the flow and stocks of materials and substances through various processes and is a decision-support tool for evaluating technology efficiency and industrial practices for managing resources and environmental impacts.

MFA can provide an integrated view of the economy and the environment by capturing flows that are not used, producing a relevant impact and revealing how flows of material shift within a defined geographical region (Valenzuela-Venegas et al. 2016). MFA provides methodologically organized accounts in physical units based on the principle of mass balancing (Brunner and Rechberger 2004; OECD 2015; Sendra et al. 2007). The system under study is broken down into its most basic components and interconnections are mapped among these components to gain a transparent overview of how the different components are interrelated. Once the current state is modelled, various scenarios may be simulated to evaluate alternative strategies to increase resource efficiency and environmental performance in the system. Figure 3 provides a simplified figure of fishing gear processes in a region. The flow diagram indicates possible plastics material losses in the system through the entrance into the ocean compartment, landfill and incineration. Assessing these flows helps to determine indicator values for both the current system, as well as to determine expected values based on simulations of alternative strategies. Collecting data to quantifying this system requires retrieving data from stakeholders, existing datasets and published scientific material and reports.

In addition, other impact methods may be utilized along with the aforementioned to measure indicators values. Required approaches depend on selected indicators. A key principle to follow through assessing performance pertaining to economic, environmental, social and other aspects is to maintain a systems perspective. This is important to avoid problem-shifting and sub-optimization, i.e. solving a problem while creating new ones.

4.5 Step 5: Develop Improvement Strategies

Based on the analytical outputs from step 4, strategies must be developed in order to meet the targets set forth by relevant SDGs for FGRM. The knowledge of stocks and flows from different waste material recovered from fishing gear may help identify opportunities for sustainable circular business models and solutions.

Table 3 Potential strategies and mechanisms for sustainable management of FGRM

Strategy	Mechanism	Description
Drift net prevention	Gear clean-up	Organized ocean clean-up systems where fishing vessels are used to retrieve lost gear. Examples of such systems are the "Fishing for litter campaign" and the annual ocean clean-ups organized by the Norwegian Directorate of Fisheries
	Harmonized port waste fee system	Vessels calling at port may a fixed fee irrespective of amounts of waste. The intention is to reduce the amount of waste thrown overboard (Newman et al. 2015) and reduce administrative burden on ports (Øhlenschlæger et al. 2013)
	Penalty schemes	Vessels that do not discharge waste in ports are financially penalized unless they can provide proof of delivery at another port. The penalty amount must be enough to make the vessel lose money by illegally discharging a net at sea (Macfadyen et al. 2009)
	Environmental tax	Internalizing the cost of gear loss and dumping through imposing and environmental tax on gear
	Gear marking	Marking to help identify gear ownership and retrieve lost gear through navigational technology. May be combined with penalty schemes if intentional dumping can be proven
	Spatial zoning	Areas with high levels of fishing activity often put fishermen at a higher risk for gear loss or entanglement. Zoning schemes or spatial management is one way to notify fishermen of these high-risk areas. These zoning schemes rely on reporting and derelict gear surveys in order to map out potential navigation hazards
Incentivize recycling and reuse	Landfill tax	Increase the price of landfill waste to encourage other forms of treatment (recovery, recycling, reuse) that are higher up in the waste hierarchy. These landfill taxes not only cover the costs of a landfill's operation and maintenance but also offers incentive to reduce the amount of waste (Ten Brink et al. 2009)
	Extended producer responsibility	Gear manufacturers are responsible for the EOL treatment of their fishing gear products. In effect, this removes the inconvenience and cost factors associated with waste management from the fishermen. By linking the manufacturer to the products EOL stage, the scheme can also indirectly encourage more life cycle focused product design (Sherrington et al. 2016)
	Deposit refund systems	A deposit refund system would require the consumer to pay a deposit upon the purchase of fishing gear. Once the gear reaches the end of life stage, the consumer could return the net and retrieve the deposit
	Reward schemes	"Gear buy back" schemes implemented to encourage fishermen or other actors to bring gear back to shore for a reward and appropriate disposal

FGRM strategies should increase gear recovery, recycling and reuse to the extent possible and feasible. Table 3 lists some examples of potential mechanisms or strategies that may be implemented, either in isolation or in combination, to improve FGRM.

In evaluating the feasibility of alternative strategies, the environmental, social and economic aspects must be evaluated in concert by using the SDGs and developed indicator sets. It is important to reiterate between designing and evaluating solutions to converge on a permissible course of action. For FGRM, this entails modelling and analyzing alternative technologies, regulatory rules, inter-organizational management systems and other mechanisms to control ALDFG issues and promote fishing gear plastics material recovery and recycling.

4.6 Step 6: Decide and Implement

The final step of the framework concerns deciding a course of action. When various strategies have been modelled and analysed and their performance relative to chosen SDG indicators is measured, decision-makers must make a final decision on a strategy to implement. The iteration between steps 4 and 5 should develop one or several feasible strategies that help attain the SDGs. In the case where multiple strategies exist, decision-makers may use multi-criteria appraisals to identify preferred strategies. This requires adding subjective preference information to define the relative importance of selected indicators. Figure 5 shows an example of a multi-criteria problem structure with four alternative strategies to be comparatively evaluated against indicators relative to the four selected SDGs.

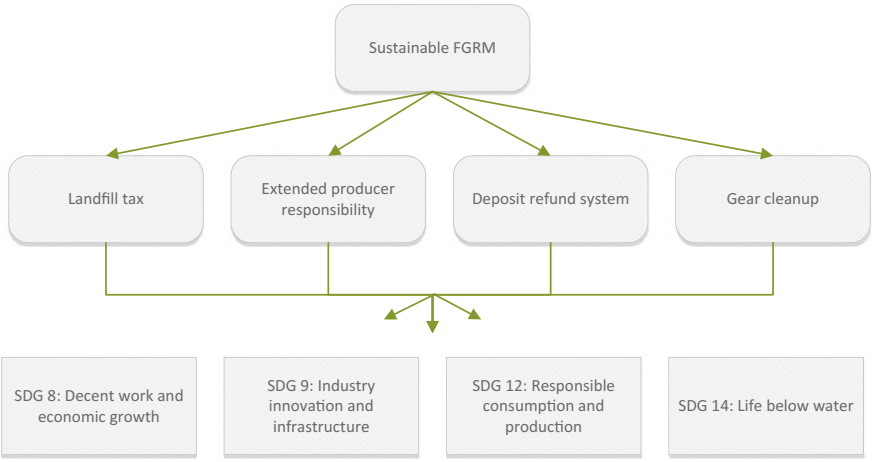

Fig. 5 A decision structure for FGRM strategies

5 Discussion and Conclusion

Development of national, regional or local policies for the implementation of SDG targets demands synergistic corporation between science and policy. Given the all-inclusive scope of the SDGs, inputs from science are deemed significant for policy-makers at various levels of society to assess the economic, social and environmental implications of their strategies in an integrated way over the long term. This study provides a systems engineering-based framework to facilitate synergy between the SDGs and policy-makers. This is illustrated through the identification of relevant SDGs, targets and further development of a set of indicators to monitor and ensure sustainable FGRM. The framework offers a stepwise approach to problem-solving through the integration of life cycle and systems thinking and the utilization of tools and concepts from multiple disciplines. This multidisciplinary approach helps link hard data, retrieved and analysed through mathematical modelling, with soft data, which is collected and analysed with social and business research methods and theories. Combined, decision-makers gain a comprehensive understanding of a complex problem and may trace decisions through logical reasoning and analysis.

Application of this systemic framework reveals that using the SDGs and identifying relevant targets for FGRM provides a guided approach to understanding and outlining social, environmental and economic dimensions of sustainability problems. The selected goals and underlying targets are intuitive, informative and can easily be accounted through the development of practical indicators. The steps described in this framework build the logical understanding of the issues pertaining to FGRM, while the opportunity to include stakeholders provides transparency in defining the problem. Through the collection and analysis of indicator data through industrial ecology and system analysis tools, new and innovative solutions may also be identified.

Although the systemic framework proposed in this paper helps in translating and operationalizing the SDGs in the organizational sector, this is not necessarily the only approach applicable for all the sectors. Selections of relevant SDGs, targets and subsequent indicators are essentially subjective and relevant for the selected case study and region and might vary while reproducing the study elsewhere. Moreover, the scope of the current study focuses on recovery and management of fishing gear without the inclusion of other sources of marine litter while developing the set of indicators. Furthermore, the case study provided only serves as an illustration of possible connections between SDGs, targets, indicators and improvement strategies. The framework should be applied and tested in real-life case studies that focus on a target region where FGRM strategies are needed. Further development, testing and application of impact assessment tools, such as material flow analysis (MFA) and life cycle assessment (LCA), will also help extend the understanding of the current state, in addition to scenarios that include strategies for better fishing gear life cycle management and opportunities to develop circular business models. This is the topic for a forthcoming paper.

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Transportation Infrastructure Project Evaluation: Transforming CBA to Include a Life Cycle Perspective

Heather Luclaire Jones, Filipe Moura and Tiago Domingos

Abstract

The United Nations Sustainable Development Summit 2015 adopted a set of Sustainable Development Goals (SDGs) which reveal the need for the integration of the three main dimensions of sustainable development: the economic, social, and environmental. Sustainability is often cited as a reason to build transportation infrastructure such as high-speed rail. A transport CBA that integrates economic, social, and environmental costs and benefits is needed to support these claims. Most transport CBAs ignore or pay little attention to the life cycle costs and benefits over the life of the project. In order to avoid potentially misleading results, the infrastructure project must be examined over the entire life of the project. In transport CBAs, the environmental impacts are only considered during the operation phase. The aim of this research is to account for the environmental impacts for the entire life cycle of the project and better reflecting the costs and benefits of the project throughout its entire life cycle. Transforming CBA to include a life cycle perspective will be accomplished by performing, monetizing, and including a life cycle assessment

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(LCA) into the CBA finally tying economic, social, and environmental impacts into a single project evaluation tool.

Keywords
Economic · Social · Environmental · Project evaluation · Cost–benefit analysis · Life cycle perspective

1 Introduction

Sustainable development has been declared as the goal for present and future growth by agencies such as the United Nations (1992, 2005, 2011, 2012, 2015) and by the countries that signed the Paris Agreement (UN 2015). Most of these entities also require project evaluation, usually in the form of cost–benefit analysis (CBA), for approval of these projects (UN 1972; Jones et al. 2014; Mishan and Quah 2007). These two requirements do not typically align. Sustainable development has three main dimensions, economic, social, and environmental. CBA usually includes an economic analysis that incorporates some social costs and benefits. However, in most of the cases (e.g., transport infrastructure), environmental costs and benefits are inadequately covered. Thus, the need for the integration of the three dimensions into a sustainable science evaluation tool arises.

In project evaluation, environmental impacts are "inadequately quantified, only guardedly accurate, and generally unimpressive as rational-scientific exercises" (Culhane 1987). There is a lack of data and ex-post audits (Florio and Sartori 2010; Grimaldi et al. 2010; Kjerkreit et al. 2008; Short and Kopp 2005) which indicates that agencies possess inadequate information about consequences of projects, which implies that little learning takes place and they can neither refine their predictive decision-making models nor mitigate adverse project consequences (Flyvbjerg et al. 2003; Wood et al. 2000). Most forecasts made are not accurate. Those that are found accurate are deemed so by their vagueness or because they are qualitative (Buckley 1991; Culhane 1987; Wood et al. 2000).

Critics contend whether these elements should be monetized, and if so, how it should be done (Banister and Berechman 2000; van Wee et al. 2003). Some argue that environmental elements are priceless goods that should not be monetized (Heinzerling and Ackerman 2002). Others argue that common methods used for monetization are inherently flawed or subjective (Ackerman 2008; Button 2010; Feng and Wang 2005; Niemeyer and Spash 2001). Others claim that as many impacts as possible should be monetized and included (Bateman et al. 1993; Bristow and Nellthorp 2000). While agreement may be a long way off, the discussion is important and might have a large impact on future CBA exercises.

There are two major concerns with environmental valuation. The first is that there are many impacts that are very project specific that would require detailed studies to include, e.g., biodiversity loss. The second is that the impacts are usually accounted only regarding the operation stage and the other stages are ignored.

CBA monetizes some environmental elements such as energy use and emissions, mainly during the operation life cycle stages—PM_{10}, SO_2, NO_X, and CO_2 (Guhnemann 1999; Hayashi and Morisugi 2000; Mandell 2011; Spash 2000; Ulgiati and Basosi 2010; van Wee et al. 2003). However, other elements are disregarded such as the value of the esthetics of land if nothing were to be built, cultural heritage, health and safety, peace and quiet, water and air quality, ecosystems functions, and biodiversity (Murray et al. 2011; Spash 2000). Impacts related to resource withdrawal from the environment such as mining for construction materials, threat to biodiversity, and eco-toxicological potential from particulate matter could be included (Ulgiati and Basosi 2010). The time horizon chosen is important for environmental impacts as some (such as irreversible deforestation costs) take decades to appear (Hansen and Gilberg 2003).

Clearly, as many environmental impacts as possible should be included in CBA. These impacts are difficult to monetize and have large uncertainty ranges. These impacts include landscape and habitat preservation, biodiversity loss, and exposure level of the population among other project-specific impacts. Further research into monetizing and including these impacts is needed. However, these impacts are very project specific and difficult to obtain, therefore general guidelines would be an area of further research.

In order to account for energy consumption and environmental impacts (usually, noise and air emissions), most CBAs use only the period when the transport infrastructure is operating, and the impacts from construction and end of life are not accounted for and substantially underestimate the total life cycle emissions. High-speed rail (HSR) is generally thought to be a more environmentally beneficial mode of transport; however, its construction requires a significant amount of energy-intensive construction materials such as concrete and steel and significant emissions in the production of heavy construction equipment (Westin and Kageson 2012). In order to understand the true costs and benefits for development projects, all environmental emissions should be considered (Tatari and Kucukvar 2012; Weitz et al. 1999), namely along all stages of the life cycle. The inclusion of a life cycle assessment (LCA) in CBA would account for the impacts of the entire transportation infrastructure life cycle. Adding environmental impacts into CBA is a way of integrating economic and environmental considerations into decision-making (Beder 2000).

Operation emissions such as the savings from less car traffic and the emissions released from trains should not only be included, but it should also include the huge environmental load placed by the transport infrastructure. The lifetime energy costs of the concrete, metals, and machinery used for construction and maintenance are high and should be assessed (Ulgiati and Basosi 2010).

It is estimated that road construction, maintenance, lighting, herbicides, and salting accounted for 14% of the life cycle energy consumption of cars and 16% of CO_2 emissions, proving to be significant (Chester and Horvath 2007a). When life

cycle components are included, greenhouse gas (GHG) emissions increase 2.1 times for heavy rail, 1.4 times for high-speed rail, and 1.3 times for air, and in that criteria air pollutants increase 1.1–29 times for heavy rail, 1.2–1.4 times for high-speed rail, and 1.5–9 times for air (Chester and Horvath 2007b).

A few other LCAs for transportation projects such as passenger and freight rail, air transport, road transport, and inland waterway among others and several geographical locations such as in China, Germany, United States, Switzerland, Sweden, Norway, and Korea have been performed. However, none of them place these inside of a CBA, and LCA has not been performed for any rail or HSR projects in Portugal or the Iberian Peninsula. Chester and Horvath (2007a, b) have produced the most comprehensive study of transportation so far, but the geographical focus is solely on the U.S.

2 Methodology

The objective of this study is to assess the environmental impacts resulting from the construction, maintenance, operation, and end of life disposal of a transport project and to include the results in a project evaluation tool which will integrate the social, economic, and environmental dimensions providing an improvement to the accounting for sustainable development. The Portuguese HSR will be used as a case study, but any transport project in any geographical area could be used.

2.1 Life Cycle Assessment

A life cycle assessment for the Portuguese HSR project was performed and published in a peer-reviewed journal. Excerpts are included here to provide a general understanding of the process. Details can be found in Jones et al. (2016).

The geographic scope is the HSR line from Lisbon north to Porto. The functional unit (FU) is one kilometer (km) of high-speed rail in Portugal for the seven main processes and passenger kilometers (pkm) at the assembly level. Only passenger rail is planned for the project, so freight rail (tkm) was not included in this analysis. System boundaries include the materials, construction and manufacturing, operation and disposal of both the railway track, and the train (Fig. 1).

The boundary defined for the system includes all of the operations performed during the construction and operation of high-speed rail along with the construction and operation of rolling stock. It is based on an Ecoinvent unit process, Transport Services (Spielmann et al. 2007). The main processes within this unit process are as follows: (1) the construction of the railway track, (2) the operation and maintenance of the track, (3) the construction of the train, (4) the operation of the train, (5) the maintenance of train, (6) the disposal of the train, and (7) the disposal of the track (Fig. 2). The energy and emissions from the extraction, transformation, transportation, and use and disposal of bulk materials (i.e., steel, copper, aluminum, rubber, and synthetics) used in the processes are included in this analysis.

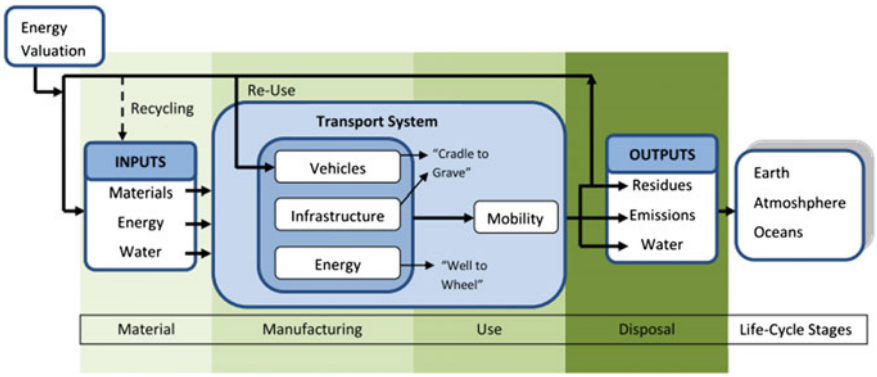

Fig. 1 System boundaries. *Source* Jones et al. (2016)

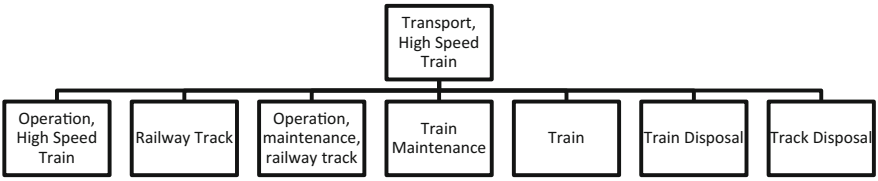

Fig. 2 Major processes of high-speed rail. *Source* Jones et al. (2016)

The SimaPro LCA software (PRé Consultants 2013) and Ecoinvent database (Spielmann et al. 2007) are used here to perform the LCA. A process-based approach is used due to the availability and customizability of the upstream processes along with the established and acceptable provisions for circularity and system boundaries in the database, and the software and database's adherence to ISO 14040 (ISO 2006a, b; PRé Consultants,2013; Spielmann et al. 2007). Ecoinvent is widely recognized as the largest and the most consistent international LCA database (Sun 2014).

ReCiPe was selected as the Impact Assessment Method. It is the successor to and integrator of Eco-indicator 99 and CML-IA, and is widely used in Europe (Goedkoop et al. 2013). The impact categories selected for analysis were those which are commonly used in transportation LCA so that comparisons could be made (Barzaga-Castellanos et al. 2001; Facanha and Horvath 2006; Fries and Hellweg 2014; Spielmann and Scholz 2005; von Rozycki et al. 2003): climate change (kg CO_2-eq.), terrestrial acidification (kg SO_2), and particulate matter formation (kg PM_{10}).

For each of the main processes (refer to Fig. 2), requirements were calculated and were put into the LCA. The track length was multiplied by the number of years of use to obtain the functional unit for the construction and operation and maintenance of railway track. The unit considered is a meter year. Meter years were calculated for the construction of the railway track, meter years for 35 years of the

Table 1 Quantity and type of materials used in train manufacturing and maintenance and track construction

Material	Quantity	Unit
Project characteristics		
Track	279	km
Track construction	5	Years
Track operation and maintenance	35	Years
Trains	38	Train
Train operation and maintenance	3,403,784,119	Pkm/year
Per train manufacturing and maintenance		
Reinforcing steel, at plant	279,000	kg
Steel, low-alloyed, at plant	88,800	kg
Aluminum, production mix, at plant	90,125	kg
Copper, at regional storage	34,525	kg
Per meteryear of track		
Concrete, exacting, at plant	0.0419	M^3
Reinforcing steel, at plant	10.6	kg
Steel, low-alloyed, at plant	1.88	kg
Aluminum, production mix, at plant	0.125	kg
Copper, at regional storage	0.424	kg
Pig iron, at plant	0.74	kg
Tin, at regional storage	0.005	kg

Source RAVE (2009), Jones et al. (2016)

operation and maintenance of the track were calculated. The number of trains needed was calculated for the construction and maintenance of trains. This was obtained from the Cost–Benefit Analysis that was performed for this project (RAVE 2009). The quantity and type of materials used are presented in Table 1.

2.2 Environmental Impacts

To include environmental impacts in the new integrated sustainable development project evaluation tool the life cycle emissions have to be monetized. There are a few methods that are generally accepted. Emission trading schemes, carbon tax, or the social cost of carbon can be used to determine the price of carbon.

There is limited data on the price that should be assigned to the other emissions. However, there is some evidence available. PM_{10} and NMVOC are not examined in details in the LCA because other transportation LCAs do not include them in details, and therefore there is limited data for comparison within LCA. They are included here in the environmental impacts monetization because they were included in the original case study and for consistency and completeness. It is worth noting that after peaking in 2006 both SO_2 and NOx were at substantially lower

values [$2.12 for ton SO_2 and $15.89 in 2011 (U.S. EIA 2012)] due to much lower emissions and are no longer of much concern (U.S. EPA 2015). The prices for PM_{10} and NMVOC followed much of the same trajectory although not quite upto the same degree.

2.2.1 Monetizing Emissions

The current case study only accounts for emissions during the operation of the train. Therefore, the emissions from the other major processes must also be included. The train operation stage emissions are spread over the years in which it operates. The other life cycle stage emissions must be accounted for in the proper years, especially with discounting and the large track construction emissions in the early stage.

The emissions from track construction are spread over the first five years (which are the 5 years of construction). The train manufacturing emissions are weighted by the number of trains at the beginning (27) and the purchase of the second wave (11) and then spread over the two years prior to the start of operation and the start of the second wave. Train maintenance emissions are spread over the period of operation in line with maintenance costs. The emissions from the disposal of track and trains are included in the last year of analysis. The emissions from the additional life cycle stages are multiplied by the emission prices of the impact categories and then put back into the CBA.

3 The Case of High-Speed Rail in Portugal

To determine the impact of the integrated sustainable development project evaluation tool advancements on policy and decision-making, the case study of the Lisbon to Porto HSR link is used.

For the case study the Portuguese High-Speed Rail (PHSR) CBA from RAVE (2009) will be used. Full information is available in RAVE's report (RAVE 2009). It is a large-scale transportation infrastructure project that is one of the 30 priority projects of the TEN-T program of the European Commission.

In order to calculate the costs and benefits for the CBA, the difference between the "Do-Minimum" (DM) and "Do-Something" (DS) was used by RAVE, and it represents the data used. Data for "Do-Nothing" was not available. All values for residual value (RV) and NPV are in thousands. The DM alternative includes the high-speed (HS) links between Lisbon and Madrid and between Porto and Vigo. The DS alternative includes those two links plus a HS link between Lisbon and Porto. Since the only difference is the HS link between Lisbon and Porto, these are the only values that need to be determined (refer to Fig. 3).

It would be a dedicated line (refer to Fig. 4) and would cost roughly €4.5 billion and would be 297 km long and will include five stations (Lisbon, Leira, Coimbra, Aveiro, and Porto). The link between Lisbon and Porto would have a maximum speed of 300 km per hour and is estimated to take 1 h and 15 min with speeds of

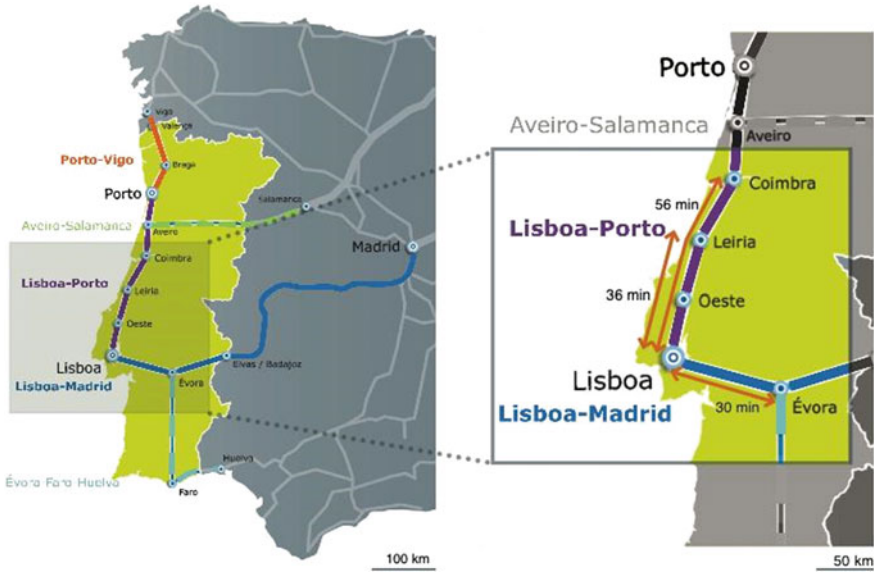

Fig. 3 Difference between "do-minimum" and "do-something." *Source* RAVE (2009)

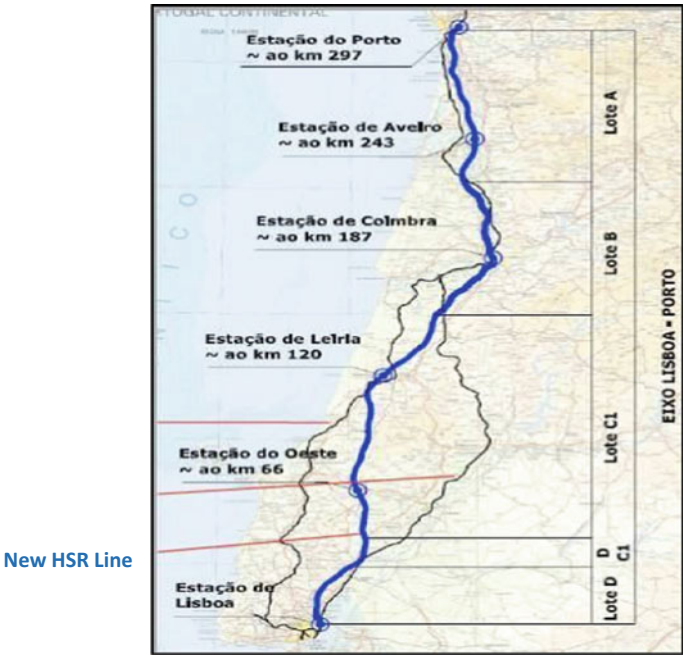

Fig. 4 Dedicated line compared to existing lines. *Source* RAVE (2009)

Table 2 Cumulative total benefits and costs (calculated based on RAVE 2009)

Description	Cumulative total (in € thousands)
Benefits	
User vehicle operating costs (excl. HSR)	8,553,827
Travel time savings	8,617,511
Accidents	477,003
Environmental benefits	468,069
Direct employment benefits	2,450,471
Wider economic benefits	3,395,954
Total benefits	23,962,835
Discounted benefits	7,468,376
Costs	
Fixed assets	3,387,411
Rolling stock acquisition	668,034
Replacement costs	1,531,972
Operating costs	3,203,207
Residual value	−934,877
Total costs	7,855,747
Discounted costs	4,420,785
Difference between discounted benefits and discounted costs (NPV)	3,047,785

Source Calculated from RAVE (2009)

240 km per hour on services without intermediate stops. The PHSR has 5 years of construction followed by 35 years of operation.

The cumulative total costs and benefits are presented in Table 2.

4 Results

In order to integrate the three sustainable development dimensions into the project evaluation tool, the life cycle emissions must be assessed. This is done through LCA. The life cycle emissions are then monetized and put back into the CBA accounting for all of the dimensions.

4.1 LCA Results

The total life cycle emissions for each impact category from ReCiPe are presented in Table 3 along with the contribution from each major process. Only the impact categories that are commonly used in transportation LCA are analyzed in further detail below.

Table 3 Total impact category life cycle emissions and major process contribution (rounded numbers, none are zero)

Impact category name	Unit	Total	Train operation (%)	Train manufacturing (%)	Train maintenance (%)	Track construction (%)	Track operation and maintenance (%)	Train disposal (%)	Track disposal (%)
Climate change	kg (CO_2 to air)	684,228,220	69	13	10	2	6	0	0
Ozone depletion	kg (CFC-11 to air)	46	65	13	14	2	6	0	0
Human toxicity	kg (14DCB to urban air)	238,145,503	54	31	6	4	5	0	0
Photochemical oxidant formation	kg (NMVOC to air)	2,582,624	67	12	14	2	6	0	0
Particulate matter formation	kg (PM_{10} to air)	2,433,341	82	9	4	1	4	0	0
Ionizing radiation	kg (U^{235} to air)	60,391,666	70	18	9	1	1	0	0
Terrestrial acidification	kg (SO_2 to air)	4,856,352	76	9	7	1	7	0	0
Freshwater eutrophication	kg (P to freshwater)	258,990	65	20	7	2	6	0	0
Marine eutrophication	kg (N to freshwater)	136,621	69	13	9	2	6	0	0
Terrestrial ecotoxicity	kg (14DCB to industrial soil)	139,154	73	11	7	1	7	0	0
Freshwater ecotoxicity	kg (14DCB to freshwater)	4,411,748	56	29	6	4	5	0	0
Marine ecotoxicity	kg (14-DCB to marine water)	4,815,219	57	28	6	3	5	0	0

(continued)

Table 3 (continued)

Impact category name	Unit	Total	Train operation (%)	Train manufacturing (%)	Train maintenance (%)	Track construction (%)	Track operation and maintenance (%)	Train disposal (%)	Track disposal (%)
Agricultural land occupation	$M^2 \times$ year (agricultural land)	16,849,333	51	9	34	1	5	0	0
Urban land occupation	$M^2 \times$ year (urban land)1	249,172,550	1	0	0	0	99	0	0
Natural land transformation	M^2 (natural land)	1,113,457	8	1	1	0	89	0	0
Water depletion	M^3 (water)	2,315,164	60	20	10	5	5	0	0
Mineral resource depletion	kg (Fe)	77,993,121	3	79	3	14	0	0	0
Fossil resource depletion	kg (oil)	221,526,521	66	16	11	2	6	0	0

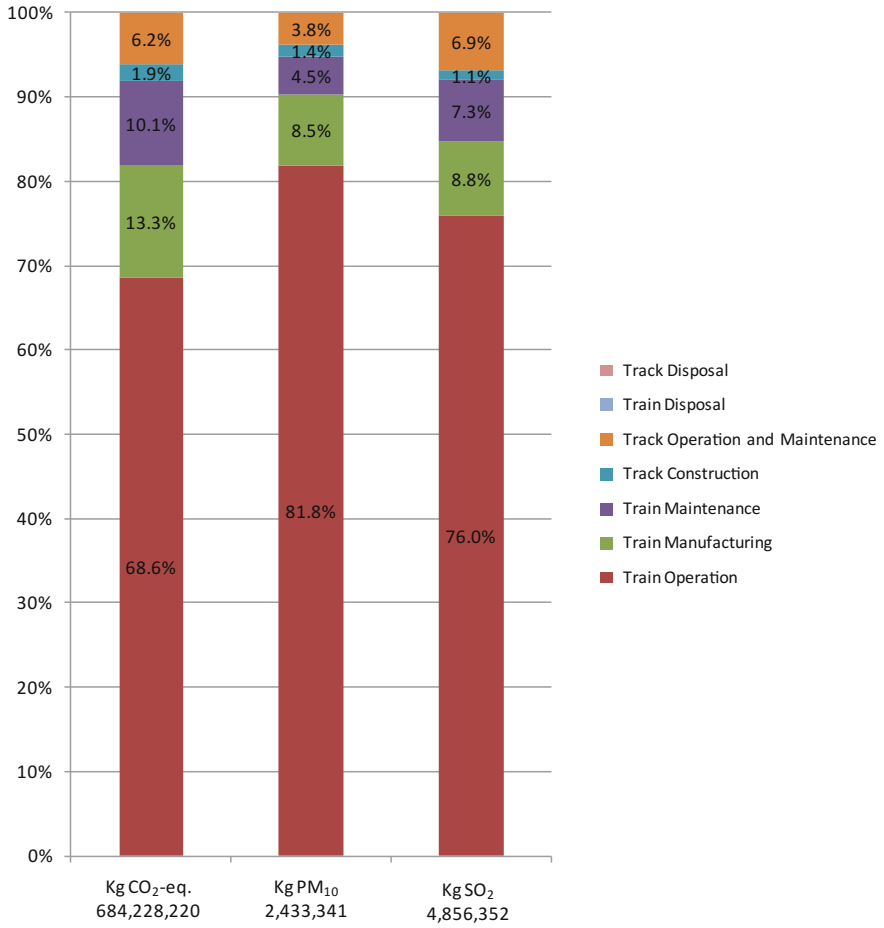

Fig. 5 Life cycle impact from the Portuguese high-speed rail line. *Source* Jones et al. (2016)

Regarding GHG emissions, the life cycle environmental impact is 684 thousand tons of CO_2 equivalents (ton CO_2-eq.). Train operation contributes 69%, train manufacturing 13%, train maintenance 10%, operation and maintenance of track 6%, and track construction 2% (Fig. 5). In comparison, in China 86% of GHG emissions come from operation (Yue 2013). In the U.S. 47% comes from operation and 47% from infrastructure construction and operation (Chester and Horvath 2012).

The HSR project produces 4.9 million kilograms of SO_2 (kg SO_2) during its life cycle. Train operation contributes 76%, train manufacturing 9%, train maintenance 7%, track operation and maintenance 7%, and track construction 1% (Fig. 5). For comparative purposes, in China 91% of the terrestrial acidification impact comes

from operation (Yue 2013) and in the U.S. 49% comes from operation and 45% from infrastructure construction and operation (Chester and Horvath 2012).

This project produces 2.4 million kilograms of PM_{10} (kg PM_{10}) over its lifetime. The makeup of this 2.4 million kilograms of PM_{10} is broken down as follows: the operation of the train contributes 82%, train manufacturing 9%, train maintenance 4%, operation and maintenance of track 4%, and track construction 1% (Fig. 5). For comparative purposes, in the U.S. 49% of particulate matter formation comes from operation and 45% from infrastructure construction and operation (Chester and Horvath 2012).

For comparative purposes, 1 pkm for the standard French High-Speed Train system was calculated using SimaPro software (PRé Consultants 2013), it gave the value of 0.0163 kg CO_2-eq. The same 1 pkm for the Portuguese adjusted system produced 0.0137 kg CO_2-eq. Other LCA reports for different countries were analyzed (refer to Table 4).

The total life cycle impact for kg CO_2-eq. was divided by the total pkm. This resulted in 0.007 kg CO_2-eq. This is slightly lower than some of the other studies because the Portuguese situation does not include barges for transportation of bulk materials; the distances for construction materials to be shipped is shorter since an important quantity of materials is produced in Portugal; there are fewer tunnels in Portugal (Utah Foundation 2010); Portugal has an important share of renewable sources in the energy mix); the HSR project base case assumes high demand (RAVE 2009). The energy mix and demand rates will be explored in the sensitivity analysis, in the next section.

4.1.1 Sensitivity Analysis

A sensitivity analysis was conducted to see the impact that changes in two of the inputs had on the total environmental impact. The first input is the electricity mix, because it is the main driver of train operation which is the largest contributor to the total environmental impact. The next input for the sensitivity analysis is transportation demand, because this input directly influences the per pkm impact.

Table 4 Life cycle kg CO_2-eq. for 1 Pkm by country as reported by study

Country	kg CO_2-eq. for 1 Pkm
Sweden	0.013
Portugal	0.014
France	0.016
Norway	0.017–0.027
United States	0.023–0.094
Europe average	0.027
Average	0.034
China	0.043
Germany	0.069

Sources Yue (2013), Schlaupittz (2008), von Rozycki et al. (2003), Uppenberg et al. (2003), Chester and Horvath (2012), PRé Consultants (2013), Jones et al. (2016)

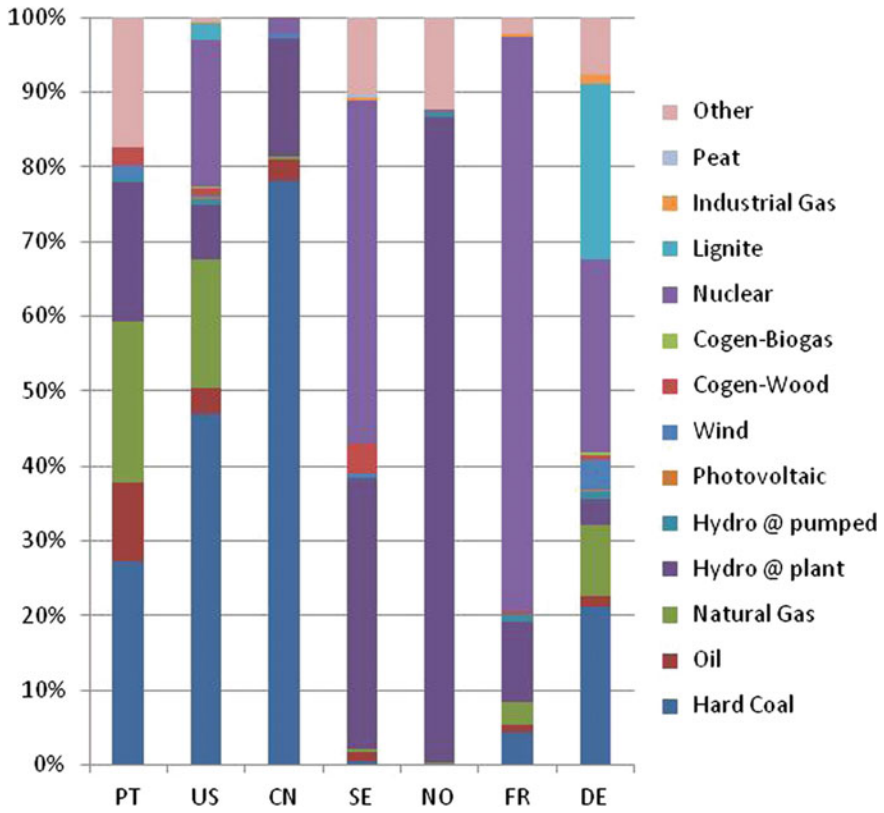

Fig. 6 Electricity mix by country. *Source* PRé Consultants (2010), Jones et al. (2016)

Electricity Mix

The electricity mix is the main driver of train operation impacts. Electricity mix varies greatly by country. The U.S., China, Sweden, Norway, France, and Germany electricity mixes (as supplied by SimaPro) were each applied to the Portuguese case study (PRé Consultants 2010).

The biggest user of hard coal (as a fraction of total electricity sources) is China followed by the U.S. and Germany (when including Lignite) with Sweden, Norway, and France using negligible amounts. The largest user of natural gas is Portugal and then the U.S. Norway is the only large user of hydropower while France and Sweden are the largest nuclear users (refer to Fig. 6).

To carry out this (refer to Table 5), first, 1pkm using the identified country's electricity mix was calculated (kg CO_2-eq./Pkm). Then the 1pkm impact is multiplied by the case study's total pkm to get the total impact (kg CO_2-eq./Pkm * Case Study Total Pkm). Next, the case study's LCA is adjusted for the calculated or assumed values for meter years, number of trains, and total pkm over the life cycle. This results in Total kg CO_2-eq. (Total kg CO_2-eq. based on Total Pkm). This value

is then divided by the case study life cycle total pkm to determine kg CO_2-eq. per pkm (Total kg CO_2-eq./Case Study Total Pkm).

After calculating the total CO_2-eq. emissions produced by the infrastructure's life cycle, the impact of the processes was analyzed. In the original case study using the Portuguese electricity mix, train operation was 69% of the impact. Then the Portuguese electricity mix was replaced with the electricity mixes from the countries with the largest alternative sources (nuclear for Sweden and France; hydropower for Norway). Using Sweden's mix, 32% of the impact was from train manufacturing, 25% train operations, and 25% train maintenance. France was similar to Sweden with 31% from train manufacturing, 26% from train operations, and 24% from train maintenance. For Norway, 37% was from train manufacturing, 13% was from train operations, and 28% was from train maintenance. Replacing the Portuguese electricity mix with the U.S. energy mix, it was 73% from train operation and 81% from train operation using the Chinese mix. Replacing the Portuguese electricity mix with Germany's energy mix, it was very similar to the case study with 69% from train operation, due to the similarity of the two countries' electricity mixes. Figure 7 shows the changes in the major processes contributions to the total impact.

In addition to altering the contributions of the major processes to the total impact, the electricity mix used directly impacts the total level of emissions. By applying the electricity mixes from several countries to the Portuguese case study, the impact of the electricity mix used was evident. The sensitivity analysis showed that this substitution resulted in a much lower impact when the electricity mixes from Sweden, Norway, and France were applied. The base case of using the Portuguese mix was somewhat higher than the previous three countries but had a lower impact than using the mix of the U.S. and a substantially lower impact than the Chinese mix. The outcome was quite similar when using the Germany mix. Figure 8 shows the sensitivity of the environmental impact by substituting the electricity mix.

Table 5 Impact of applying different country energy mixes on the total life cycle impacts of the Portuguese HSR case study

Electricity mix	kg CO_2-eq/Pkm	kg CO_2-eq/Pkm × case study total Pkm	Total kg CO_2-eq. based on total Pkm	Total kg CO_2-eq./case study total Pkm
Norway	0.009	817 million	247 million	0.003
Sweden	0.009	856 million	286 million	0.003
France	0.010	862 million	292 million	0.003
Portugal	0.013	1.25 billion	684 million	0.007
Germany	0.014	1.30 billion	726 million	0.008
United States	0.015	1.38 billion	804 million	0.009
China	0.018	1.68 billion	1.11 billion	0.012

Source Jones et al. (2016)

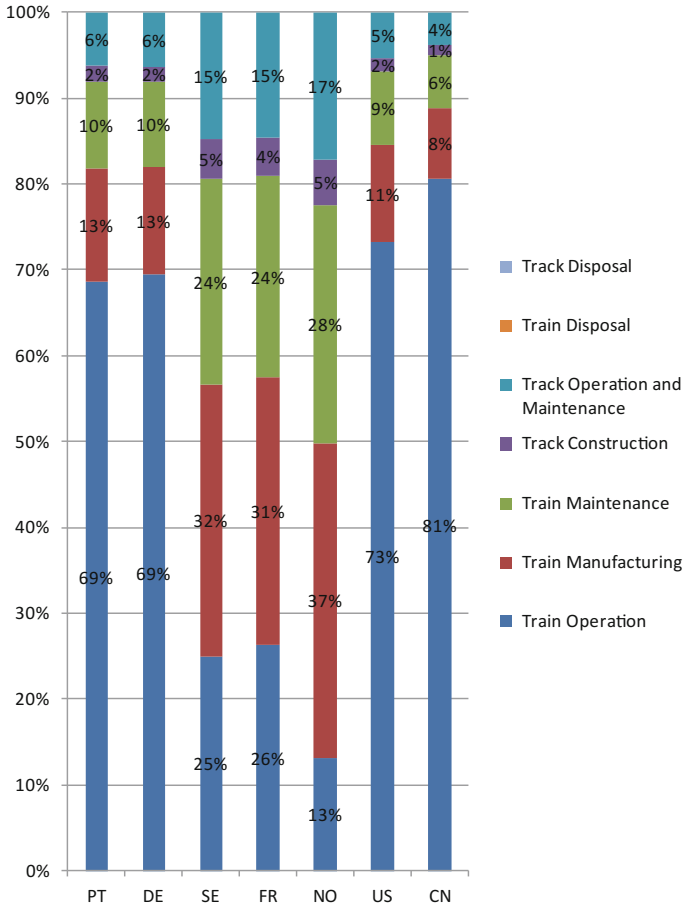

Fig. 7 Major process contributions to the total impact from electricity mix sensitivity analysis. *Source* Jones et al. (2016)

This sensitivity analysis shows that the type of electricity used drives the total impact of the project significantly (for example, using the electricity mix of Norway would have 63% less kg CO_2-eq impact), and it also influences which of the major processes contribute most to the impact, and it also influences which of the major processes contribute the most to the impact. In cleaner electricity countries such as France and Sweden, environmental impact improvements could be made in the train manufacturing and maintenance. For countries with fewer alternative energy sources, high-speed rail projects can greatly reduce environmental impacts by using a different source of primary energy, if possible, and by having the information on the environmental impact of the electricity mix used where the trains are manufactured.

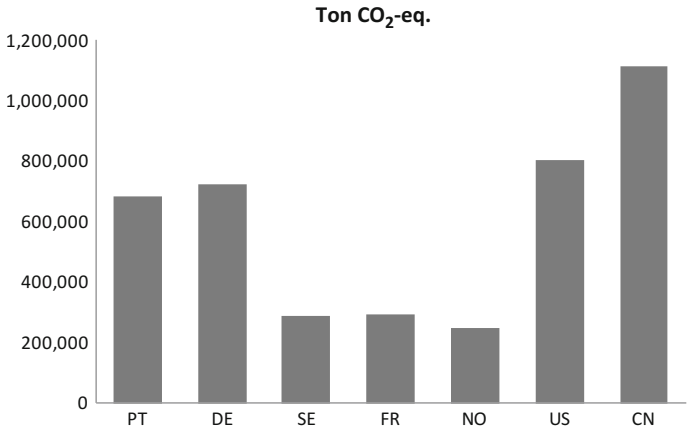

Fig. 8 Ton CO_2-eq. for the Portuguese High-Speed Rail Case Study when using a different country's electricity mix sensitivity analysis. *Source* Jones et al. (2016)

Transportation Demand

Transportation demand forecasts are often too optimistic (Mayer and McGoey-Smith 2006; Rasouli and Timmermans 2012; Skamris and Flyvbjerg 1997; World Bank 2005). The average inaccuracy of rail projects traffic forecasts is −39% (i.e., traffic was 39% lower than forecast) meaning that the forecasts were overestimated by 65% (Flyvbjerg et al. 2003). For large projects, traffic forecasts are commonly incorrect by 20–60% when compared to actual development (Skamris and Flyvbjerg 1997).

The total life cycle pkm of the case study was adjusted to reflect traffic that was 25% lower, 50% lower, and 75% lower, where it was assumed that the train occupancy rate remained unchanged (which is acceptable since the timetables are usually fixed). Obviously, the lower level of ridership has a lower total level of environmental impact (especially in light of the large contribution of the train operation process to the impact). However, the per pkm impact becomes higher as demand goes lower, since the remaining stages of the HRS life cycle remain unchanged. Rail network and tracks are not significantly affected by the pkm reduction. Likewise, the number of trains was held constant as the commitment for the trains occurs before estimated demand can be compared to actual demand (Flyvbjerg 2007). SimaPro (PRé Consultants 2013) calculates environmental impact based on pkm, whereas the number of trips is not an input. The per pkm impact for a 25% lower demand is 0.008 kg CO_2-eq. (567 million total kg CO_2-eq.); 0.010 kg CO_2-eq. (450 million total kg CO_2-eq.) for 50% lower demand; and 0.015 kg CO_2-eq. (332 million total kg CO_2-eq.) for 75% lower demand. Figure 9 shows the per pkm kg CO_2-eq. based upon applying sensitivity analysis to the demand forecast.

Naturally, the contribution of the processes also changes with demand (refer to Fig. 10). Train operation goes from 69% contribution at 100% of the forecast

demand to 35% contribution at 75% lower demand. This shows all processes should be included when considering the environmental impact.

This sensitivity analysis shows that the total environmental impact is related to total pkm and, since all other stages remain unchanged, per pkm CO_2-eq. increases as travel demand falls. This highlights the extent to which the major process contributions to the total impact can change in relation to the travel demand. Decision-making should explore and encompass the possible differences and potential solutions to encourage the use.

4.2 Monetizing Environmental Impact Results

The case study (RAVE 2009) calculates the emissions by mode by multiplying the change in vehicle distance traveled with the dollar amount of the emissions. This method includes only the operational stage. However, it does take into account the benefits from modal switch, so the life cycle impacts from track construction, train manufacturing, train maintenance, train disposal, and track disposal are added to the environmental impacts in the CBA.

Based upon the LCA, the project produced 172,675 ton CO_2-eq., 833 ton SO_2, 350 ton PM_{10}, 707 ton NMVOC, and 33 ton N additional life cycle impacts for the processes listed in Table 6). These additional emissions amount to €11.1 million (or €14.5 million depending on which prices selected).

The case study has €468.07 million in impacts from the operation of the train. The sustainable development (SD) base case using the same emission prices has €457 million in impacts, a reduction of the benefits of €11.1 million (Table 7). The environmental benefits from the modal switch to HSR are larger than the emissions from the additional life cycle stages. Therefore, the inclusion of life cycle emissions results in a **reduction of benefits** rather than turning it into an actual cost.

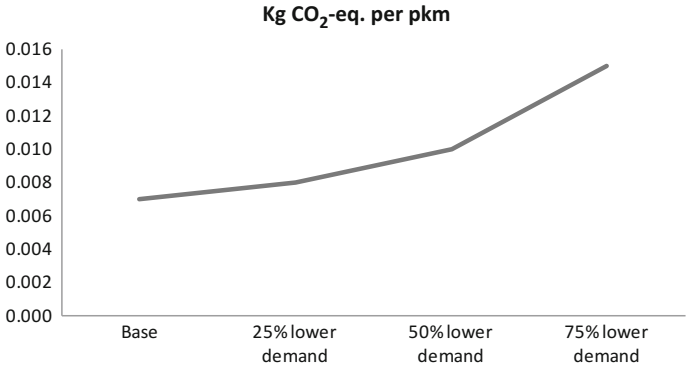

Fig. 9 kg CO_2-eq. per Pkm based on demand estimate sensitivity analysis. *Source* Jones et al. (2016)

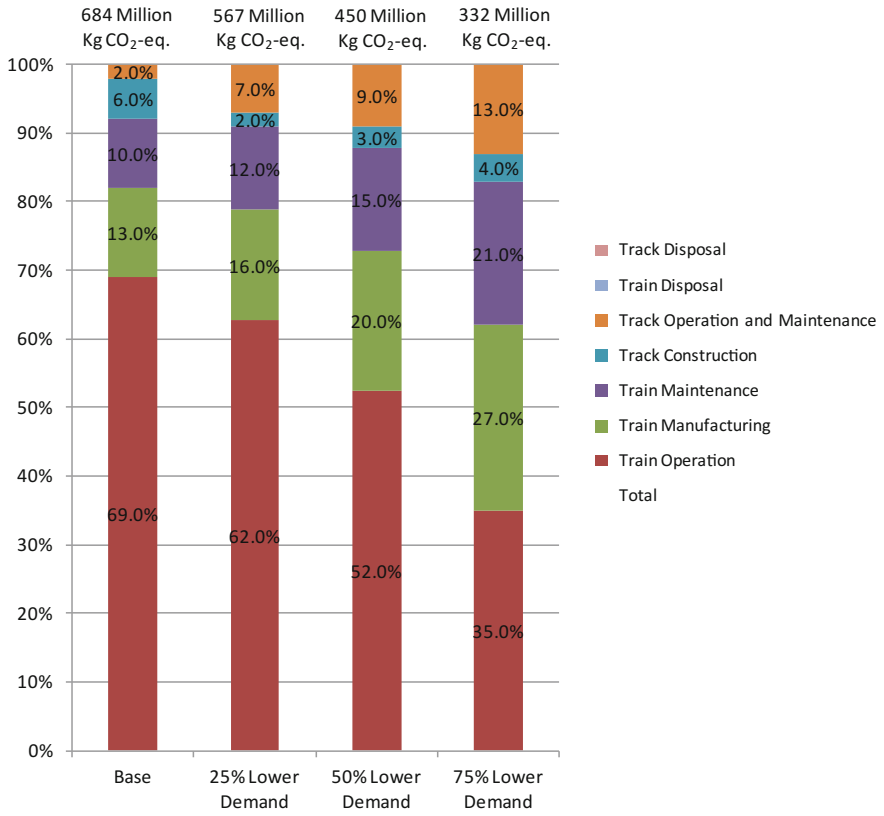

Fig. 10 Major process contribution to the total impact from demand estimate sensitivity analysis. *Source* Jones et al. (2016)

Table 6 Impacts from additional life cycle stages

Impact category	Impacts from additional life cycle stages (tons)
CO_2-eq.	172,675
SO_2	833
PM_{10}	350
NMVOC	707
N	33

4.2.1 Scenario Analysis

Scenarios are derived from the different pricing methodologies that represent the likely values, the high end and low end of those found within the methodology literature (Jones et al. 2016).

Because the original case study used 2007 data, the price of carbon selected as the likely case will be €20 which equates to roughly $25 at that time (Chevallier

Table 7 Difference in emissions and NPV based on life cycle stages (thousands)

	Original case study	Sustainable development base case	Reduction in benefits
Emissions	€468,069	€456,950	€11,119
NPV	€3,047,785	€3,042,250	€5535

Table 8 Impact category values by scenario

Impact category	Base case (PHSR CBA)	"Likely"	High end	Low end
ton CO_2-eq.	€26	€20	€85	€15
ton SO_2	€3800	€3500	€5600	€3000
ton PM_{10}	€8000	€22,000	€26,000	€5800
ton NMVOC	€800	€500	€950	€322
ton N	€3000	€1300	€4400	€790

Table 9 Difference in environmental impacts and NPV based on scenario (thousands)

	Difference from PHSR CBA (non-LCP)		Difference from LCP base case	
	Environmental impacts	NPV	Environmental impacts	NPV
Likely	€14,461	€7357	€3342	€1822
High	€29,255	€14,684	€18,136	€9150
Low	€7371	€3675	−€3747	−€1859

2010). The €26 used in the PHSR CBA will be used in the base case. The low-end value for carbon is €15 which is based upon an approximation of the exchange rate of $20 at the time. All of the values are presented in Table 8.

The difference between the likely case and the non-SD emissions are €14.5 million and €3.3 million, respectively, from the SD base case. The likely case has a larger reduction in benefits than the base case despite having a lower price of carbon. As seen in the next sub-section, it is mainly due to the change in price of PM_{10}. All of the scenarios have a reduction in benefits compared to the non-SD case study. Only the low case contributes less to the reduction in benefits. The low case adds €7.4 million in benefit reduction than do the non-SD impacts. Table 9 presents the difference in monetized environmental impacts and NPV by scenario.

4.2.2 Discount Rate Sensitivity Analysis

The choice of the discount rate has a critical impact on the discounted value of the environmental impacts and the NPV. The breakeven rate for the NPV is approximately 10.77%. The difference in the reduction of benefit for environmental impacts from the lowest discount rate of 5% and the highest at 12% is more than €88 million (except for the high scenario which is €85 million). Moving from 5 to 8.5% makes a

Table 10 Impact of discount rate on monetized environmental emissions (thousands)

	Undiscounted	5%	8.5%	10.77%	12%
Base	€456,950	€130,045	€69,532	€48,936	€41,073
Likely	€453,608	€128,222	€68,053	€47,607	€39,811
High	€438,814	€120,895	€62,322	€42,540	€35,033
Low	€460,697	€131,904	€70,988	€50,224	€42,287

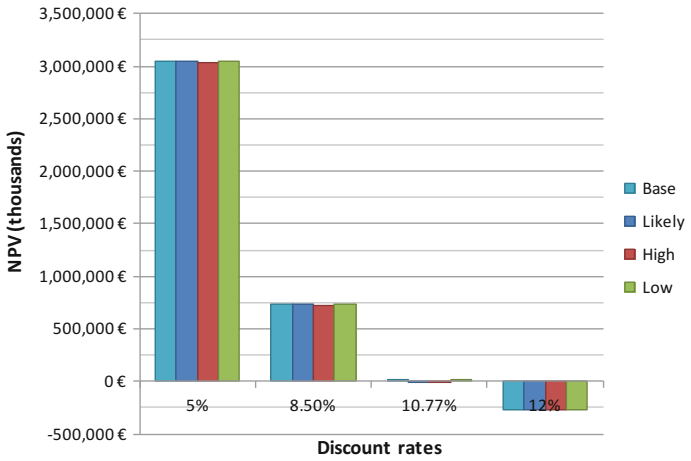

Fig. 11 Impact of discount rate on NPV (thousands)

difference of nearly €60 million. That is a significant difference that comes from changing only the discount rate. It has an even more profound effect on the NPV of the project. The change in discount rate can cause the project to lose €2.3 billion at 8.5% and €3.3 billion at 12%. Changes in the environmental impacts and NPV based on discount rate are presented in Table 10 and Fig. 11. The monetized environmental emissions are highly sensitive to the discount rate, and small changes can make projects to be rejected despite large environmental benefits.

4.2.3 Transportation Demand Sensitivity Analysis

As established previously in Sect. 4.1.1.2 traffic forecasts are often wrong. The modal switch benefits rely heavily on the demand forecasts (as do many other cost and benefit categories). The fewer kilometers switched, the lower the benefits. The environmental impacts from the construction of the track, manufacturing of the trains (assumes the second wave of rolling stock is not altered,) and the end of life for the track and train are fixed. The level of demand has a large impact on the environmental impacts. Having only a 25% lower demand than forecasted causes a loss of €117 million in environmental impact benefits and close to €1.1 billion from NPV (Table 11; Fig. 12).

Table 11 Environmental impact by percent lower demand than as forecasted (thousands)

	Undiscounted	−25%	−50%	−60%	−75%
Environmental impact					
Base	€456,950	€339,933	€222,916	€176,109	€105,898
Likely	€453,608	€336,590	€219,573	€172,766	€102,556
High	€438,814	€321,796	€204,779	€157,972	€87,762
Low	€460,697	€343,680	€226,663	€179,856	€109,646

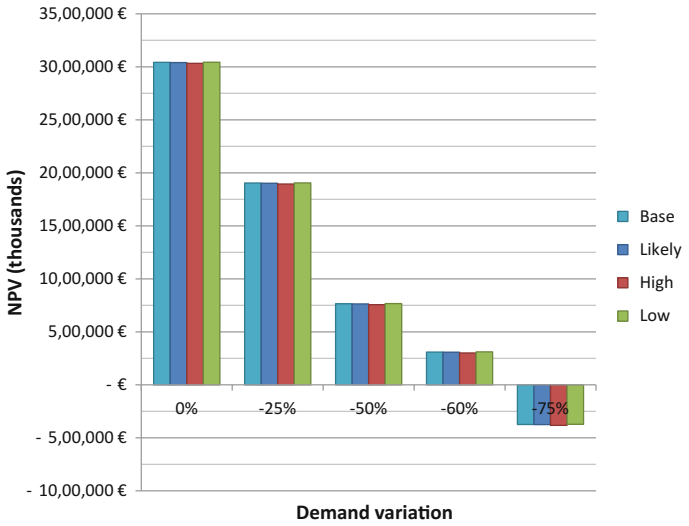

Fig. 12 NPV by percent lower demand than as forecasted (thousands)

5 Conclusions

Accounting for all life cycle emissions and then monetizing them and placing them back into the economic analysis section of CBA is a step towards integrating the three dimensions (social, economic, and environmental) of sustainable development into a project evaluation tool.

5.1 LCA Conclusions

This paper assesses the life cycle environmental impact of the proposed High-Speed Rail line for Portugal. It determines the processes that are the largest contributors to the environmental impact. The operation of the train is the largest contributor to the environmental impact (69% of CO_2-eq., 76% of SO_2, and 82% of PM_{10}). However,

most project analyses, including cost–benefit analysis, include only the environmental impact from the train operation process. For CO_2-eq., it means that 31% of the total impact is ignored because the impact from construction, maintenance, and end of life is not included.

This LCA achieves the goal of providing a more comprehensive estimate of the environmental impact by providing the lifetime emissions per pkm and for the total project which can serve as a baseline for high-speed rail in Portugal and the Iberian Peninsula. A modified inventory analysis was created and is available.

Using the original assumed total life cycle pkm, this LCA is in line with other analyzed LCAs. The differences can be attributed to the different types of transportation (i.e., barges) for inputs such as construction materials, the length of transport (domestic versus import, country size by roadway and railway lines), electricity mix, and demand levels. Portugal's lack of inland waterway transport, shorter shipping distances, predominant transportation of construction materials by rail, and domestic production of copper and tin contribute to lower pkm emissions than countries such as the United States, China, and Germany.

For electricity, clearly the type of mix drives the total amount of environmental impact. Cleaner fuels lead to cleaner rail systems. While the energy source is hard to change on a project basis, investments could be made to offset the impacts. HSR is a national level transportations strategy, which as in the case study of Portugal can be coupled with a strategy of investment in renewable electricity. Knowledge of the impacts of the energy source used for train manufacturing can be evaluated during decision-making.

Demand levels determine the total pkm and per pkm impact, as emptier trains will have lower environmental efficiency than the filled trains. Travel demand forecasts are commonly inaccurate so a sensitivity analysis on demand level was performed in order to determine the extent to which environmental impacts can vary.

Uncertainty analysis and LCA method choice are two areas where further research could be performed. Uncertainty analysis was conducted at the unit process level. The selection of a different impact assessment methodology would allow for further exploration of uncertainty analysis. This LCA was performed using a process-based methodology due to the requirement of the impacts produced by a specific process and the availability and customizability of the database and software used. The use of an EIO-LCA or a hybrid approach would allow an alternative look at the environmental impacts in the context of the entire economy and could offer another comparison point.

5.2 Monetizing Environmental Impact Conclusions

The degree of environmental impacts included in CBA has implications for policy and decision-making. While the differences between including life cycle impacts or not, in this case, seems fairly minor, it still represents millions of Euros. In some situations [especially when the costs and benefits are more even (B/C ratio closer to

1)] the inclusion or exclusion of life cycle impacts can change the sign of the NPV. Not including the life cycle impacts would mean not accounting for 172,675 ton CO_2-eq., 833 ton SO_2, 350 ton PM_{10}, 707 ton NMVOC, and 33 ton N for a value of at least €7.4 million, and more likely between €11.1 and €14.5 million.

More importantly, ensuring all life cycle impacts are included is especially important when claiming that HSR is a greener option. The impacts from all life cycle stages such as construction, manufacturing, maintenance, and disposal should be evaluated when making this claim.

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Flood Vulnerability and the Three Dimensions of Sustainability Philosophy: An Innovative Concept Design for Rapid Assessment

J. Wakeford, C. House, T.E. Butt, P. Paul and C.D. Beal

Abstract

This paper proposes the concept design of a novel Localised Rapid Flood Vulnerability Index. This proposed index has been initially tested and applied to a specific locale in Somerset, UK. The early analysis demonstrates that flood vulnerability may be unique to an individual location, despite the flood risk being considered the same for identical adjacent properties. Interpretation of these findings should provide increases in understanding of the interaction between the socio-economic and natural environmental requirements and overall flood vulnerability at a localised level. This initial research demonstrates the need for a rapid and cost effective flood vulnerability assessment tool at the localised scale.

Keywords

Climate change · Socio-economic · Sustainability · Flood risk · Flood mapping Flood vulnerability · GIS

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1 Introduction

1.1 Background

Flooding is a critical socio-economic and environmental issue impacting both the developed and developing world (IPCC 2014). As an example, the UK's summer floods of 2007 cost in excess of €4 billion alone. Furthermore, these figures do not include the multitude of small-scale hazards and insurance claims linked to flooding on an annual basis. Overall, flooding is the most financially costly and most frequent of all natural hazards facing Europe (EEA 2010). Reoccurrence of such flooding events and incidents is increasing due to the impacts of climate change and their related anthropogenic associations (Pall et al. 2011; The Royal Society 2014). Therefore, there is a growing need to develop a rapid means to measure the flood vulnerability of communities. This paper proposes and tests one such rapid vulnerability assessment tool.

1.2 Current Flood Risk Assessment Methods

The detailed investigation of an individual UK location's flood risk is currently carried out by completing a Flood Risk Assessment (FRA). It is now a legal requirement for any development that falls under specified criteria (Crown 2014). FRA's actively aid in the reduction of insurance costs via identification of resilience/resistance levels, and by proposing modification measures and assessing overall risk. However, FRA's can be costly, time-consuming, unnecessary, and are not a failsafe system (BBC 2013; Pardoe et al. 2011; McCabe 2013; Maude 2014).

2 Methodology

2.1 A New Concept Design: Localised Rapid Flood Vulnerability Index (LRFVI)

The relationship between flood risk and flood vulnerability and their definitions alter depending on exact context and use, and therefore clarity in precise usage and definition of precise terms is essential (Table 1). Flood risk in England is largely specified via flood maps produced by the Environment Agency (EA). However, this does not indicate which specific receptor in the flood risk area will be hit by floodwater, or by virtue of its individual characteristics what scale of flood risk this constitutes as depicted in Fig. 1. Thus, the actual degree of vulnerability of a specific receptor can vary depending on the way it is being considered under a risk analysis (Table 1). This is referred to as the degree of vulnerability of that specific receptor, which may itself be a single building, a house, a neighbourhood or an entire community located in the flood risk area. Hence, the exact approach and

Table 1 Definitions of terminology used within the paper

Risk	The possibility of exposure to harm or damage from a hazard, i.e. EA defined flood risk as the probability of a flooding episode of varying magnitude to affect a location
Vulnerability	Lack of capacity to resist inundation of flood water
Flood/flooding	Any source of water that can inundate a location with the potential for damage
Resilience	The ability of a location to be inundated with flood water and return to its normal state
Resistance	The degree to which a location can halt the ingress of water that would cause damage

proposed methodology being advocated in this paper focuses on a tailored vulnerability analysis carried out at the appropriate level and scale. This subsequently avoids the current system of applying a 'blanket' approach to flood risk assessment. It is anticipated that this innovative approach could also save time and effort while still proving more effective than traditional methods of assessment.

2.2 LRFVI: Factors and Parameters Used to Generate It

The proposed list of factors that relate to flood vulnerability is divided into four main parameters. Parameter *A* refers to an assessment of the location's external flood defence limit. Parameter *B* assesses topography and water management occurring just outside of the location's boundary. Parameter *C* identifies the presence of any nearby national flood defences. Parameter *D* uses current flood risk designations as set by either NRW TAN 15 (Technical Advice Note 15: Development and Flood Risk 2004) (Wales) or EA maps (England) for this specific location and is scored accordingly within the proposed matrix. Two additional parameters are proposed that may be used in specific locations and instances. The first is Parameter *E* which is simply an additional scoring factor that is added when the combined parameter score of $A + B + C + D = 16+$. This parameter is in-line with the one used in the Palmer et al. (2011) method, which gives an additional weighting of 4 to the total score of earlier parameters so as to highlight the most vulnerable of locations. The second and final factor is Parameter *F*, which is only applied when known historical flooding of a location is present in significance. It is proposed that this devised list of factors and parameters would be regularly critically assessed and reviewed by experts within the flooding and insurance industry thereby ensuring their relevancy and validity for usage. Thus the methodology proposed here is a further adaptation from the Palmer et al. (2011) method, and it has enabled the concept development of the LRFVI formula and matrix (Tables 2 and 3). The Palmer et al. (2011) method specifically investigates the social, economic and environmental (SEE) vulnerability of the coastline. Hence the addition of this further concept is also proposed under this novel concept methodology.

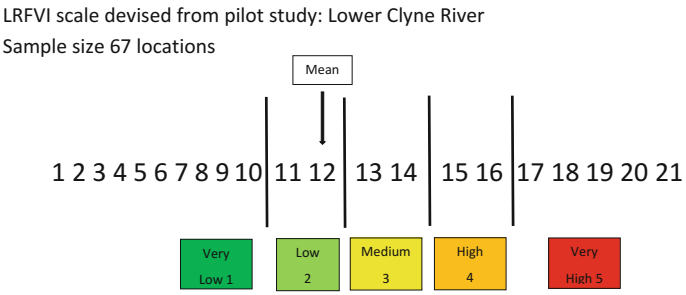

Fig. 1 Localised rapid flood vulnerability index—vulnerability scoring scale

Table 2 LRFVI formula

Relative localised rapid flood vulnerability index formula = $A + B + C + D + E + F$
A = Location external defence limit, B = local topography/water management reducing flooding, C = national flood defence, D = EA flood zone designation, E = factor of 4 added to highlight flooding severity of location (if $A + B + C + D = 16$) and F = factor of 1 added to highlight historic flooding. This translates into the LRFVI matrix as seen in Table 3

So an identified list of SEE locations and land uses affected by flooding will be compiled from varying sources and via desktop/field studies' observations (Ketchum 1972; Crown 2004; Pitt 2007; Palmer et al. 2011) with further assessment by experts within the field to ensure relevancy and validity for usage.

2.3 Concept Development of the LRFVI Scale

A pilot study conducted on the lower section of the Clyne River, Swansea, provided development of the scaling system required to produce the final vulnerability rating (Fig. 1), prior to its actual application within the Queen Camel location in Somerset, UK.

A standard statistical analysis of the study data composed of sixty-seven samples from the Clyne River site produced a final score value of LRFVI ranging from 8 to 21, with 8 being lowest and 21 the highest vulnerability score possible. A typical value returned was 12. Production of the final index scale required the development of a unique alternative method befitting the broadest of flooding contexts when compared to that of original Palmer et al. (2011) method which only focused on coastlines.

On analysing the River Clyde data, identified changes in the level of resilience/resistance of features occurred at specific points within the scoring scale. It was noted that significant differences in vulnerability occurred between scores of

Table 3 Localised rapid flood vulnerability index

Parameters	Extremely low (score 1)	Low (score 2)	Moderate (score 3)	High (score 4)
A: location external defence limit	>1 m	1–0.5 m	up to 0.5 m	No defence
B: local topography/water management reducing flooding	Very good	Good	Average	Poor
C: national flood defence	>2 m	1–2 m	up to 1 m	No defence
D: EA flood zone designation	Very low	Low	Medium	High
E: factor of 4 added to highlight flooding risk of location				
F: factor of 1 added to highlight historic flooding				
Score: min 4 max 16 + 4 + 1 = 21				
$A + B + C + \mathrm{D} + E + F = 21$				
Add *E* when $A + B + C + D = 16$				
Add *F* when location has known history of flooding				

10 and 11, due to an increase of vulnerability relating to one or more of the four parameters. Further changes in flood vulnerability occurred, with increasing vulnerability observed between scores 12/13, 14/15 and 16/17 respectively.

Utilising this natural correlation of change in vulnerability it was possible to create the LRFVI scoring scale from which the final vulnerability rating of any location can be assigned (Fig. 1). When cross referencing with the corresponding flood risk assessments made by the EA and TAN 15 flood risk maps, a score of 12 was confirmed thus returning a low flood vulnerability on the proposed LRFVI rating scale.

2.4 Application of the LRFVI Concept Methodology: Queen Camel Case Study

LRFVI test results from the first case study zone sited at Queen Camel showed that seven of the 305 locations assessed are sited within very high-risk areas with 17 sited within medium to high flood vulnerable areas.

Evaluation of associated socio-economic and environmental usage enabled identification of the two locations scoring very high in vulnerability, namely, the school car park and the A359 High Street road, of SEE category 8. The land usage of these sites provides increased resilience, by requiring minimal mitigation to enable rapid reuse after floodwaters have receded. In contrast, the remaining locations sited within the higher risk sites comprised residential housing, business offices, other infrastructure and agricultural installations. The location of the school,

electricity sub-station and the two residential properties, Mildmay Orchard and Milestone respectively, both located to the west of the main High Street A359, all scored medium and high vulnerability values respectively. This is indicative of flood plain land sited next to the River Cam that flows to the north of the village. The location of Mildmay Orchard, although obtaining medium flood vulnerability, has historically been inundated four times by floodwater since 1986. In response installation of flood resistance barriers up to one metre in height on the exterior of the property have been implemented (Anon 2014). These external resistance improvements are reflected within the LRFVI by reducing vulnerability scores when compared to the neighbouring locations of the school and various residential properties whose own scores vary from high to medium.

The majority of residential properties scoring medium and high values are long established within the village, and prior to modern day planning regulations. The location of the older properties on the eastside of High Street road, surrounding the village Church, is consistent with historical settlement patterns observed in this local region, with siting of the actual Church being on much higher grounds (Lorenz et al. 2001; Victoria County History 2014). This is represented collectively by lower vulnerability score values.

New developments within closer proximity to the river and within its floodplain have occurred in recent times via the conversion of farm buildings. An indication of the extent of this natural floodplain is further established by the presence of a designated floodplain to the north side of the river. Representation of this fact is shown in the final scoring system, since there is a reduction of vulnerability appraisal from high to medium, thus mitigating the effects of any small-scale flooding.

The presence of high values obtained for Parameters *B* and *D* is an indication of the potential for flooding of the area, and it is confirmed via identification of historical flooding of these locations. The LRFVI clearly identifies via high Parameter *B*, *C* and *D* values for four locations situated within an area that serves as a natural floodplain separated by High Street road. Using a cost benefit analysis, interpretation of the Parameter *C* values within the medium to very high-risk areas seems to advocate against the implementation of further flood protection measures as practical solutions.

Extensive housing development encircles the original village. The individual low scores seen in Parameters *B* and *D* indicate the areas chosen for development have naturally low flooding potential with 93% of locations assessed obtaining very low and low vulnerability ratings, indicating appropriate sighting for this intended land usage. The location of the new medical practice, under category 8 infrastructure, is as expected sited within an area of very low vulnerability that complies with current planning policy requirements. The fields to the west of the A359 bridge over the River Cam are evidently the continuation of the floodplain for the river that has been developed within the village vicinity. In summary, the Queen Camel data clearly demonstrates the identification of individual location's vulnerability to flooding changes despite there being no change in assigned flood risk.

3 Discussion

Interpretation of the corresponding parameter score values ranging from 1 to 4 reveals certain trends and occurrence combinations that give insight into the land surveyed and its flood risk perception (Table 4). Data analysis identifies high score occurrence of Parameters *A* and *B* with lower scores for Parameters *C* and *D* respectively, which indicates these areas are served by a form of flood defence with the local topography being prone to flooding. High Parameter *A* scores in this specific scenario indicate there is a reduced perception of flooding risk since no individual action has been taken, with an increasing resistance to flooding. In these cases reliance is upon national defences alone, as has been documented in similar case studies completed in the Netherlands (Baan and Klijn 2004; Botzen et al. 2009). The opposite is observed in this data set as well with some areas having low scoring Parameter *B* and *D* values, coupled with a high Parameter *C* score of 4, collectively implying the area is not liable to flooding. The occurrence of this combination of scores is anticipated when assessing new land development for structural and socio-economic use since these identified areas usually are of very low or low vulnerability.

As such, there is also a middle ground of scores observed in these data sets. It was expected to observe a reduction in Parameter *A* scores relative to an increase in Parameters *B* and *D* ones. This was observed in a limited number of locations, implying a reliance on national defence rather than individual resistance, and a reduced overall flood risk perception. This outcome further supports the work of Baan and Klijn (2004), Botzen et al. (2009), and Botzen and van den Bergh (2012), who all observed the Bayesian theory of a reduction in overall perceived flood risk being relative to the reduction in flooding episodes over time due to implementation of national defences.

In addition to its suitability as a rapid assessment method for individual location's, extensive long term assessment of these same locations, usually spanning decades, would provide insight into the changing vulnerability of individual

Table 4 Observed patterns within the parameter scores

Parameter *A*	Parameter *B*	Parameter *C*	Parameter *D*	Vulnerability pattern
1	1	4	1	Very low flood vulnerability
3/4	1/2	4	1/2	Low flood vulnerability risk
3	4	4	1	Medium risk in matrix/low on EA flooding map
1/2	3/4	1/2/3	1/2	High flood risk potential with national defence and high flood risk perception
3/4	3/4	1/2/3	1/2	High flood risk potential with national defence and low flood risk perception
4	4	4	4	Very high vulnerability

locations and the surrounding area to climate change effects, which is more akin to the original usage of these proposed vulnerability indexes. Hence this would assist in providing more realistic data to calculate flood insurance risk relative to the location's unique conditions.

3.1 Summary of Case Study Outcomes

It is apparent that a key outcome of this study is that the LRFVI matrix provides valuable information relating to an individual location's vulnerability to flooding that echoes with the majority of flood zone assessments made by the EA and TAN 15 flood maps used within the investigation. However, this index provides increased detail in comparison to the flooding maps through its ability to identify an individual location's unique resistance to flooding. This confirms the theory that the current approach employed within the flood industry is lacking in details since neighbouring locations can have a differing vulnerability.

The use of the LRFVI within the land management sector, construction sector and consumer user sector would allow rapid evaluation of a location's vulnerability to flooding, permitting further designation of this land for appropriate use, i.e. if the LRFVI returns a high or very high vulnerability score, the location should not be developed for infrastructure of social or economic use that was not resilient or resistant to flooding. Alternatively, this implies the location could have value for social wellbeing and the natural environmental, as many floodplains are home to vast numbers of rare and endangered species and habitat, as was present within this study area of the Somerset levels and moors (Astell-Burt et al. 2013; Opperman et al. 2013; Kousky and Walls 2014; Wolch et al. 2014). Thus this study indicates that the LRFVI method has the ability to be used at any location, regardless of current or intended use.

The rapid nature of this proposed assessment procedure allows a single location's vulnerability to be assessed within a much shorter time than that of a formal FRA, the wider benefits of which impact the private and commercial sectors by speeding up planning decisions and by reducing insurance costs for property owners. This index method would decrease the need to instigate costly and lengthy FRA's for locations with borderline flood risks levels.

4 Conclusions

1. Addressing weaknesses within vulnerability indices is key to producing a rapid assessment method. The method developed by Palmer et al. (2011), being validated and reliable, provided fundamental structure required for this study and eliminated a number of issues identified. Combining the SEE assessment

method is beneficial since it allows quick cross analysis of locations within highly vulnerable locales through basic data analysis coupled with improving understanding of land use.

2. Although the fundamental structure of the LRFVI is not new, its application for assessing flood vulnerability from the aspect of a specific location is unique within current theory and practice. The factors, parameters, matrix and scoring system are unique to this case study, with the LRFVI providing representation of flood vulnerability regardless of the level of flood risk actually assigned.
3. The LRFVI efficiently identifies any natural or developed location within high-risk areas that have the ability to be resistant to flooding and the level of resistance that is present, all represented as a vulnerability score. The impact of this approach has the potential to be both negative and positive in the outcome, for identified within the data are a number of locations classed as having the same flood risk but have varying levels of flood vulnerability. With all locations having >1% risk of flooding in any given year classed as high risk, the combination of the LRFVI with current EA/NRW and internal company flood risk maps would enable more reflective flood insurance without the need for bespoke FRA's to be carried out on a location with borderline >1% risk. Additionally, the use of the LRFVI would further justify the need for FRA's on the locations that require them, potentially giving the location a combined high flood vulnerability and risk value, thereby increasing the cost of insurance.
4. Through further data analysis and remote systems analysis using GIS modelling, it is feasible for the overall flooding vulnerability of a geographical area to be obtained, thus maintaining each individual location's status. When combined with flood risk maps, this would enable a detailed picture of the urban sprawl's evolution and areas affected by flooding, and how development was progressing and adapting within flood-prone areas.

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Transition Towards Sustainability in Hull University Business School: A Study of Curricular Sustainability in the Teaching Processes

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Abstract

The transition to sustainable development has become a strategic line of action that increasingly finds links to the quality of higher education (HE). A growing number of HE accreditation agencies include sustainability as a criterion for their standards and assessments, with a consideration of the degree of "curricular sustainability" of programmes, i.e. the extent to which contents, principles and values of sustainable development are present in HE formative processes. These aspects are directly related to the teaching practice of lecturers, and constitute the focus of this work. This research is currently being conducted at Hull University Business School (HUBS) with the aim of understanding the degree of coherence between the teaching practice of lecturers and the principles and values of sustainable development. It aims to evaluate such teaching practice from lecturers' own perceptions in order to identify shortcomings and provide HUBS with information that can support future improvement. It is an empirical descriptive study whose variables are established from the quality standards of the Association to Advance Collegiate Schools of Business (AACSB), and taking into account the recommendations of the UK Quality Assurance Agency for Higher Education (QAA) and the Higher Education Academy (HEA) to implement education for sustainable development at higher education level. The results support the need to promote the role of lecturers as "change agents" for

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sustainability and show that there is a group of lecturers who could be motivated to build learning networks for curricular sustainability.

Keywords
Curricular sustainability · Higher education · Teaching practice · Education for sustainable development

1 Introduction—Sustainability as a Criterion of Quality of Higher Education

The commitment of universities with the demands of sustainable development has become a strategic line of action directly linked to the quality of higher education (HE). Evidence of this is that sustainability is increasingly being included by international HE quality accreditation agencies, such as the Association to Advance Collegiate Schools of Business (AACSB 2016), among the criteria for accreditation of HE institutions. This inclusion is not surprising since the concept of quality is dynamic and needs regular updating in response to scientific trends, social developments and innovations, among others. And within these, sustainability is increasingly regarded as an important socio-cultural focus by the highest international agencies.

Simultaneously, the number of higher education institutions (HEIs) in the international arena making a commitment to a transition towards sustainability is also increasing (Leal Filho 2006, 2009, 2015; Barth et al. 2016; Davim and Leal Filho 2016). Some significant examples of initiatives supporting this mission include the Sustainability Tracking, Assessment and Rating System (STARS) in the United States and Canada, promoted by the Association for the Advancement of Sustainability in Higher Education (AASHE); or in the United Kingdom the ECOCAMPUS certification tool, together with the work carried out by organizations like People and Planet, the Green League for Universities, and Environmental Association of Universities and Colleges (EAUC). It is also worth highlighting the European project University Educators for Sustainable Development (EU4SD), composed of fifty-two universities in thirty-three European countries, united in the common goal of providing support to teachers of all subjects, to guide student learning consistent with the principles and values of sustainable development.

This multitude of actions and initiatives in the field can be clustered into two main lines of work. The first focuses on the greening of operations and internal organizational management and seeks to transform HEIs into efficient organizations governed by the principles and values of sustainability, while at the same time becoming suitable learning contexts to facilitate education for sustainable development (ESD) (Brinkhurst et al 2011; Chambers and Walker 2016; Hoover and Harder 2015; Lee and Schaltegger 2014; Wright and Wilton 2012; Wright 2010;

Santini et al. 2016; Schmitt Figueiro and Raufflet 2015). The second line of work is focused on changes to the curriculum, seeking innovation of both content and teaching methodologies, and guiding learning achievements consistent with the requirements of sustainable development, i.e. promoting ESD by developing "curricular sustainability" (Barth 2015; Barth and Rieckmann 2012; Aznar et al. 2011; La Harpe and Thomas 2009; Junyent and Geli de Ciurana 2008; Barth et al. 2007; among others).

Taking sustainability as a criterion of higher education quality requires HEIs to advance on both fronts, adopting strategies for change both in organizational management and in the design and implementation of educational initiatives aiming to provide students with the necessary skills for sustainable development. This is required when viewing the overall quality of the organization from a systemic perspective. But for that, and as a first strategy, it is important to carry out an improvement–oriented evaluation of an organization's current status.

It is this perspective that frames the research presented below. Our focus is on Hull University Business School (HUBS), an internationally recognized HE Business School with multiple accreditations (e.g. AACSB, AMBA). The objective of the research is to analyze the teaching practice of lecturers in the light of the recommendations issued by HE quality bodies and accreditation agencies, within the framework of ESD. To do so, the viewpoints of the lecturers will be analysed, using as data their own perceptions on their professional practice in significant aspects of university teaching. Our aim is to identify any possible weaknesses in current teaching practice from a sustainability perspective that could be addressed through future institutional strategies. The results could contribute to the quality of HE by analyzing a key element underpinning the success of any improvement processes for curricular sustainability, namely, the teaching practice of lecturers.

These processes are a central pillar for the transformation of universities into active agents supporting the consolidation of sustainable societies. They consist of the explicit inclusion of principles, values and contents of sustainability into courses and curricula, not only in the design phase but also in their implementation and evaluation. They, therefore, require the active commitment of lecturers to sustainability and adherence in their teaching practice to the ESD model (UNESCO 2015) at epistemological but also axiological and procedural levels. Achieving this is one of the priorities being pursued by international educational bodies and fora promoting ESD (UNECE 2013; UNESCO 2014a, b).

2 Context-Hull University Business School and Sustainable Development

Like most HEIs in the UK, HUBS needs to take note of the call that the Higher Education Funding Council for England (HEFCE) and the Higher Education Academy have been doing for more than a decade for the development of sustainability literacy in graduates (e.g. HEFCE 2008, 2009, 2014a, b; HEA 2014).

This appeal has been reaffirmed in the latest version of its policy for sustainable development in HE, that recognized sustainable development as one of the major challenges facing society, and that the HE sector had a unique position in society to address it. However, its supporting consultation document also identified that curriculum is "the area where most work was needed", with the following presented as a common view in the sector:

> the integration of sustainability into courses has not been very widespread. Whilst many modules are being developed that consider sustainability issues, they are often bolted on to courses that have changed little for many years. Instead of sustainability being a separate module, a reconsideration of all aspects of courses is needed to change the emphasis towards the requirements of the new ways in which things must be done. However, we recognise that this is not an insignificant task. (HEFCE 2014a, p. 2)

HEFCE adopts as basic principles the following: to live within the limits of nature; ensure a strong, healthy and just society; achieve a sustainable economy; use science responsibly and promote good governance. All of these are in turn explicitly characteristic of a sustainability focus. To support this vision, for more than three decades HEFCE has included among its strategies the funding of projects and dissemination of good practice in education for sustainability (e.g. Tilbury and Ryan 2012).

In the case of the University of Hull, its commitment to and interpretation of ESD is expressed by an explicit institutional vision and provision of supporting resources that aim to give:

> guidance on the incorporation of sustainability awareness in the curriculum across all disciplines (…) (and raise) awareness among students about sustainable development and providing them with opportunities to develop the knowledge and skills to engage in critical debate about the issues. (University of Hull 2016a)

At Hull policies and decisions on sustainable development are covered under two main internal documents: the University of Hull Strategic Plan 2016–2020, and the University of Hull Learning, Teaching and Student Experience Strategy 2012–2015. In the former, quality and sustainability are directly linked, with the text declaring explicitly that, "Excellence, empowerment and sustainability are the common threads which unite our vision, mission, strategic intent and priorities" (University of Hull 2016b, p. 5). The latter document identifies the following strategic objectives as part of the organization's curriculum reform efforts:

> Engaging our students with topics such as social justice, social regeneration, environmental sustainability and global economies will provide them with 'an appreciation for interdisciplinary approaches to understanding the challenges and issues of the 21st century. (University of Hull 2012, p. 6)

> We will develop a comprehensive skills framework and (…) global perspectives on contemporary issues, such as sustainable development, will be key features of our framework. (University of Hull 2012, p. 7)

Furthermore, the commitments of those strategies were developed taking into account the views of:

- the international Agenda of priorities as identified by the UN and UNESCO.
- the government's strategy for SD.
- employers [or the graduate profile this demand according to reports from institutions such as the Department for Innovation, Universities and Skills (QAA 2016); Learning and Skills Council; and Higher Education Academy (Drayson 2015a)].
- students [that increasingly demand this type of skills, as per a report of the Higher Education Academy (Drayson 2015b)].
- research funding bodies (that use ethical criteria and of environmental impact for project funding decisions).
- professional accreditation funding bodies (with some including SD criteria for course accreditation[1]).

The institutional context described seems therefore to offer a favourable opportunity for HUBS to transition towards sustainability. Therefore, at this point, the question is if (and how much) receptiveness there might be among lecturers to use this opportunity to trigger the curriculum changes that sustainability education would demand. The answer to this question could be positive if support is found to the hypothesis of this research, that is: the teaching practice carried out is consistent with the principles and values of sustainable development. Confirmation of this hypothesis could be considered an indicator of the responsiveness of teachers to potential institutional initiatives aiming to facilitate processes of transition towards curricular sustainability, and their potential to act as change agents towards an ESD model.

3 Objectives

Taking as a starting point the hypothesis previously stated, this research aims to have an insight over the degree of coherence between the current teaching practice of lecturers of HUBS—as perceived by themselves—and teaching practice that promotes the model of ESD, as recommended by HEFCE (2008, 2009, 2014a, b) and high international agencies (UNESCO 2014a, b; UNECE 2009, 2013). Simultaneously, the research aims to link the teaching practice at HUBS with the quality standards proposed by AACSB, many of these mirroring what is equally expected in an ESD-centred model. Such convergence would be particularly interesting for HUBS, as it has a long tradition as a leading business school in Systems Thinking in the UK, so the inherent systemic values of ESD should—in principle—be expected to be more readily embedded in lecturers' teaching and practice.

[1]For instance, professional accreditation for Engineers in the UK requires these to "undertake engineering activities in a way that contributes to sustainable development" (Engineering Council 2014, p. 12).

The research was conducted during the academic year 2015–2016 and has focused attention first on the outcomes of the teaching processes; i.e. on the skills and capabilities that, in the opinion of lecturers, students have been able to acquire and are able to implement after completing their courses. In addition, it also focused on three other significant features of the teaching–learning processes: (a) approach to teaching that lecturers adopt; (b) teaching methodologies used; and (c) issues considered in the assessment of learning.

4 Methodology

This is an early stage exploratory research based on an empirical study of descriptive nature. Data were collected through a questionnaire of 35 questions using a Likert scale with 5 degrees of increasing agreement (see Annex I). The variables were established drawing from the quality standards of AACSB and taking into account the guidance and recommendations for ESD in HE provided by the UK's Quality Assurance Agency for Higher Education and the Higher Education Academy (QAA/HEA 2014). When taken together, these provide a good proxy model to assess an ESD-centred quality provision (see Annex I).

The questionnaire is divided into four sections: (A) Standard 8 of AACSB—Criteria focusing on degree programme learning goals, curriculum management and assurance of learning. (B) Standard 9 of AACSB—criteria focusing on "Curriculum Content", that should be appropriate to general expectations for the degree programme type and learning goals. (C) Standard 13 of AACSB—criteria focusing on how curricula facilitate student academic and professional engagement. (D) Standard 12 of AACSB—criteria focusing on teaching enhancement and effectiveness of faculty staff.

Given the small size of the population, all HUBS lecturers were asked to complete the questionnaire through a request endorsed by the Faculty Dean. The application of the questionnaire, which was available for two weeks, was conducted online using the Google Forms programme. Descriptive statistical analysis of the data obtained generated an overview and identification of the relative representativeness of answers for each level of the Likert scale, as well as the average score for each category analysed and in each of the four sections described above. While acknowledging the limitations of the sample, the analysis of results confirmed the relevance of embedding sustainability values in the curriculum design and practice.

5 Results

HUBS has 114 permanent lecturing staff of which 20 responded to the questionnaire (17.54% of the population). Table 1 shows the mean scores and response rates in the different gradations of the scale corresponding to each section of the questionnaire.

In the four standards of AACSB, the group means were greater than 3.5, on a scale of 5. According to the data, the way HUBS teachers perceive their teaching practice is not far from the recommendations of an ESD-centred practice. More than 50% of cases state that they "agree" or "strongly agree" with the statements of the questionnaire, and all such statements reflect types of teaching practices characteristic of an ESD model (UNESCO 2014a, b). We can, therefore, assume that the majority of survey participants are following in their practice the general guidelines of such a model.

After this first consideration of the general data, the following sections will present the results in more detail, articulated in three main sub-sections: (a) skills for sustainability acquired by students; (b) characteristics of teaching practice in line with the ESD model; (c) improvement issues as recognized by lecturers.

5.1 Competencies for Sustainability Acquired by Students

Results for these issues are offered in Table 2. About 70% of lecturers consider that their students will be able to identify and describe aspects of their respective subjects that relate to sustainable development. From this, we can infer that, in general terms, those students are literate in sustainability issues, as well as being able to establish relationships in their future practice that can lead them to make informed decisions. It is worth noting that in this block of questions there are almost no answers rated as "strong disagreement". Only in one case (item 3), 5% of lecturers considered that students at the end of their programmes would not be sufficiently equipped to clarify their own views on ways that sustainability can be achieved in different communities. In the remaining 14 questions that range of the scale has received no responses.

Table 1 Global data

Question number	Average valuation (1–5)	Strongly disagree (%)	Disagree (%)	Neutral/ undecided (%)	Agree (%)	Strongly agree (%)
Standard 8	3.6	1.0	18.0	22.0	38.0	21.0
Standard 9	3.6	0.0	17.3	29.6	32.2	21.0
Standard 13	3.7	6.5	17.1	16.9	23.5	36.0
Standard 12	3.7	2.5	7.5	35.0	26.3	28.8

Table 2 Lecturers' opinions on students' sustainability literacy

Question	Average rating	1. Strongly disagree (%)	2. Disagree (%)	3. Neutral/ undecided (%)	4. Agree (%)	5. Strongly agree (%)
1	3.7	0	20	15	40	25
2	3.5	0	20	30	30	20
3	3.6	5	10	25	40	20
4	3.5	0	25	20	35	20
5	3.7	0	15	20	45	20
6	3.9	0	10	20	40	30
7	3.8	0	11	32	26	32
8	3.5	0	16	32	42	10
9	3.7	0	15	25	40	20
10	3.1	0	30	40	25	5
11	3.3	0	20	45	25	10
12	3.8	0	15	20	35	30
13	3.3	0	30	30	20	20
14	3.8	0	10	26	32	32
15	3.6	0	16	26	37	21

In the set of questions regarding sustainability competencies, the answers to items 6, 7, 12 and 14 are particularly noteworthy, with 30% of lecturers having the highest degree of agreement on the influence the teaching practices in their respective modules in promoting students' ability to: (a) describe how aspects of the discipline relate to sustainable development; (b) identify local and global interrelationships between economic, environmental and social systems; (c) understand that economic growth can lead to positive or negative environmental changes; and (d) critically assess and analyze sustainability issues, including real-life examples, within the context of their own discipline or profession.

Similarly, 40% of the lecturers participating in the survey stated their agreement to items 1, 3, 5, 6, 8 and 9. This means they recognize the ability of their students to think systemically, recognize connections and interactions between factors, understand that actions have multiple consequences, and the need to make decisions on natural resources not only on economic criteria but also ecological and social. They also consider students are generally able to discuss issues of SD in interdisciplinary professional contexts, communicate orally and in writing complex problems of sustainability and explain how their module can contribute to SD.

5.2 Characteristics of the Teaching Practice According to the ESD Model

Data relating to lecturers' teaching practice is shown in Table 3. Three main aspects are covered: the approach to teaching that lecturers adopt in their practice, specific teaching methods and assessment approaches.

Regarding the approach to teaching (items 16–20), the positioning of the respondents is very emphatic. The 70% of respondents strongly agree that their educational activities are linked to problems of real life, and half of the respondents say that they promote participatory learning approaches and encourage dialogue among divergent views. To a lesser extent, but still, with a high agreement score, 40% of lecturers declared that in their subjects there are strong opportunities for deep reflection and debate.

Regarding specific methodologies used in teaching processes (items 21–28), "stimulus activities" is the item showing a higher percentage of "strong agreement" (45%), followed by "case studies" with 40%. These results are very consistent with the strong use of teaching approaches oriented towards real-life problems, as reflected in responses to item 20 above.

Finally, regarding assessment approaches (items 29–32), 85% of lecturers state that they require students to apply critical thinking and problem-solving skills. And 75% use assessment approaches that require the application of such skills for solving practical problems. 40% of respondents attributed the highest level of

Table 3 Lecturers' opinions on their own teaching practice

Question	Average rating	1. Strongly disagree (%)	2. Disagree (%)	3. Neutral/ undecided (%)	4. Agree (%)	5. Strongly agree (%)
16	4.2	5	5	10	25	55
17	3.9	5	5	25	25	40
18	4.2	0	15	5	30	50
19	3.7	5	15	15	35	30
20	4.3	5	5	15	5	70
21	3.9	0	20	15	25	40
22	3.9	0	20	20	15	45
23	3.4	0	37	11	26	26
24	3.5	12	18	12	29	29
25	2.8	11	33	33	11	11
26	3.6	5	25	10	30	30
27	2.2	47	16	11	21	5
28	2.8	11	42	11	26	11
29	4.2	0	5	10	45	40
30	4.2	5	0	20	25	50
31	3.8	0	15	35	10	40
32	3.8	0	15	30	15	40

Table 4 Training needs recognized by lecturers

Question	Average rating	1. Strongly disagree (%)	2. Disagree (%)	3. Neutral/ undecided (%)	4. Agree (%)	5. Strongly agree (%)
32	3.8	0	15	30	15	40
33	3.6	0	5	50	25	20
34	3.7	0	5	45	30	20
35	3.9	0	10	30	25	35

agreement to the use of peer evaluation and activities that encourage learning in the domains of values, attitudes and behaviours.

5.3 Areas of Improvement Recognized by Lecturers

When asked about aspects where they would welcome additional institutional support to improve their teaching practice, as seen in Table 4, 45% or more of respondents either "agree" or "strongly agree" with all points asked.

Notably, the majority of the group (55%) acknowledge needing support to embed in their modules ESD-focused content, knowledge and skills, in other words, the basis of the process that aims to achieve curricular sustainability of modules and programmes. And, likewise, a majority (60%) of lecturers states their interest in receiving training on ESD teaching enhancement and development activities.

When asked whether HUBS should provide such training, exactly half of teachers (50%) were in favour of it, and a somewhat lower percentage (45%) considered needing support to use experiential learning pedagogical approaches for ESD teaching.

6 Discussion

The participation in the survey of only 17.54% of teaching staff does not allow for a categorical confirmation of the hypothesis of this research, nor is it possible to consider the results conclusive or generalize the findings. However, without denying the existence of other possible influencing factors, and in the context of the exploratory nature of this research, we can interpret this level of participation as an indication of the degree of interest in the subject among lecturers at HUBS. From this perspective, the data suggests the institutional need to more strongly encouraging teaching staff to embrace the role of "change agents for sustainability", as educators of future professionals and citizens.

On the other hand, those subjects that have participated in the study did show a good degree of involvement with the ESD model. From the responses of how they themselves perceive their teaching practice, virtually all items asked had response

averages close to level 4 of our 5-point Likert scales. Such good practice can be considered to be overall consistent with the features that experts attribute to the type of education that allows the development of citizens committed to sustainability. Therefore, we can consider that the group of lecturers who participated in this research includes an initial seed or core that may be predisposed to be motivated by the institution to develop a network of teaching innovation, and take part in dynamics of collective learning oriented towards the curricular sustainability of programmes at HUBS.

Considering the questionnaire as a whole, the highest correspondence between teaching practice and the model of ESD is in the responses to items 16, 18, 20, 29 and 30 (with an overall "agreement" average above 4). The topics in which HUBS performs best according to lecturers are the following: teaching and learning activities linked to real-life concerns (issue 20), exploration of divergent views in a safe environment (issue 16), democratic and participatory learning approaches (issue 18), provision of formative tasks that enable the development of critical thinking and problem-solving (issue 29), and opportunities to apply these skills to real-world problems (issue 30). All of these issues correspond to Standard 13 of AACSB criteria, which focuses on how curricula facilitate student academic and professional engagement. These results can be considered consistent with the background on systems thinking research underlying much of HUBS' research tradition, and it is possible that there is a level of mutual-influencing happening between research and teaching interests from staff. The responses reveal the strengths of HUBS' lecturers from an ESD perspective, so these aspects could serve as levers to energize a systematic institutional process of transformation of subjects towards curricular sustainability. For instance, the dominance that lecturers have on ESD teaching methods could be used to concentrate the focus of innovation in other weaker aspects impacting staff's interest in curricular sustainability.

Also, some of the items in the section on teaching methodologies exhibit the greatest divergence between the teaching practice of research participants and the model of ESD. Namely, questions 25, 27 and 28 have average "agreement" scores below 3 points. The topics in which HUBS could improve more according to respondents are the following: use of service learning (issue 27), use of place-based learning (issue 25) and use of fieldwork and action research (issue 28). All of these issues correspond to Standard 13 of AACSB criteria, which focuses on how curricula facilitate student academic and professional engagement. Given these identified weaknesses, they could be addressed as areas for improvement within a possible systematic plan for teacher training, within a larger institutional framework of promoting processes for curricular sustainability.

With regards to the acquisition by students of skills and competencies for sustainable development, only 30% of lecturers "strongly agreed" with the influence of their respective modules to achieve these educational achievements. This fact allows inferring that, even though some degree of sustainability literacy was produced, the training needs persist. Therefore, there should be a further strengthening of processes of learning and teaching, so that ESD aims can reach the entire student

population; but this should be done with a level of commitment that can ensure an effective diffusion of training quality goals and achievements.

Finally, lecturers recognized their training needs in ESD and seemed particularly concerned about methodological aspects. A large group of teachers would welcome training on such aspects, provided by the institution.

7 Conclusion

In summary, we can highlight three main conclusions from this research and the results discussed above:

(i) In HUBS, there is a body of lecturers with teaching practices consistent and coherent with the ESD model, but teaching methodologies is an area that needs further strengthening to increase such coherence.
(ii) There is room—and need—at HUBS to stress the relative importance of sustainability as a framework to frame for students' acquisition of life-long skills and competencies.
(iii) Processes of "curricular sustainability" at HUBS are already under way. The School appears to have a group of pioneering teachers who could be further incentivized by an institutional strategy that promotes change and could actively contribute to the diffusion of such processes.

Ultimately, this research confirms that a window of opportunity is open that, if taken advantage of, could trigger institutional processes of curricular sustainability and boost HUBS' transition towards sustainable development. Nonetheless, there are obvious limitations of the study and analysis, stemming from the low response rates. A longitudinal multi-year research approach tied to quality processes of continuous improvement would provide a useful complement to the data presented here and allow the opportunity to further refine the research instruments. In future research, it would also be recommendable not only to increase the sample size but also to complement the research with qualitative approaches, e.g. interviews or focus groups. We believe this research also offers a case study that could be replicated in other universities aiming at similar goals.

Annex I

Faculty Survey

The AACSB Accreditation Standards recognize in their Preamble that "society is increasingly demanding that companies become more accountable for their actions, exhibit a greater sense of social responsibility, and embrace more sustainable

practices", and that business schools must respond to it and "hold themselves accountable for improving business practice" (AACSB 2016, p. 3). Therefore, one of the core eligibility criteria for AACSB is that:

> The school must demonstrate a commitment to address, engage, and respond to current and emerging corporate social responsibility issues (e.g. diversity, sustainable development, environmental sustainability and globalization of economic activity across cultures) through its policies, procedures, curricula, research, and/or outreach activities. (Criterion C, AACSB 2016, p. 9)

The Standards go on to set a range of criteria and recommendations on how such commitments can be pursued and evidenced.

At the UK level, the QAA and HEA have also released guidance for higher education providers for incorporation of "Education for Sustainable Development" within the curricula (QAA/HEA 2014), that can support the aims above.

This questionnaire will focus only on the curricular dimension of this agenda in HUBS. It aims to provide a first reflective opportunity of the degree to which some aspects of our curricula and teaching practices, as perceived by lecturers, meet the AACSB and QAA guidance on this matter. It is hoped that its results can also inform future practice and guidance at HUBS.

Notes:

> This is an anonymous questionnaire. Please ensure that you do not write your name, or any other comments that will make you identifiable. By completing the questionnaire you are consenting to take part in this research.
>
> This questionnaire is part of a research by Dra. Maria Angeles Murga Menoyo, of the Spanish National University for Distance Education (eq. to the UK Open University), and currently a guest researcher at HUBS. The research focus on "Universities in transition towards sustainability: systemic analysis of the processes of network creation and operative proposal formulation applicable to the Spanish context".
>
> This work has also the collaboration of Dr. Angela Espinosa and Dr. Fernando Correia from HUBS. If you have any queries on the questionnaire or research please contact Prof. Murga-Menoyo at M.Murga-Menoyo@hull.ac.uk.

Standard 8 of AACSB criteria focuses on degree programme learning goals, curricula management and assurance of learning.

For assurance of learning purposes, AACSB accreditation is concerned with broad, programme-level focused learning goals for each degree programme, and these should derive from and be consonant with the school's mission, expected outcomes and strategies.

The School's Learning & Teaching Vision is:

> To provide managers, at all stages of their career, with an excellent educational experience that inspires them to be responsible leaders in a complex world.

The QAA definition of "education for sustainable development" provides one way of interpreting such Vision:

> The process of equipping students with the knowledge and understanding, skills and attributes needed to work and live in a way that safeguards environmental, social and economic wellbeing, both in the present and for future generations.

With these in mind, and thinking about the **programmes you contribute to**, do you think that at the end of the programme students will be equipped to:

1. Understand the need for decisions about natural resources to involve judgements not just about economic viability but about risks to future ecological, social or cultural wellbeing.
2. Understand the interconnections between the activities of different generations, demographic groups and cultures, and recognizing that there may be tensions and competing factors among them.
3. Clarify their own views on ways that sustainability can be achieved in different local and global communities and circumstances
4. Employ leadership for sustainable development by challenging assumptions and negotiating alternatives to unsustainable current practices, especially within their own discipline or area of study.
5. Engage in interdisciplinary discussion in their professional lives to inform their thinking about sustainable futures and seek holistic, creative solutions to problems

Other comments?

Standard 9 of AACSB criteria focuses on "Curriculum Content", that should be appropriate to general expectations for the degree programme type and learning goals.

For AACSB, all general management and specialist degree programmes at the bachelor's, master's and doctoral level would normally include learning experiences that address the following knowledge and skills areas (amongst others):

- Social responsibility, including sustainability, and ethical behaviour and approaches to management
- Ethical understanding and reasoning (able to identify ethical issues and address the issues in a socially responsible manner)
- Reflective thinking (able to understand oneself in the context of society)

Thinking about the **content of your modules** in terms of knowledge and skills, to what extent do you think **students of your module(s)** will be able to do the following:

6. Describe how aspects of their own discipline or area of study contributes to sustainable development.
7. Describe the relationships between environmental, social and economic systems, from local to global level
8. Describe complex sustainability issues in clear terms and communicate about them effectively and succinctly, both orally and in writing

9. Think systemically, in terms of recognizing connections and interactions between factors, and understand that actions often have multiple consequences.
10. Identify the interactions between human communities and ecological systems and the potential impacts upon each other.
11. Identify the root causes of unsustainable development, including environmental, social and economic actions, and the links to cultural considerations
12. Identify that positive or negative environmental change may arise from economic growth
13. Demonstrate that both unsustainable and sustainable practices take place in an evolving context, necessitating adaptability in policy and planning responses
14. Critically assess and analyze sustainability issues that need to be addressed, including real-life examples, within the context of their own discipline, area of study or profession
15. Tackle and negotiate sustainable development conflicts with an awareness of different perspectives and motivations

Other comments?

Standard 13 of AACSB criteria focuses on how curricula facilitate student academic and professional engagement.

Under this standard, for any teaching and learning model employed, degree programme curricula should include approaches that actively engage students in learning through experiential learning opportunities. Recommended pedagogical approaches suitable for challenging students in this way include problem-based learning, projects, simulations, etc. These also mirror the QAA/HEA recommendations on pedagogical approaches for sustainability education.

In the modules you teach:

16. Divergent views can be shared and explored in a safe environment
17. There are opportunities for deep and critical reflection on students' own perspectives and what has influenced their thinking and practices in this area
18. Democratic and participatory learning approaches are promoted
19. Interdisciplinary approaches, systems thinking and holistic thinking are encouraged
20. Teaching, learning and assessment activities are linked to real-life concerns.

In your teaching, to what extent to you use:

21. *Case studies*—real-life examples of sustainable development issues—from local to global—and how these have been, or might be, addressed.
22. *Stimulus activities* provision of prompts -such as a quotation, newspaper article, poem, artwork, etc. to stimulate discussion or reflection on a sustainability topic.
23. *Simulation* simulates real-life situations and encourage students to participate. Such activities can include role-plays, debating, mock trials and gaming.

24. *Experiential project work*—Practical learning by experiencing real situations. (Example: learn to cook by cooking.)
25. *Place-based learning*—students work in collaboration with local stakeholders to define a problem, using local knowledge, and jointly devising and implementing solutions.
26. *Problem-based learning*—providing opportunities for student-led, collaborative work which can be focused on a real-world problem or issue.
27. *Service learning*—a method of teaching that combines classroom instruction with meaningful community service
28. *Fieldwork and action research*—providing opportunities for learning through direct, concrete experiences, enhancing the understanding that comes from observing or participating in "real-world" manifestations of theoretical concepts and processes.

Your assessment includes…

29. Formative tasks that enable the development of critical thinking and problem-solving
30. Opportunities to apply these skills to real-world problems
31. Activities that encourage affective learning in the domains of values, attitudes and behaviours.
32. Peer contributions.

Other comments?

Standard 12 of AACSB criteria focuses on teaching enhancement and effectiveness of faculty staff.

Under this standard, the School should develop activities focused on teaching enhancement to all faculty with teaching responsibilities.

Thinking about the subject of this survey (education for sustainable development—ESD), do you feel you need support to:

33. Embed ESD in your modules in terms of contents, knowledge and skills?
34. Use experiential learning pedagogical approaches for ESD teaching, as recommended by QAA?
35. Do you think the School should provide ESD teaching enhancement and development activities for its teaching staff?
36. Would you be interested in attending any ESD teaching enhancement and development activities?

Other comments?

Thank you very much

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From Education for Sustainable Development to Education for Environmental Sustainability: Reconnecting the Disconnected SDGs

Mohamed Walid and Johannes M. Luetz

Abstract

Education and environmental sustainability are issues of great importance. Both are intertwined and cannot be meaningfully discussed in isolation. Nevertheless, it is education that serves the cause towards environmental sustainability. This would suggest that education in itself is incomplete if it fails to firmly integrate environmental sustainability within its agenda. A closer look at the SDGs suggests that the notion of environmental sustainability is not expressly integrated within Goal 4 on education ("Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all"). While numerous points elaborate the individual targets, SDG Goal 4 makes no single explicit reference to any concern related to environmental sustainability. This raises a number of important questions. If environmental sustainability is not even embedded within the goal, can education be expected to deliver environmental sustainability outcomes? Do the SDGs, in aiming for "sustainable development", predominantly refer to economic development, merely sustained over time and space? Are policy makers and development professionals in danger of inadvertently divorcing the inalienable union that education has with environmental sustainability? Is the sustainable development agenda risking diluting the fundamental basis—environmental sustainability—upon which it was originally articulated (Brundtland Report in Report of the World Commission on Environment and Development: Our common future 1987)? These are enquiries the research addresses. This paper is informed by an analysis of expert literature,

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including a systematic keyword search, and field research conducted in Bangladesh.

Keywords
Environmental sustainability · Sustainable development · Environmental education · Behavioural change

1 Introduction

Education and environmental sustainability are strongly bound to each other by a cause–effect relationship, whereby the former is typically understood to lead to the latter (Howe 2009). In this sequence, education serves as a means towards reaching environmental sustainability ends. While in theory, this may seem to be a plausible and logical induction, in practice it proves to be a much more unstable relationship.

Recent decades have seen a gradual shift in emphasis from environmental sustainability (ES) to sustainable development (SD). This new focus on SD with its triple bottom line approach to harnessing well-being, encapsulating (1) economic; (2) societal/social; and (3) environmental pillars, increasingly obscured the causal relationship that education has with ES or SD at large. This shift could be explained at the macro level in light of the split among economists between those favouring mainstream neoclassical economic model and those believing in ecological economic modelling. The former begets environmental economics with its consequent reliance on technology and modern means to lead to economic development with a sensibility to issues of sustainability vis-à-vis ecological economics with its stronger emphasis on the question of how to maintain sustainability.

While economic and concomitant social outcomes led by technological advancements are understandably attractive contemporary measures of modern quality education in both international and national arenas, particularly with respect to gender balance (Sachs 2012; Kates et al. 2005), they should by no means justify a progressively diminishing emphasis on environmental issues.

The result of this shift of focus and the consequent ambiguity it inflicted upon the environmental dimension gave birth to two models of education for sustainable future at large. One is dubbed environmental education (EE), and the other is an education for sustainable development (ESD). The relationship between both models of education has been the focus of discussion in the literature (e.g. Cartea 2005; UNESCO 2009). This debate about whether EE is part of ESD or not has been quite strong (Pavlova 2011). The coexistence of both models of education to address environmental concerns reflects the main assumption of this study, namely that the value of the "environment" in the realm of sustainability has weakened or at least become more ambiguous with respect to its influence on sustainability,

particularly since its integration as one of the three pillars of SD with its two other pillars (economy and society).

This paper is organised into seven sections. Section 2 introduces methodological approaches and analytical considerations. Section 3 then reviews relevant literature and offers a broad chronological discourse on the evolution of environmental education, including the gradual shift from ES to SD. It also highlights important implications that this shift in focus has had on environmental education. Section 4 then follows this same path more narrowly by taking a closer comparative look at both the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs) with respect to environmental sustainability education.[1] Section 5 reports the main findings of this study and offers an analytical discussion of questions raised in the abstract with their relevant implications on education. This section also proposes and introduces a new conceptual model that integrates multiple modalities of education, incorporating *Formal, Informal and Non-formal Education for Environmental Sustainability (FINEES)* as a means of reinvigorating a more holistic focus on education that encapsulates both SD and ES. Section 6 applies the FINEES model to Bangladesh as a naturalistic case example of the theory in practice. This is followed by Sect. 7, which offers a concluding synthesis of the paper's main points, as well as a shortlist of recommendations for policy makers.

2 Methodological Approaches and Research Limitations

This research paper is based on a review of the expert literature, particularly policy-related documents. It leans towards a deductive approach in testing the theory and hypothesis that the influence and weight of the "environment" on notions of sustainability have had an overall diminishing role in education, progressively weakening across much of the global political landscape from ES to SD.

Quantitative data used in this paper are derived from a systematic keyword search that queried UN policy documents for search words of interest, including ES and SD. This keyword search is limited in scope to all 23 English languages UN Human Development Reports (HDRs) published to date (from 1990 to 2015). These reports were chosen because of their global influence and appeal.[2] Such focus could also be viewed as a limitation. The justification to limited focus on the HDRs, however, is the global view the paper attempted to take in order to construct a general universal model that could be appraised and applied in different contexts.

To construct its model, the paper was informed by the systems-thinking approach used in management discipline to scrutinise the different components, the linkages and interactions between those components (Cabrera et al. 2008). Here, the

[1]Millennium Development Goals (MDGs 2000–2015) http://www.un.org/millenniumgoals/ and Sustainable Development Goals (SDGs 2015–2030) http://www.un.org/sustainabledevelopment/sustainable-development-goals/.

[2]UN HDRs were accessed online at http://hdr.undp.org/en/global-reports.

systems looked into are primarily ES and SD. As a process-based system, education is used as the mediator variable that explains or rationalises the space of interaction between the system of ES first (as the predecessor of sustainability with a unique emphasis on environmental issues), and SD second (as the successor and mega-system with its three pillars—economy, society and environment). Education as a system was classified into three categories ranging from formal to informal and non-formal.

This study is also informed by Ph.D. research conducted in Bangladesh in November and December 2011.[3] The detailed method of data collection is available as Chapter "Corporate sustainable strategies in Dom Pedro I industrial road axis, São Paulo, Brazil" in the unabridged Bangladesh case study (Luetz 2013, Sect. 5.3) and also elaborated in similar case study research (Luetz 2017).

3 Broad Chronology on the Evolution of Environmental Education (EE)

Environmental education (EE) is not a matter of contemporary discussion only; it can be traced back in time. The field is quite rich with a tumultuous history (Carter and Simmons 2010). From as early as the eighteenth century, it has been ingrained in political philosophy of the Enlightenment thinker Jean-Jacques Rousseau (1712–1778), who both inspired early forms of environmentalism (LaFreniere 1990), and also emphasised the value of education as long as it revolves around the environment and away from the gated communities (Gianoutsos 2006). A few years later this foray into early forms of EE was followed by the Swiss naturalist Louis Agassiz (1807–1873), who is known to have encouraged students to "study nature, not books" (McCrea 2006).

Leaping forward in time for another major juncture for EE, in 1970 the world celebrated the first Earth Day on April 22nd (Earth Day Network 2016). The event invited the world to "hold hands" for environmental issues. In 1971 the North American Association for Environmental Education (NAAEE) was instituted to promote environmental literacy through EE programmes (Disinger, McCrea and Wicks 2001). In 1972 came the United Nations Conference on Human Environment, which was held in Stockholm. The Conference deliberated the role of education for ES. It is worth mentioning that education and its relation to ES were referred to in the declaration of the Conference two times (UNEP 1972), articulated under Principle 19:

> Education in environmental matters, for the younger generation as well as adults, giving due consideration to the underprivileged, is essential in order to broaden the basis for an enlightened opinion and responsible conduct by individuals, enterprises and communities in protecting and improving the environment in its full human dimension. It is also essential that mass media of communications avoid contributing to the deterioration of the environment, but, on the contrary, disseminates information of an educational nature on the

[3] A short background video to the Bangladesh field research was published by UNSW Australia on 18 February 2015 and may be accessed at https://youtu.be/PBJeelgnadU.

> need to project and improve the environment in order to enable mal (sic) to develop in every respect.

With respect to higher education formal establishments, Principle 20 (below) emphasised the importance of stimulating scientific research in order to address environmental challenges:

> Scientific research and development in the context of environmental problems, both national and multinational, must be promoted in all countries, especially the developing countries. In this connection, the free flow of up-to-date scientific information and transfer of experience must be supported and assisted, to facilitate the solution of environmental problems; environmental technologies should be made available to developing countries on terms which would encourage their wide dissemination without constituting an economic burden on the developing countries.

The Stockholm Declaration also found that environmental problems arose from basic human needs, including education, not being adequately met. Textual analysis of the declaration further shows that while education was clearly identified as a driver for environmental preservation, its spatial focus was predominantly applied to developing countries. In this context, the Stockholm Conference appears to have set the tone for an overall limiting application of EE, with its scope being narrowed from the "whole world" to "developing countries". This can be seen in Paragraph 4 of the declaration:

> In the developing countries most of the environmental problems are caused by under-development. Millions continue to live far below the minimum levels required for a decent human existence, deprived of adequate food and clothing, shelter and education, health and sanitation. Therefore, the developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment. For the same purpose, the industrialized countries should make efforts to reduce the gap themselves and the developing countries. In the industrialized countries, environmental problems are generally related to industrialization and technological development.

A similar critique that may be drawn from the declaration is the further limiting connotation of environment as "human environment", as can be inferred from the opening introductory paragraph, which delineates the purpose of the Conference: "to inspire and guide the people of the world in the preservation and enhancement of the *human environment*" (emphasis added). This limitation goes against the broadness of what the environment as a term could incorporate. It also misses out on the extent to which human environment is affected directly or indirectly by other non-human environments.

Fountaining from the Stockholm Declaration, the United Nations Education Scientific and Cultural Organization (UNESCO) and the United Nations Environment Program (UNEP) generated two other major declarations that further paved the path for EE. These were the Belgrade Charter (1975) and the Tbilisi Declaration (1977). The Belgrade Charter was the first credited for introducing informal education to promote the EE among the general population. The Tbilisi Declaration then rectified what the Stockholm Declaration narrowly and strictly defined, i.e. it amended and re-enlarged the concept of environment back again from merely

"human environment" to "world environment". This can be inferred from Paragraph three:

> The declaration noted the unanimous accord in the important role of environmental education in the preservation and improvement of the world's environment, as well as in the sound and balanced development of the world's communities.

Furthermore, the Tbilisi Accord (1977) was a leading universal agreement in setting guiding principles for EE at all governance levels – local, national, regional and international and for all age groups inside and outside formal education settings. The Tbilisi Declaration also endorsed five key objectives for EE (ibid): (1) helping people at individual and societal level by raising their awareness respecting environmental challenges; (2) promoting applied knowledge about the environment and its associated problems; (3) instilling positive attitudinal change among individuals to actively participate in improving the conditions around their environments; (4) enhancing skills that are conducive to solving environmental issues; and lastly (5) forging active participation at all levels among individuals and groups to discuss and propose resolutions for the environment.

This paper uses the definition of EE as set by the Tbilisi Declaration (1977, I. 2.):

> Environmental education is the result of the reorientation and dovetailing of different disciplines and educational experiences which facilitate an integrated perception of the problems of the environment, enabling more rational actions capable of meeting social needs to be taken.

Henceforth, education has remained one of the strongest and most logical instruments, with which to encourage and support ES.

Education is often seen as a means to an end, in which the desired result—heightened awareness—ultimately supports positive behavioural change. Within the context of education, ES could be considered as the end—a desired outcome that is attained through empowering individual and societal actions towards preserving the environment. Environment referred to here broadly encompasses any ecological system, ranging from human habitats in urban settings to natural areas in rural contexts, irrespective of whether these areas sustain mammalian life, including that of humans.

3.1 From ES to SD: Implications on Education

Having sketched a broad chronology on the origins of EE, the paper now turns to address the progressive shift from ES to SD, and how this shift in emphasis impacted EE.

The buzzword "sustainable development" was born with the Brundtland Report (1987) and then taken and incorporated in the subsequent Rio Declaration (1992) with its Agenda 21. The widespread appeal of the Brundtland Report arises from its dramatically expanded concept of sustainability, which was far more broadly applied to numerous future development related concerns. The report is probably

most famously remembered for coining the following definition of SD: "Sustainable Development—Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report 1987, p. 16).[4] Agenda 21 added to this broadening view, both by elucidating the concept of SD and by embellishing the goals of SD. It stressed the necessity of balancing environmental, societal and economic considerations to improve the quality of life while also protecting the environment. Moreover, Chapter 36 of Agenda 21 also focused on "reorienting education towards sustainable development" (United Nations Conference on Environment and Development 1992).

This broadening definitional understanding had a very important consequence: as the concept of SD was gaining currency among policymakers and development experts, the term ES was becoming increasingly shrouded in blurriness. The new and broadened concept of SD created a kind of competitive ground for the three pillars due to sometimes their internal separateness and in other times the submergence of one pillar due to the popularity of another. The ramification of this development is significant: while education had formerly been understood as an indispensable instrument for reaching universally agreed goals (MDGs & SDGs), education has now started to become more and more loosely attached to the term ES. This can be inferred from a reading of Agenda 21 where none of the four areas of action for education make any reference to the concept of ES:

1. Improve the quality of basic education;
2. Reorient existing education programmes to address sustainable development;
3. Develop public awareness and understanding; and
4. Provide training for all sectors of private and civil society.

Other international conferences that indirectly influenced EE include the International Conference on Environment and Society in Thessaloniki in 1997 and the 2002 World Summit on Sustainable Development in Johannesburg (NAAEE 2004).

To recap, ES was once a highly respected term until the early 1990s. As SD progressively "took over", more and more attention shifted away from a singular focus on the "environment" to a multifaceted and broadened focus on "development". That includes the inception of UNESCO's Education for Sustainable Development (ESD) in 2005, which focused education on SD, rather than on ES. Moreover, ESD came as a very important development in the quest for environmental then sustainable development and the accompanying role of education to both (UNESCO 2012). For the first time, education now had an internationally recognised programme allocated only to SD and its underlining derivative, EE. The vision of ESD is to empower people to take responsibility for shaping their future. It equips learners with skills and knowledge they need to develop the behaviours requisite to achieving SD (Wolbring and Burke 2013).

[4]For more compact reading on the evolution of sustainable development, please consult *What is Sustainable Development*, https://www.hks.harvard.edu/sustsci/ists/docs/whatisSD_env_kates_0504.pdf.

Looking into the history of SD at a glance shows that ESD ultimately came to serve the three pillars of sustainability—economy, society and the environment. Henceforth, once again, the "environment" pillar was conceptually established as one of the three pillars of sustainability rather than singularly standing out as the major pillar or cornerstone of sustainability. With that being said, it comes as no surprise that out of five fundamental types of learning ESD supports for SD only twice was the word "environment" mentioned (UNESCO 2011). The five types of learning are namely the following:

1. Learning to know;
2. Learning to be;
3. Learning to live together;
4. Learning to do; and
5. Learning to transform oneself and society.

A detailed look into the document of the aforementioned five types of learning reveals that "Environment" is mentioned only in the learning to be (2) and learning to live together (3).

Overall, what can be concluded from developments related to ES and education pertinent to it through to SD and its education; that is ESD, is the observed correlation between education as a dependent variable and sustainability as an independent variable in whichever form the latter takes: be it dubbed with a sole emphasis on environment: (ES) or approached as a three-pillar model: (SD). By extension, following on the meta-analytical study of the 37 UN System-wide flagship reports by Vladimirova and Le Blanc (2015) (Fig. 1), the study draws a statistically appropriated linear equation for the relation between education and sustainability, whereby education serves as the means to the end, namely, sustainability; and the latter would affect and alter the former's focus depending on what it emphasises: ES or SD.

$$Y = \beta 1 + \beta X + e$$

where X is the explanatory variable—that is sustainability (be the focus is on ES or SD).

And where Y is the dependent variable—that is education.

The slope of the line is $\beta 2$ and $\beta 1$ is the intercept (the value of Y when $X = 0$).

For each change in the explanatory variable—sustainability—education would alter accordingly between the sole focus on environment and the centrality of attention on SD with the environment being embedded as one of the three pillars—environment, society and economy. This statistical formula shows that in both scenarios of education, environmental issues persist; nevertheless, the extent and

SDG area	Direction*	Number of reports covering this area**	Number of causal links put forward
1	SDG 4 →SDG 1	13	4
	SDG 1 →SDG 4		2
2	SDG 4 →SDG 2	8	3
	SDG 2 →SDG 4		1
3	SDG 4 →SDG 3	18	4
	SDG 3 →SDG 4		None
5	SDG 4 → SDG 5	19	7
	SDG 5 →SDG 4		3
6	SDG 4 →SDG 6	8	1
	SDG 6 →SDG 4		4
7	SDG 4 →SDG 7	6	5
	SDG 7 →SDG 4		7
8	SDG 4 →SDG 8	21	>10
	SDG 8 →SDG 4		4
9	SDG 4 →SDG 9	10	3
	SDG 9 →SDG 4		2
10	SDG 4 →SDG 10	11	7
	SDG 10 →SDG 4		4
11	SDG 4 →SDG 11	6	1
	SDG 11 →SDG 4		2
12	SDG 4 →SDG 12	9	5
	SDG 12 →SDG 4		2
13	SDG 4 →SDG 13	9	6
	SDG 13 →SDG 4		1
14	SDG 4 →SDG 14	0	None
	SDG 14 →SDG 4		None
15	SDG 4 →SDG 15	10	3
	SDG 15 →SDG 4		3
16	SDG 4 →SDG 16	19	6
	SDG 16 →SDG 4		4
17	SDG 4 →SDG 17	19	None
	SDG 17 →SDG 4		4

Fig. 1 Adaptation from the UNDESA meta-analytical study by Vladimirova and Le Blanc (2015) on the causal link between education and the SDGs. The *arrows point* into the direction of the causal relation. SDGs pertinent to education and environmental goals in the table are: *Education*—SDG 4: quality education; *Environment*—SDG 6: clean water and sanitation, SDG 7: affordable and clean energy, SDG 13: climate action, SDG 14: life below water, SDG 15: Life on land

depth vary. The bottom line is that this research finds that currently environmental issues are tackled as an embedded factor within the broader realm of SD, rather than by means of a unique independent function of education (UNEP 2013).

4 From the MDGs to the SDGs: EE for Sustainability

Having explored the broader historical interrelationships between education and ES and SD, a glance at the SDGs tells a story of an even more deteriorating relationship between education and the environment. The SDG dedicated to education is Goal 4: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". While this goal focuses on the social and economically equitable dimensions of development in its main statement, it fails to make any specific mention of the environment. Tying this back to the three main pillars of SD, it seems that environment not only weakened in relative terms in the realm of sustainability; its position has been jeopardised in absolute terms. That is to say, whereas the two other pillars of SD (economy and society) have been clearly stipulated in the SDG 4 on education, environment as the third pillar has been left with no seat in this SDG statement on education. Nowhere in the ten targets of SDG 4 has environment been mentioned even once (Fig. 2).

By contrast, looking into the predecessor goals, namely the MDGs, it becomes obvious the stark difference between the explicit emphasis it puts on ES on the one hand in MDG 7 and the role of education within the same goal—and articulated further through the ESD, which was launched by UNESCO (UNESCO 2009). To that end, MDGs and particularly MDG 7, seem to accelerate more in terms of the clear intention it has when pinpointing to ES and the role of education. This

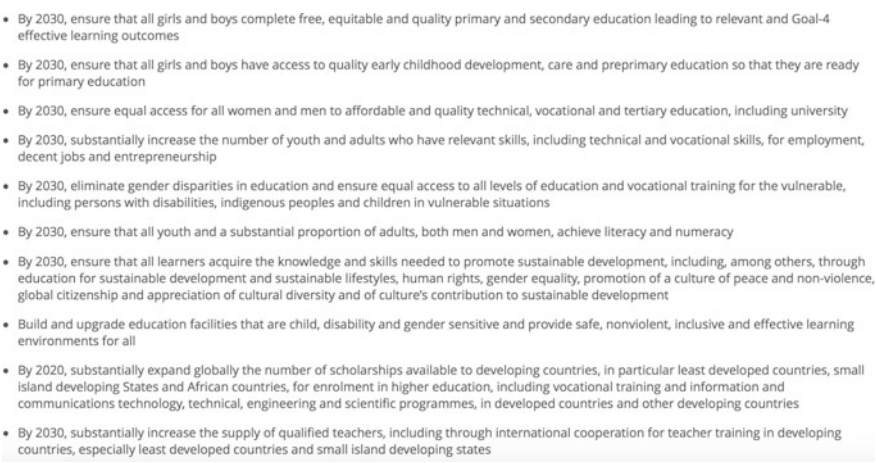

Fig. 2 Targets of SDG 4 on education, adopted from UNESCO Global Education Monitoring. Report webpage http://en.unesco.org/gem-report/sdg-goal-4

becomes even clearer when MDG 7 is directly compared to SDG 4. Whereas MDG 7 fleshed out ES, neither SDG 4 nor any other goal makes any explicit reference to education for ES or to the over-arching concept, SD.

A systematic keyword search within all 23 English languages UN Human Development Reports (HDRs) published to date reveals that the use of sustainability language consistently favours SD over ES. This may not be surprising, seeing that ever since the Brundtland Report (1987), ES has been broadly and conceptually subsumed within SD. The only clear spike in the data is in UN HDR 2003: *Millennium Development Goals: A Compact Among Nations to End Human Poverty* (Figs. 3 and 4).

Year	Human Development Reports	ES Total	SD Total	% ES/SD
1990	Concept and Measurement of Human Development	0	7	0
1991	Financing Human Development	0	11	0
1992	Global Dimensions of Human Development	1	51	2
1993	People's Participation	0	19	0
1994	New Dimensions of Human Security	1	94	1.1
1995	Gender and Human Development	2	37	5.4
1996	Economic Growth and Human Development	1	58	1.7
1997	Human Development to Eradicate Poverty	1	24	4.2
1998	Consumption for Human Development	13	94	13.8
1999	Globalization with a Human Face	4	28	14.3
2000	Human Rights and Human Development	0	15	0
2001	Making New Technologies Work for Human Development	1	23	4.3
2002	Deepening Democracy in a Fragmented World	4	25	16
2003	Millennium Development Goals: A Compact Among Nations to End Human Poverty	49	174	28.2
2004	Cultural Liberty in Today's Diverse World	2	54	3.7
2005	International cooperation at a crossroads: Aid, trade and security in an unequal world	2	64	3.1
2006	Beyond scarcity: Power, poverty and the global water crisis	16	152	10.5
2007/2008	Fighting climate change: Human solidarity in a divided world	11	151	7.3
2009	Overcoming barriers: Human mobility and development	0	13	0
2010	The Real Wealth of Nations: Pathways to Human Development	11	111	9.9
2011	Sustainability and Equity: A Better Future for All	42	279	15.1
2013	The Rise of the South: Human Progress in a Diverse World	6	72	8.3
2014	Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience	3	99	3
2015	Work for Human Development	24	245	9.8
all years	all reports considered together	194	1900	10.2 (average all years)

Fig. 3 Frequency table of UN HDRs published from 1990 to 2015. The data shows ES to be largely a subset of the political SD agenda. The only spike is the 2003 report that covered the MDGs: ES terminology represented 28.2% of all SD language used in the report

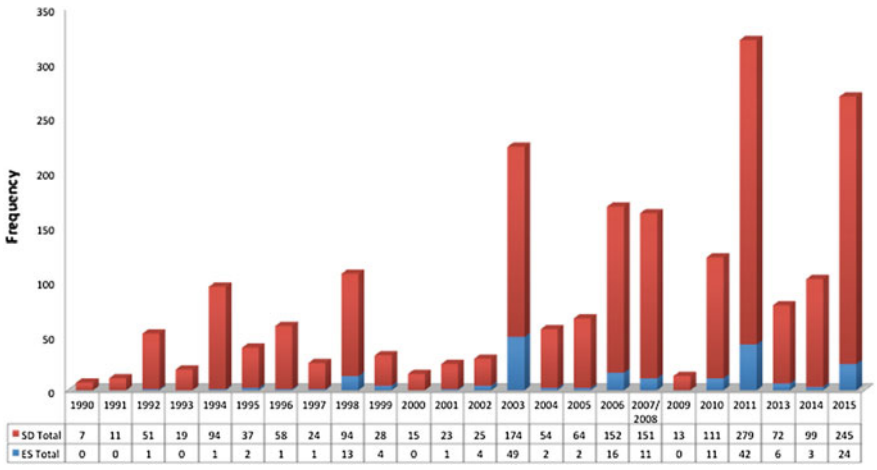

Fig. 4 Frequency graph of UN HDRs published from 1990 to 2015

The alarming theme that, however, emerges from both the MDGs and SDGs is the apparent missing synergy and interlinkages between the goal on education and the one(s) on ES (UNEP 2013). The design that informs both MDGs and SDGs in general terms seems to be an outcome/result-oriented model that lacks consideration to the drivers that lead to the desired changes those goals identified in the first place. This explains the missing link between education and ES in those universal goals on the one hand, and the neglect to mention the role of education in goal(s) pertinent to ES, on the other.

What also seems to be counter-intuitive is that the MDGs were enumerated in eight goals, whereas SDGs in 17 goals. Whilst the MDGs dedicated one goal for ES, they did not allude at any instance to education as a driver for it. Equally and oppositely, the goal on education (goal 2) targeted only universal primary education with not one target or a strand on EE within this goal. The SDGs are also surprising in the sense that being broken down into 17 goals from the original eight in the MDGs, not one of those 17 sought to make an explicit call either for education for ES, or ES in the goal related to education. This reticence to connect ES and education (in whichever form that could be) in any goal is discomforting, especially with the reality in mind that education is indispensable for achieving ES or SD at large.

5 Discussion, Analysis, Synthesis: Unifying Environmental Sustainability Education

Having sketched the history and development of EE and its transformation to education for SD, and the overall weakened position of EE under the SDGs, this study now puts forward a way in which environmental emphasis in education can get more attention, dedication and traction within the realm of SD. This would happen most reliably through connecting EE to all educational settings. By education settings, the paper refers to three setups through which education is channelled. These are: formal (e.g. universities), informal (elsewhere) and non-formal/incidental settings (e.g. natural habitat). As a main vehicle and driver for ES at the individual, institutional and societal levels, EE should be strongly streamlined in each of these educational settings.

This section elaborates on each education setting, starting with the most popular one; that is, the formal education setting, e.g. in schools and universities. Teaching dedicated to ES and represented in units and/or subjects informing students about different aspects of environmental management and climate adaptation should be mainstreamed. Adding to that, integrating and diffusing environmental issues into entire curricula (by means of activities related to environmental teaching) in subjects such as math, language, arts, etc. should be the new norm in the process of safeguarding quality control and accreditation of a subject.

Sustainability policies in formal education settings may also logically use education as an instrument for positive behavioural change. Designing those policies should occur in harmony with human behaviour and mechanisms of change

informed by behavioural sciences, particularly using the sub-fields of individual and group psychology, and theory of change.

On the lines of revamping formal education for ES, the paper advocates for environmental positive behavioural change induced from education in three waves. Each wave would allow for a natural cascade effect into the next wave. Those waves are to:

W1. Promote the notion of environmental sustainability among students;
W2. Empower students with skills and competences that enable them to change their behaviour accordingly;
W3. Encourage students to disseminate knowledge and skills on environmental protection from the fixation of simple habits pertinent to issues such as how to be efficient in using bathroom tissues through to more sophisticated issues such as the how to choose home-ware that is environment-friendly and efficient such as compact fluorescent lamps.

Since the advent of the Decade of Education for Sustainable Development (DESD) in 2005, EE has enjoyed growing popularity in formal settings around the world. Schools have been brought much closer to communities through engagement projects between them and public and private actors. Schools and universities in partnership with NGOs and the civil society have implemented EE programmes, thanks to the marriage between education and environmental sustainability resulting from the ESD. Plenty of examples are available (UNESCO 2012). Countries like the UAE, in collaboration with World Wildlife Fund (WWF), partook in EE programmes to promote environmentally aware citizenry, and have attracted the attention of thousands of students across the country (Nayar 2013). Another programme in Japan, "Youth X Change" by UNESCO and UNEP, targeted elementary schools with the aim of cultivating an environmentally prudent style of life, symbolised in choices students make in their normal daily lives. In general terms, after conducting a synthesis of practical- and expert-literature on environmental education projects and programmes since the initiation of the ESD, the focus from these programmes has been to either of the following:

1. Raise environmental awareness in daily practices; or
2. Raise environmental performance in daily choices

In this framework, EE programmes should not merely be a matter of rhetoric, i.e. being solely "environmently friendly" or dubbing an institution as such without further enhancing action-based exercises for environmental preservation. Similar to action research (Punch 2014), such engagement is more about being environmentally responsible and action-oriented by equipping students with practical life skills and competences that transform them into effective leaders, having communication and management acumen that can address environmental issues in their surroundings, be that in their home, their school, their community or in whichever context they may find themselves in.

Moving on to informal education setting, research suggests that people acquire more knowledge and skills from informal learning than formal one (Grip 2015). Furthermore, there is a global trend in which parents and students alike are increasingly dissatisfied with formal education systems. This is due to the fact that informal settings can cater for each student's needs more than systematic generalised formal education (Dib 1988). Lastly, brick and mortar formal education is simply not available in all landscapes (or to all socio-economic strata of society), whereas informal approaches can be much more flexible both in the presence and delivery of education. Hence, it makes full sense to underpin the value of EE in informal settings. After all, the reality is that to achieve 100% ES, it is a prerequisite to disseminate EE across all human and natural environments. Since the 1972 UN Conference on the Environment in Stockholm, this has been a key message. By virtue of this statement, EE could be attained provided that it fosters meaningful participation vertically and horizontally across the different segments of society (Flowers et al. 2009). And EE in informal settings is not only a matter of developing countries; it can also very well apply in developed countries. In Australia, a metropolitan local government authority conducted an EE project among low-income non-English speaking residents. The purpose of the project was to inform about storm water pollution. This kind of community-based informal EE has been applied with considerable success in different localities around the world. Such learning is deliberative and allows for engagement, discussion and group work, rather than time-predetermined instructional classes given within four-walled university settings.

The third and final EE setting of importance is the non-formal setting. Given what Skanavis and Petreniti (2006) from the University of the Aegean have called the "invasion of the non-formal environmental education in formal education", it is important to at least sketch the contours of what non-formal EE represents. According to Tahir (1997, p. 87), non-formal EE is the "type of intentional education which is for the development of, among various sectors of the society, environmental concepts, skills, attitudes and ethics which are carried on in various community institutions which may or may not include the schools and universities". The role of non-formal EE is to supplement the contributions of formal educational settings. While formal EE typically solidifies knowledge and competences related to environmental actions through labs and other formal infrastructure and architecture, non-formal EE is not limited in scope to the formal education sector. Simply put, non-formal EE can effectively raise both awareness and performance (cf, focus two from ESD projects).

The importance of non-formal EE emanates also from its nature and salience of attracting learners in their habitats. In other words, students do not need to first attend education establishment to receive EE, as in the case of the formal one. This allows behavioural change to occur. To explain in brief how this happens. As put by Nobel Prize winner Kahneman (2013), people have dual thinking processes in their mind. There is system one which is about behaviours we go about in our daily lives without too much effort in thinking; and system two which is about slow analytical reflection in our mind that requires high cognition and awareness before we engage in a particular act.

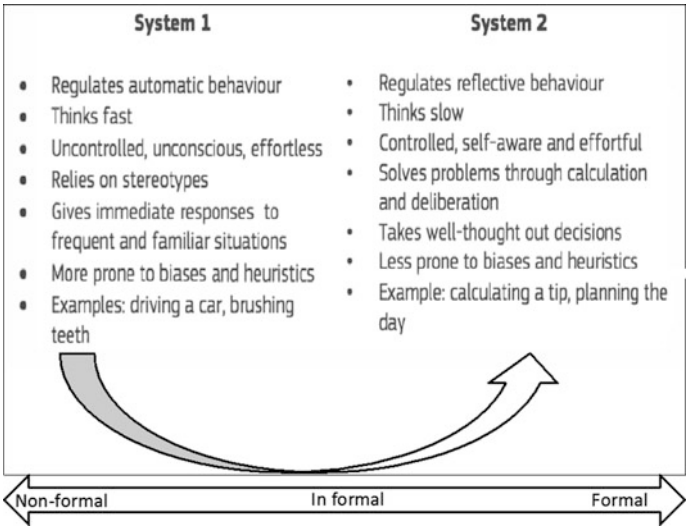

Fig. 5 Illustration denotes the cognitive transition for learners through the internalisation process of knowledge and skills acquired from the immersion into the formal-in formal-non-formal spectrum of education modalities. Quoted from *Applying behavioural sciences to EU Policy-making* (van Bavel et al. 2013) on the application of behavioural sciences to policy-making

Non-formal EE, if done well, would be able to address system one, which we use much more given its ease in our daily practices. The benefit of which would then allow for a positive behavioural change in both system one (addressed through the non-formal/incidential EE) and system two (tackled through formal EE), which is able to bring out the analytical dimension of the learner. The significance of non-formal EE in formal settings has been even more stretched by some authors (e.g. Heimlich 1993) to signify the interchangeability between the term non-formal EE and EE in general out of the belief that the latter should be often exercised in non-formal settings. To that extent, non-formal EE should be integral to formal EE, let alone the SDGs on the environment at large (Fig. 5).

5.1 Towards an Environmentally Inclusive Path: Formal, Informal and Non-formal Education for Environmental Sustainability (FINEES) Framework

Having enumerated the three education systems, the intention of this paper is to advocate for a new approach that utilises them jointly in one conceptual framework: the *Formal, Informal, and Non-formal Education for Environmental Sustainability* (FINEES model). The idea is to harness their natural/normative benefits in their setups as well as to build on the powers of their pedagogical methods to allow for a fuller ES model. This framework is proposed as a more comprehensive path,

given that it is broadly inclusive of all population segments. Combining both formal and non-formal EE has already been realised in some contexts, such as in the case of the Centers of Environmental Education of the Ministry of National Education and Religious Affairs in Greece (Skanavis and Petreniti 2006).

The paper goes beyond this binary combination to include also the informal system in its framework. As such, this paper proposes that traditional formal settings such as universities should also incorporate elements of informal and non-formal education. By this, the paper refers to the injection of informal pedagogical methods into formal education settings to stimulate participatory paradigm shift for the education community at large. This would allow learners to take responsibility and action for the environment and sustainability matters. To illustrate, for instance, universities should develop campus-wide, student-led activities with active teacher engagement to really instill interaction between both students and teachers as participants, rather than students on the one side listening to teachers, and lecturers on the other side as instructors.

Having a holistic integral model with all educational modalities—formal, informal and non-formal, would furthermore ensure that the role of education in environmentally sustainable development amplified in the quest to achieve the SDGs is not a mere "chalk-and-talk" exercise (Koshy et al. 2008) but rather an effective and efficient instrument towards fulfilment of the SDGs. This would allow for collaborative synergy among the three pillars of sustainable development through a fully rounded education framework that utilises the formal system (with its more economic analytical emphasis); the informal (with its social dimension); and the non-formal (with its tools, e.g. field trips, etc. that focus primarily on the environment in its natural habitat) (Fig. 6).

This paper now takes a look at a real-life case example that complements the discussion by means of theory-practice integration and FINEES model application.

6 Bangladesh: A Case Study for EE in Practice and the Applicability of FINEES

Bangladesh has one of the highest population densities in the world and for numerous development-related reasons lends itself as a useful case example for the discussion of EE and the FINEES model application. Naturalistic case observation is useful here as it can provide a better understanding of behaviour and behaviour change in settings where motivational issues are intertwined by multicausal factors and interdependent causal relationships.

With more than 1200 people per square kilometre of land, Bangladesh has more people than all of Russia (World Bank 2011, pp. 344–345; Belt 2011, p. 64). Bangladesh is also among the poorest and most low-lying coastal countries in the world. In 2011 the United Nations Development Programme (UNDP) categorised Bangladesh as a Low Human Development country with approximately 150+ million citizens and a rank of 146 (out of 187 countries) on the Human Development

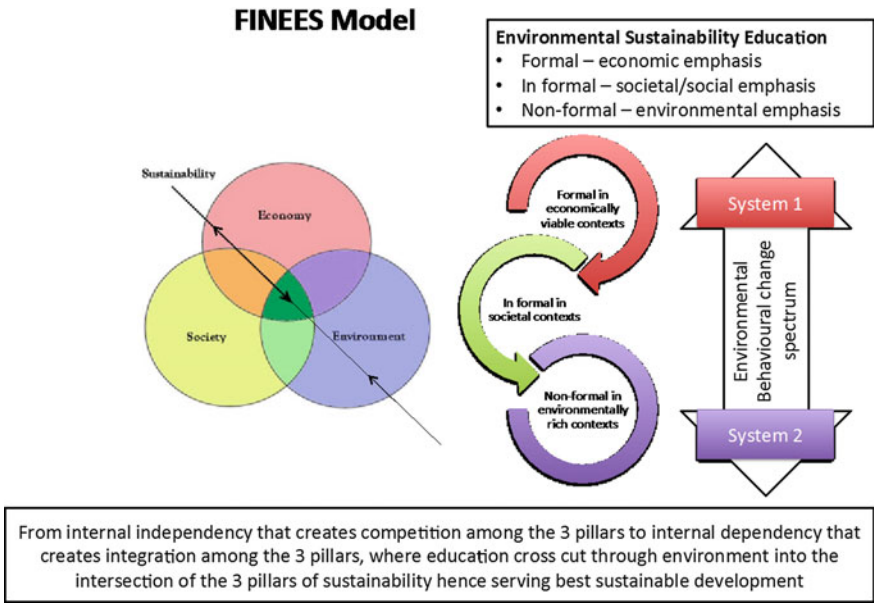

Fig. 6 Illustration shows integrated nature of the FINEES model of environmental sustainability education

Index (HDI) scale (UNDP 2011, p. 126). In 2005, 81.3% of the population lived on less than US$2 per day (UNDP 2011, p. 144). In recent years improvements in human well-being have no doubt been made, for example "the fertility rate plunged from 6.6 births per woman in 1975 to 2.4 in 2009" (UNDP 2011, p. 9), and life expectancy at birth was assessed in 2011 at 68.9 years (UNDP 2011, p. 129), up from 55.2 years in 1980 (UNDESA 2011). Development is characterised by a continued striving for SD, and education plays a crucial role. There are important environment related reasons for this. Every year thousands of people in Bangladesh are impacted and displaced by natural disasters (Luetz 2008), and mainstreaming EE into government policies and procedures seems to be broadly beneficial for affected populations in terms of providing them a better understanding of disaster causes, effects and prognosticated trends (ibid, pp. 78–87).

Perennial erosion is a case in point. According to the Centre for Environment and Geographic Information Services (CEGIS), every year anywhere between 66,500 (BSS 2012) and 1,00,000 people (Shamsuddoha 2007) become homeless due to the effects of erosion. On the Island of Bhola, Bangladesh's largest island, entire villages like Old Daulatkhan, Mirzakalu, Molongchara, Sarajgonj, Chowmohoni, Tazumiar, have been permanently lost to erosion (Luetz 2008, p. 28; cf Shamsuddoha and Chowdhury 2007, p. 23). By virtue of these facts, offering EE only in formal contexts would not be sensible to the situation of the population there given that a broad cross-section of society is eclipsed from reliable access to education (elaborated below).

While the precise causes of erosion in Bangladesh are complex, multifaceted, interrelated, and dynamic (Sarker and Thorne 2006; Sarker et al. 2011), being situated well beyond the scope of this study, the human implications of this progressive land erosion in terms of forced migration are far more straightforwardly discerned. Ph.D. field research conducted on the Island of Bhola has noted the continuing forced movement away from the eroding coast by tens of thousands of coastal dwellers (Luetz 2013, Chap. 5). A short background video to the Bangladesh field research published online by UNSW Australia[5] features this environmentally induced incremental forced human movement (https://youtu.be/PBJeelgnadU).

On numerous occasions, interview participants expressed the sentiment that the majority of erosion affected coastal dwellers are left to cope with this environmental change in the complete absence of any EE. One recurrently displaced forced migrant described how he had to move four times during the last 15 years because the land was "breaking down … very fast".[6] However, when asked what he thought was causing this creeping environmental change he responded by saying that he did not know the reasons, with his by-standing focus group participants nodding in agreement: "Everything is Allah's will. We are uneducated, we don't know". This encounter is broadly representative of many very similar encounters with local respondents. It illustrates that at grassroots level environmental changes may be concurrently conspicuous or even indisputable, and yet at the same time entirely incomprehensible.

Throughout field research, there was a strong sense that EE seems to be indispensable if people are to be enabled to better understand the changes taking place in their natural environments. And yet, data collection processes recurrently highlighted overall low levels of formal education. For example, of the 37 non-expert adult migrant respondents who indicated their highest level of educational attainment, 14 said that they had never attended school. Based on these 37 respondents' data, the average adult migrant lifelong school attendance is 2.8 years (Luetz 2013, p. 205, Fig. 5.25). This statistic broadly corresponds with UNDP data which estimates that the "[m]ean years of schooling" is 4.8 years (UNDP 2011, p. 129). This finding stresses the necessity of bringing EE to the population in multiple educational modalities, and not limiting it to four-walled formal classroom contexts only. This is where the FINEES model proves its functionality and viability given the inclusive, multi-dimensional and integrated concept approach it takes on education. Gender equity and girls' access to education furthermore illustrates that social inequities need to be tackled simultaneously within and without schools:

> Despite having achieved gender parity in primary school enrolments, Bangladesh still has a long way to go to achieve gender equity, access to quality education for all girls, completion of basic education with acceptable competency levels and relevant life skills and equal roles for women and girls in society. Gender discrimination starts from birth and continues throughout life in Bangladesh. The perceived lesser value and limited roles of girls and women are embedded in the socio-economic system. Girls' education,

[5]Published 18 February 2015.

[6]This interview situation and conversation is available in the short background video published by UNSW Australia (21:00–21:40 min): https://youtu.be/PBJeelgnadU?t=21m.

> very broadly defined, can play a part in changing these norms and practices. *The issue must be addressed both within schools and in the broader society*, starting from early childhood and continuing through adolescence. (UNICEF Bangladesh, no date, emphasis added)

Lack of reliable access to formal education is a compelling argument why formal forms of education need to be complemented by informal and non-formal approaches. The reasons are socioeconomically entrenched, as highlighted by the large number of young working children seen during fieldwork. It appeared that numerous parent respondents could not afford to send their children to school and instead sent them to work and contribute to the pool of disposable household income so the family could make meagre ends meet. Most frequently school non-attendance was explained on the grounds of present-day livelihood pressures which were perceived to be so severe as to force the children to work and contribute family income as garbage recyclers, domestic workers, burden carriers, errand couriers, etc. (WVB ACC 2011, pp. 1–2). UNICEF Bangladesh estimates that there are approximately 4.7 million working children (aged 5–14) in Bangladesh, and that "half of all child labourers do not attend school at all. […] As a result, working children get stuck in low paying, low-skilled jobs, thereby perpetuating the cycle of poverty" (UNICEF BD 2010, p. 3; cf, UCW 2011, p. ii).

In summary, if EE raises options, lack of EE forecloses them. There can be no doubt that the unequivocal panacea for Bangladesh's SD, including its management of present and future climate change adaptation challenges, will invariably involve a heightened commitment to education, free and compulsory for all. And by integrating environmental learning modules into educational designs, including through formal, informal and non-formal approaches, EE is poised to represent "no regrets" good SD practice, which will pay ES related dividends irrespective of which environmental and climate change adaptation scenarios are ultimately realised. To recapitulate, application of the FINEES model to the hard and real-life context of a country such as Bangladesh is valuable given the model's holistic integration of multiple modalities of education for the purpose of elevating the status of EE in any place to harmonise with the specific circumstances of the respective locus.

7 Concluding Synthesis and Recommendations for Policymakers

This paper reveals the discourse in the literature between the evolutionary approach to ES into SD and the paradigm-shift approach that sees ES diminishing as a result of its incorporation together with the other two pillars of society and economy in the SD. Irrespective of which view the reader takes, the point to make here is that there has been a transformation over time to ES into the notion of SD. With the importance and influence of the Brundtland Report (1987) giving its embrace to societal and economic pillars of development besides environment, ES as a major pillar has had to cope with growing interest in the other popular two pillars. While at the aspirational level, having the three pillars side-by-side were sought to

advance jointly, competition amongst them from the various agencies advocating for one over the other has been also crawling. The result of which is an overall weakened or blurry position of ES as a policy focus in its own right. This transformational shift might explain how the economic and social pillars in the SD have attracted most of the attention in the only education-related SDG (4), leaving less or no place for ES in the very same SDG.

This paper makes two recommendations. First, when addressing ES in and through education, our thinking should be more expansive, holistic and inclusive of multiple different educational approaches. If this also means changing the meanings of what a university or school stands for then a definitional shift or broadening should accompany the growing and widening scale of environmental threats. For instance, in the Pacific where schools and universities, particularly the latter, are only located in very specific urban areas, not all young people would ever be able to attend and harness the benefits of formal-only education. Developing a full-rounded, integral EE that works independently with each of the formal, informal and non-formal education strands, as well as jointly with both informal and non-formal ones integrated into the formal education system, promises to advance an environmentally responsible and action-oriented citizenry through a 100% positive behavioural change exemplified by the above-mentioned three waves of change, and the two focus areas induced from EE programmes worldwide. In short, formal, informal and non-formal approaches to EE are offered here as a policy tripod for more effective ES and SD.

Second, intergovernmental discussions and international and local consultations that include clusters from academia, the private, and the non-government sector should take place to re-establish a connection between SDG 4 on education and goals pertinent to ES. Building case and pilot studies using the Formal, Informal and Non-formal Education for Environmental Sustainability (FINEES) model would further infuse EE with an action-base for dynamic theory-practice integration. As seen in the Bangladesh case, it is more realistic to use the triad of FINEES than to rely solely on the normative formal education. Otherwise, a missed opportunity in the SDGs might be needlessly perpetuated, similar to the situation with the MDGs, where education (and EE) remained underappreciated (Gartner 2010).

As a concluding remark, the paper did not intend to reduce the positive impact the notion of SD brought on the environment. Indeed, since the intermarriage of the environment with the other two pillars, SD has allowed for an opportunity for an inclusive development rather than a fragmented one. Nevertheless, admitting the negative spill over of the very same concept on the pillar of the environment and its tandem with education is critical in the call out to revamp the plan of action to eventually reach the original aspiration of an inclusive comprehensive sustainable development, at the environmental, economic and social levels.

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Cooking Courses in Higher Education: A Method to Foster Education for Sustainable Development and Promoting Sustainable Development Goals

Uwe Neumann

Abstract

Since October 2011, we offer an optional course "CookUOS—Cooking in context of health literacy and education for sustainable development" at University of Osnabrueck assuming, that cooking and eating is a feasible method to convey ESD by combining theory with an emotional activity everybody knows (Neumann et al. 2016). CookUOS works as a "bus" to pitch science to the participants. They develop figurative and decision-making competencies, self-responsibility and self-efficiency by practice-related tasks. During interdisciplinary colloquia, CookUOS initiates by means of an obligate transdisciplinary change of perspectives a multiprofessional and interdisciplinary exchange between the participants. This paper votes for the implementation of more theory practice-based approaches in higher education to recruit multipliers. A cooking course following theoretical lectures in the curricula of higher education fosters knowledge, competencies and skills we need now and in the future to achieve ambitious agenda 2030 aims. An overview of a 6-year experience analyses pitfalls and succeeding. It furthermore points out opportunities for research as well as options to promote a transfer of knowledge within this process to society to society and vice versa.

Keywords

Kitchen · Cooking · Competence · Cooking course · Sustainability · Higher education · CookUOS · Practical implementation · Nutrition sovereignty Health literacy · Situated learning

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1 Introduction

Nutrition itself has become one of the most important, but also complex, anthropogenic issues in regard to climate change as well as the challenge of increasing expenditures in health-care systems. Although results in research are not consistent yet, the responsibility of nutrition for greenhouse gases (GHG) emissions can be set at an overall minimum of 16–22% (Grünberg and Julia 2010; Koerber et al. 2009) just only for Germany. It is further well reported that social and health policy-related challenges by increasing expenditures in the treatment of nutrition-related or-associated Non-Communicable Diseases (NCD) are obvious (Meier et al. 2015).

There is a broad scientific consensus that food and nutrition both address to Public Health and Sustainability but in opposite feasible policy, governance or educational strategies are outlined but still missing (Reisch 2013; Lang and Barling 2013; Ständige Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland 2015). In the framework of policy instruments to promote sustainable food systems, self-committing is identified as one of the relevant issues besides information-based, market-based and regulatory instruments (Reisch 2013).

The German Conference of Secretaries of Education (KMK) advised embed ESD continuously in all curricula of all school forms. For cooking courses, a scientific rationale can be seen in medicine mostly as a dietary intervention or prevention programme. The settings vary from addressing specific groups with high risk for diabetes or obesity (Tarro et al. 2014), over local or regional concepts within Public Health action processes to supply school kids with healthy food and basic nutrition literacy (Ellis et al. 2013; Fieldhouse and Thompson 2012).

In June 2016, Rockström and Sukhdev from the Stockholm Resilience Centre concluded that actually all the sustainable development goals are directly or indirectly connected to sustainable and healthy food (Rockström and Sukhdev 2016), and therefore a paradigm change in action processes is necessary. Resource management and environmental impacts of the food and agriculture sectors as well as nutrition itself are serious threats, which should get more in the focus of attention and a scientific proofed action process to reach the goals of the 2030 agenda. Undoubtfully, it urges to counteract those problems caused by increasing inequities, obesity and malnutrition or starving. A paradigm change from a curative, therapeutic point of view to a salutogenic, preventive strategy is mandatory.

Cooking courses for university students are predestined to create multipliers who later play an important role in conveying knowledge and competencies on health, nutrition and sustainability to a wide audience (Neumann 2012). Objectives of cooking courses aim to empower individuals to understand imbalances of food-availability and -distribution, surplus versus waste, shortened and ending resources as well as cooking skills as a sociocultural heritage and duty. Later it can initiate, e.g. a progress in counteracting nutrition-associated diseases or reducing waste of food and resources in private, educational, or occupational environment.

Due to global responsibility, it triggers a commitment towards Education for Sustainable Development (ESD) (Koerber et al. 2016).

The aim of this paper is to introduce CookUOS and to discuss whether it is a feasible method to foster ESD in higher education by the means of a lecture-accompanied cooking course and a portfolio of teaching and learning formats within the matrix of higher education and society impact in relation to expert knowledge and ESD knowledge. The food and nutrition-related setting and collaboration with regional stakeholders transfer a broad range of issues linked to the Sustainable Development Goals (SDG's). It further votes for the opportunity to engage students as a creative revolving capacity in the process of conception and administration of such a portfolio and for open discourses towards a permanent incorporation in all formal or non-formal educational sectors and a better support by policy and research funding.

2 How Nutrition, Cooking and Culture Connect to Sustainability

Since the discovery and control of fire, cooking has become one of the greatest cultural achievements of mankind and has determined the value of food and prepared meals (Wrangham 2009). On the other side, we see a rising tendency to use highly processed food (Gehlhar and Regmi 2005) going along with a decline in cooking skills (Lichtenstein and Ludwig 2010) beside for the past 60 years.

In the industrialised countries expenditures for food dropped from approximately 50–60% of the net household income over the last 100 years to, since 1990 relative stable, 7–14% (Statista 2016). In opposite to this, official facts and figures of the developing and emerging countries still tell another story (Regmi and Gehlhar 2001), (International Food Policy Research Institute, Welthungerhilfe and Concern Worldwide 2015). Hunger and high percentage of expenditures of household's income for food point out where and how to act.

Austerity and shortage at the very beginning of the twentieth century have changed to superabundance and low esteem, seen for example in wasting food. At this time, there may be a chance in cooking, bringing a new ethic of nutrition and responsibility closer to the low estimation of eating (Hirschfelder et al. 2015) (Fig. 1).

The idea of transporting education and social responsibility by cooking or gardening is not new. Since the serendipity of fire and consecutive its mastering, for our ancestors it was essential for survival and evolution to teach and empower their next generations with knowledge of preparation, recipes and value of food. It is also in discussion that cooking was a rationale to develop speech and writing (Wrangham 2009; Was der Mensch essen darf 2015; Glöckl and Breithecker 2014).

But cooking is also the birth time of the division of labour, social coexistence and ultimately the family (Perlès 1979). Through the division of food procurement, cultivation of agricultural products, processing and storage of food as well as the

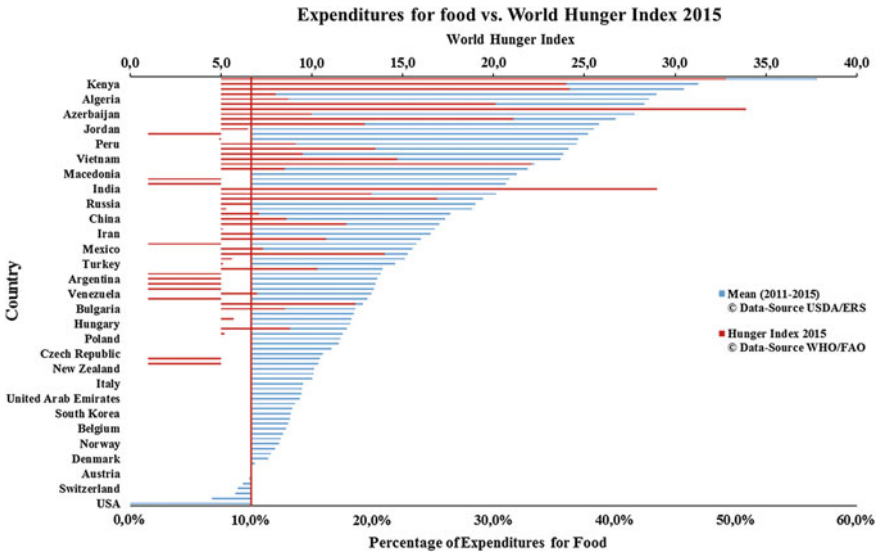

Fig. 1 Expenditures for food in relation to World-Hunger-Index

distribution or trade with it, humankind could raise to a social being. Humans Nutrition- sovereignty is reflected in the fact, that wholesome nutrition is rather more than ingesting or getting calories.

In excess nutrition is a very important economic factor. The food and nutrition industry is even bigger than automotive or computer industry (Lemke 2012). The dictum "Humans are, what they eat" (Feuerbach 2016) dated 1850, underlines the impact and the social, economic, politic, ecologic, health and cultural dimensions of nutrition. All the dimensions are in common with the goals from Education for Sustainable Development (ESD) and further the Sustainable Development Goals (SDG's).

It is not surprising that the knowledge about the value and benefits of food is of high priority. The close relationship of Nutrition–Health–Education for Sustainable Development (ESD) can be easily brought to the ground that someone who eats properly promotes his health and develops a practice-driven attitude towards sustainability and social responsibility (Zelený 1997). Cooking courses open basic pathways to sustainable competencies by autopoietic learning (Kohlberg and Eichelberger 2007). The combination of learning combined with flavour, savour and pleasure generates sustainable knowledge and empowers personal skills and resources by a contextual, an emotion- and flavour-associated approach (Shepherd 2013). Further, it mediates "Education for Sustainable Development" (ESD) and creates a "sense of coherence" feeling (Fig. 2).

Education regarding and communicating the whole process from the production and the consumption of food, forms skills and competencies about nature, science and the environment. It is intended to develop sustainable attitude and social

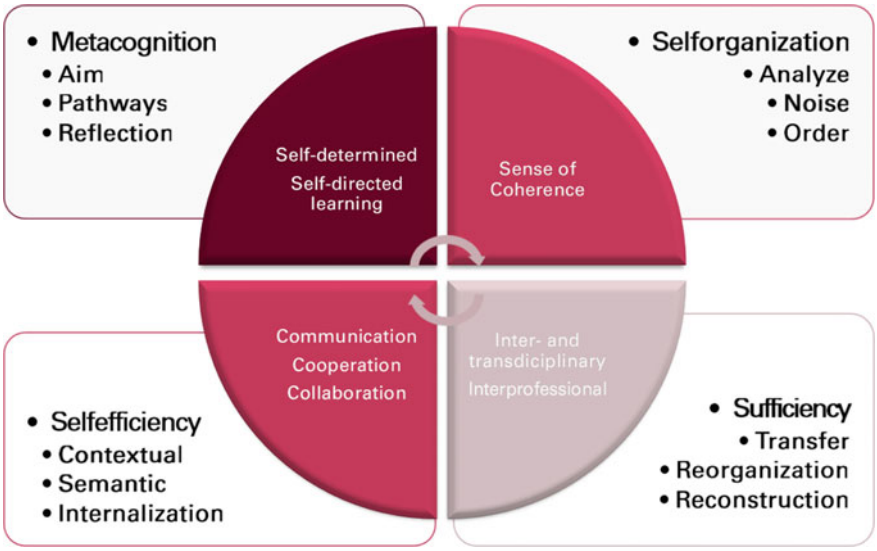

Fig. 2 Matrix of autopoietic learning [according to (Kohlberg 2012)]

responsibility (Dewey 1990, 2012) as well as becoming a valuable member of the society (Kerschensteiner 1931). Once it has been internalised it requires only little trigger to revitalise those capabilities dozing in us. Subsequently, interdependencies of nutrition and food waste, climate change and resource conservation become tangible, comprehensive and personally.

By a change of perspective, the participants take part in a reflective discussion on conditions of production, the abundance and the unequal distribution and food's impact on the environment just while buying, preparing and eating the goods. In addition to the pure nutritional value, food's addresses also other values such as compassion, justice, fellowship, participation, respect and responsibility, but also joy, enjoyment, creativity and power of innovation.

2.1 CookUOS

Homo sapiens (from *lat. homo* = man and *sapere* = savour, taste), brings it to the clue that if we raise as a savouring, scintillatingly witty species why not should we use flavour and savour to transport sustainability and its goals?

Sustainability and appreciation are inextricably linked to one's own attitude and actions. Therefore, if you want to teach and learn sustainability, it is primarily about sharpening your awareness of How To recognise and achieve values. That is exactly what CookUOS is dealing with in its portfolio, e.g. seminars, campaign days and edutainment (Neumann 2014).

To make visible that nutrition and cooking connect all the dimensions of ESD and all SDGs, an integral approach, like CookUOS, is useful to identify and characterise elements of the chain from production to consuming and waste production. In a first step, we link the SDGs to the most corresponding ESD dimensions Ecology, Society and Economy. Secondarily we address issues of the whole process of nutrition to corresponding SDGs. For example, industrial livestock animal farming harms the Biosphere and has an impact on Biodiversity. A reflective view on a cooked meal sharpens the look on land or soil management, animals or plants, as well as on the resource water and the production of greenhouse gases. As cooking needs energy, questions of innovative technologies and clean energy get into the focus. Consuming regional and seasonal food or reducing food waste helps to understand economic consequences of a responsible consumption and production as well as inequalities.

One of the main rationales was to create a learning situation and environment combining theory and practice. Kitchen and Cooking and Eating do so by bearing individual meaningfulness and relevance for the own lifestyle. Through CookUOS, competences get a practical and cultural reference and a discourse about values is initiated. CookUOS creates and trains multipliers who later will play an important role in spreading scientific knowledge and competencies into society.

Based on the first concept of a lecture accompanying cooking course within the last 5 years several other derived formats and activities have been established, e.g. field trips to get some incitation from nature or museums. To promote and to discuss the results of the students' contributions to the course with the public, a Sustainability Day with major key-note speakers, an edutainment format «T^3-scientific cooking-show», and several single-day cooking activities at the farmer's market enrich the wholesome portfolio. A homepage with blogs and social media activities broadens the recognition of the project beyond the region of origin.

Overall, CookUOS' s entire portfolio aims to elate students for ESD and more to participate as a *creative revolving capacity* and encouraged *change agents* for Sustainability in higher education and encouraging society to take part in scientific discussion and research, actually promoted as *Citizen Science*.

The setting of our course ensures, that students not only learn (*what*) is sustainability, they also develop skills (*how*) to achieve a sustainable lifestyle and finally yet importantly they understand the necessity of their role as multipliers in education (*do*)ing sustainability itself (Fig. 3).

2.2 Main Aims and Issues of CookUOS

The Dutch renaissance humanist Erasmus from Rotterdam (1465–1536) recognised, Socrates's 'thesis ... *the most learns who likes to learn*...', and imagined, logically and in consequence, that *learning will succeed best when having been taught with passion*. He identified indispensable elements of learning: communication–motivation–emotion and interaction.

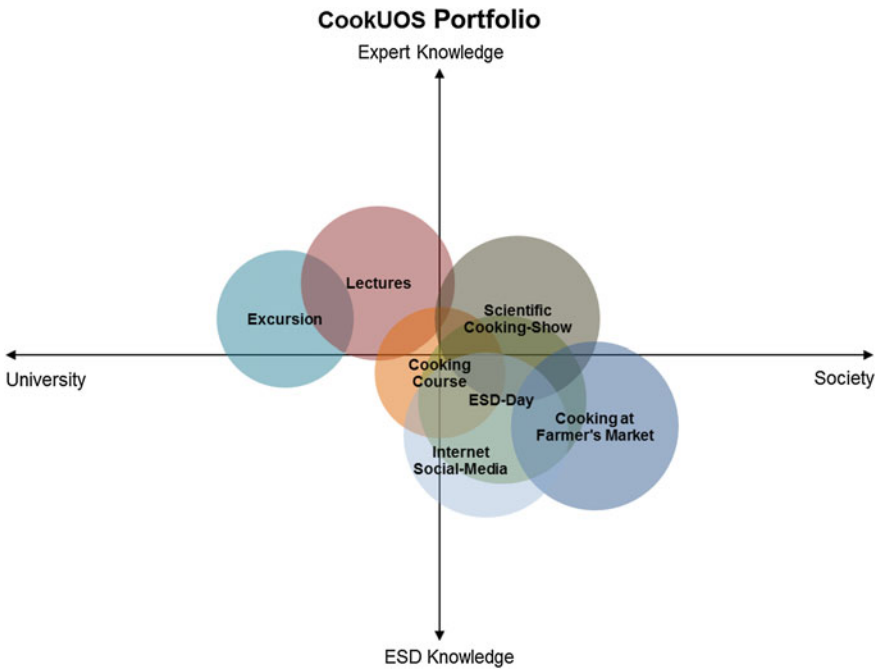

Fig. 3 Entire Portfolio conveying ESD and SDG's by the means of nutrition and cooking

In all cultures, these learning modulators are present and contribute significantly to the establishment of social norms resulting in ethical principles (morals) for thousands of years. Teaching and learning are unmistakably a deeply human issue. Today industrialised countries are strongly meritocratic oriented and specialisation, efficiency or economic reasoning often disguises the look for correlations and cross-curricular learning. This also applies to sustainability.

However, young people, especially children show a strong interest in imparting knowledge and growing competences for sustainable action. By acquiring these competencies, they will be enabled to shape and change their environment and their lives sustainably (Koh 2013; Williams and Brown 2012). Professional knowledge only leads to skills if the learners can recognise a relationship of knowledge and life with practical references.

Through the CookUOS project, we developed new ESD oriented teaching strategies in the sense of interdisciplinary situated learning. The active participation supports gaining other objectives, like the thematic focus on social competence, environmental competence, competencies in the fields of nutrition and consumption (Lavelle et al. 2016; Sepp and Hoijer 2016; Wolfson et al. 2016). They comply with competences specified during the UN Decade of Sustainable Development (United Nations Economic Commission for Europe Strategy for Education for Sustainable Development 2012) (Fig. 4).

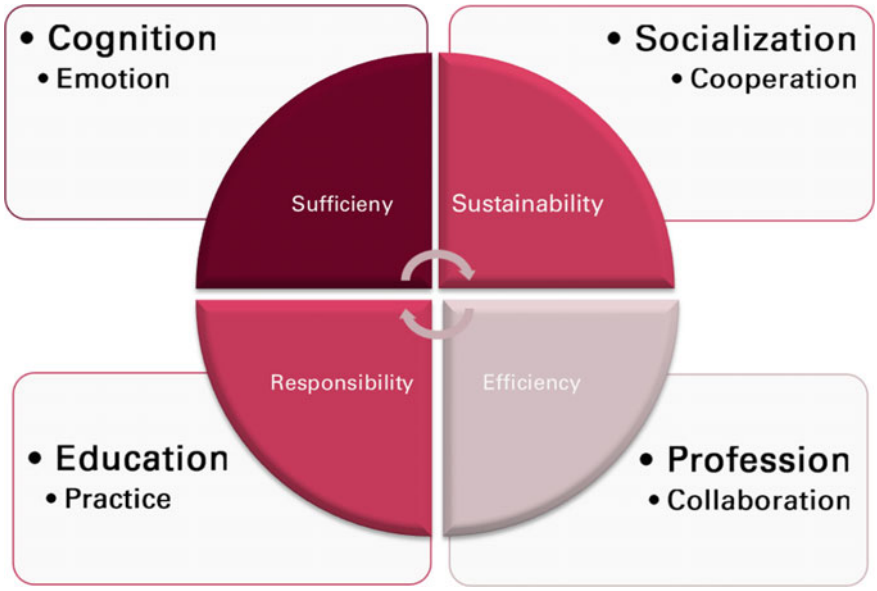

Fig. 4 Model of shaping and affecting sustainable behaviour

2.3 Setting

The CookUOS Project was born in 2010 as a collegiate project. Design, administration and mentoring of participants are the responsibility of students of the Institute for Health Research and Education of the University of Osnabrueck. A scientific advisory board supervises the Project, which is in responsibility for future research activities. Experienced senior fellows and top ranking scientists hold interdisciplinary lectures and seminars every two weeks preferably in the winter semester. On Saturdays from 8:30 am to 6:30 pm on a total of nine days, courses start with lectures and presentations. After theory follows shopping on the weekly farmer's market, cooking, eating and the joint cleaning up. The sequence intentional has parallels to a regular working day.

In the seminar section, participants listen to scientific lectures on topics such as health education and development, ecological sustainability, resource conservation and philosophical-ethical reflections. The subsequent practical courses (joint shopping, cooking and reflective table discussions) are intended to promote the willingness to transport the learned later into the professional activity and the design of own life-span.

Conscious shopping, cooking with fresh, regional and seasonal food and eating together means being active and dealing with ecology, economics and society in a critical and reflective way (Table 1).

The combination of learning and joy strengthens personal skills and resources through an experience-accompanying approach. This creates a sense of coherence.

Table 1 Main objectives of a combination lecture and cooking course

• Cooking and food as a stimulating social interaction and cultural good
• Recognise that enjoyment not excludes responsible food choices
• Cooking is an active contribution to cultural integration
• Measures for a more differentiated consumption and nutritional behaviour
• Recognition and esteem of the diversity of food and its equivalence
• Awareness of sustainable resource conservation
• Importance of regional and seasonal food offers
• Recognising links between climate and nutrition
• Esteem of food and getting back nutrition sovereignty
• Application of scientific principles for nutrition and food preparation
• Food preparation and nutrition as a health-promoting activity
• Contribution to ESD and SDG's
• Identifying benefits of cooking and the sharing of this knowledge
• Motivation of target groups to be multipliers in different venues
• Motivation to transfer knowledge into society
• Learning with all senses

What you have learned with commitment and joy someone will pass on with joy and appreciation.

Students can earn up to nine, graded ECTS-CP and a certificate of soft-skills/Diploma-Supplement. Teacher trainees, teachers and educators can receive a certificate of vocational training or further education. All other participants receive a confirmation of participation. The scalable framework can easily be tailored to various disciplines or target groups. Regardless of social status, ethnic, cultural or religious origin, CookUOS is gender and diversity compliant as well as inclusive and ready for life-long learning. Courses, events and workshops, for example, teachers, trainee teachers, educators, but also parents and scholars help to disseminate sustainable nutrition into society.

2.4 Food and Farmer's Market

Principal location for buying food is the Osnabrueck weekly farmer's market with its rich and diverse offer from local and regional producers. The choice of food focuses generally on the seasonal availability of regional products. On basis of the seasons in the autumn and winter, a form of artificial scarcity, arises. That however turns out, on closer examination, as a welcome opportunity. This supposed

limitation moves choices to unknown or in partly forgotten species and varieties of food.

As well, this apparent undersupply promotes creativity and experimentation in the selection of recipes and the preparation of menus. Old recipes of our parents and grandparents experience immediately wake up acting appreciation. The interplay of tradition, culture and modernity [including high-tech food processing methods] leads to edible and tasty results. Products and practical actions get into the foreground, meanwhile the price of goods moves into the background. The price is as it is and will negotiated only for goods from the day before or remainders in the optical quality. What is still usable can be bought slightly cheaper before thrown away, a winning situation for providers and consumers.

The course creates a holistic understanding of origin, production and consumption. The trading partners get faces, are alive and not anymore anonymous. A relationship of trust can be developed and established. The higher price of the fresh market offer is through a more enlightened purchase and the meaningful reduction of quantities and portion sizes almost completely compensated. Themes of meat consumption, fair trade and resource-saving will be addressed as unbiased as critical. During subsequent cooking and table discussions there will be plenty to talk about (Heindl 2016). Mindfulness on quality, origin and production conditions appear while purchasing and cooking.

2.5 Cooking and Service

CookUOS attaches special attention to the cooking as a central achievement of human cultural development (Methfessel 2005). After the visit to the market the choice of recipes and processing of the food are the next stages of the cultural journey through dining and food. The recipes ideally reflect the topics of the scientific lectures in the morning, for example, if the Lecture was about nutrition styles and their impact on health and environment, the students must prepare corresponding meals in vegan, vegetarian, or flexitarian style with meat as well as to taste the difference, compare and discuss pros and cons.

Centre of cooking is the teaching kitchen of a neighbouring vocational college with disciplines home economics and gastronomy. For each menu course the purchased goods are collected and sorted. Alternately, each group is responsible for a single part of the menu. Another group does not cook but operates as "Supporter" ancillary to the other teams, keyword: *Division of labour*. The group is responsible for design and decoration of the table and for procurement in the case of something has been forgotten or is not available in stock. This support has a meaning-bearing function with the same value as the cooking itself.

Under supervision and guidance of experienced chefs up to 3* Chef de Cuisine Thomas Bühner the students cook the corresponding recipes. They quickly organise themselves among the new location and the team members. They partly self-assign individual tasks that contribute to the success of the whole menu.

By the time, initial fears, stress and uncertainty shifts to a relaxing routine for steadily better time and organisation management. Meanwhile, answers are giving to any questions about food-knowledge and helpful tips to act with consideration.

The prevention of kitchen waste optimises the resources. Cutting waste or unused parts of food are beachcombed for the preparation to entrees, side dishes, or smoothies or pulverised for condiment. The value of food is looked in its entirety and a vegetable waste becomes a good basis for a broth. Organic waste drops to a minimum because they use almost everything, Taking care of wrapping reduces garbage almost to zero.

2.6 Meal and Table Talk

After the cooking, the next station of is the common meal. The non-cooking group sets up and decorates the table, which not only provides a basis for the ordinary placement of the participants. Rather, a stylish and valuable framing is composed and occasionally offers a conviviality ambience. The laid table also gives the appreciation of the efforts of the cooking groups preparing the mutual meal. Uniform crockery and cutlery, different glasses for different beverages and a decoration corresponding to the daytimes' theme will become self-evident components.

It is often the case, that even unused foodstuffs or parts thereof become stylish elements of the table decoration and raise the total value of the products. Course for course is now served and the ingredients, preparation and special features briefly presented by the teams. Even if it does not meet the taste of everyone, at least one is tried briefly and occasionally leads to an "aha" as an expression of a sensual experience. Any food intolerances are taken into consideration without comment. Personal nutritional styles or religion-based nutritional specialties are respected (Fardet and Rock 2014).

In relation to the food, conversations at the table serve the reflection of the day. The difficulties or simplicity of the preparation are discussed, as well as the quality and further processing possibilities of the foodstuffs.

3 Results and Analysis

Due to the fact, that the project is co-funded with tuition fees, granted by the Central Study-Commission and the Institute's own Study-Commission, the project was obliged to undergo evaluation by the Teaching Evaluation Service Point of the Osnabrueck University. Student's opinions on, e.g. relevance or interestingness are very helpful to estimate feasibility and success of a course. Datasets I consist only of participants of the Lectures with accompanying Cooking Course, Dataset II is the Questionnaire presented to guests of the Sustainability Day and the Scientific Cooking-Show T^3, performed by an international renowned cast of 3* Chef de Cuisine Thomas Bühner, Soft Matter Food Scientist Prof. Thomas Vilgis and Nutrition Psychologist, Prof. Thomas Ellrott, MD.

3.1 Evaluation

Teaching Evaluation Service Point evaluated our courses with standardised questionnaire FUEB in paper form at the next-to-last day of the course. The entire evaluations from March 2012 to March 2016 were combined to a unique set (Dataset I, $n = 87$). For basic statistics and visualisation, we use EvASyS® Automation Software Solution.

The whole questionnaire consists of 37 items in nine categories. One item was for written comments and individual statements. We took a close look at the categories using Box–Whisker charts created with Excel® 2016.

Mostly all categories are located in the range between agree and strongly agree. This mirrors the excellent acceptance of the course as well as the relevance and interestingness. Attendees' participation and openness for intense discussion and successful learning were one of the key reasons for subsequent funding. Overall rating of the course was Grade A (Fig. 5).

3.2 Questionnaire

In addition, after each event of the portfolio, attendees could voluntarily participate in a short, unique questionnaire (Dataset II, $n = 288$). For December 2012, up to December 2015 we achieved a return-rate of approximately 28%. A very important question was which venue for lectures with an accompanying cooking course is

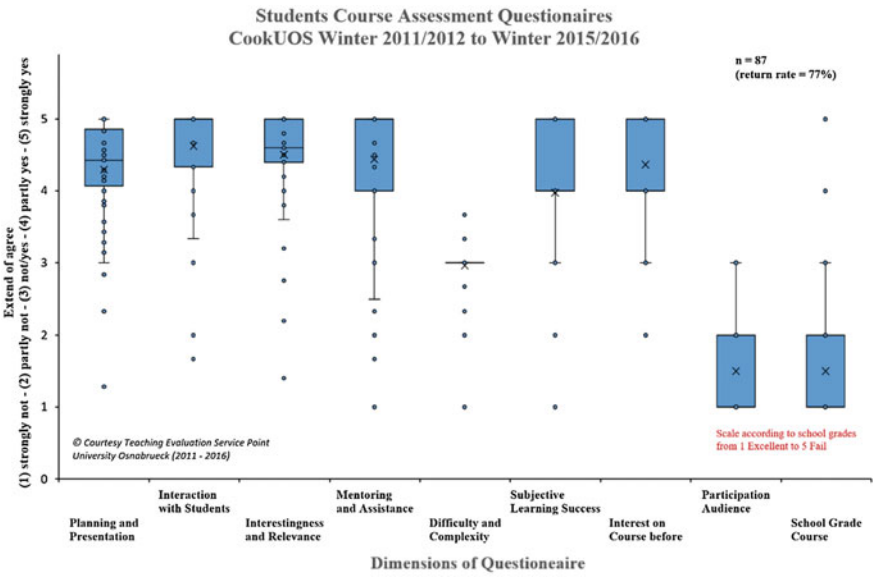

Fig. 5 Cumulative Evaluation FUEB of Courses from 2011 to 2015 (Dataset I)

preferred. For each location (Higher Education, in a school or by a private host) the participants could choose a degree of acceptance in the range of four appreciations from I strongly not agree, I do not agree, I agree to I strongly agree. Central tendency was avoided by the design of an even set.

The data sets were analysed by IBM SPSS® Ver. 24. Correlations between the three venues were compared using *t*-test. Mean values for venues Higher Education and school were significantly different from the mean value for the venue private host. Interpretation of the degree of acceptance leads to the conclusion that the location of choice for a lecture in combination with a cooking course is either in universities or in schools (Table 2; Fig. 6).

For a more detailed estimation of the CookUOS portfolios impact on ESD, a set of questions was developed and in later presented to the guests of the Sustainable Day and the «T3-Scientific Cooking-Show». Overall, the results were encouraging the team to follow the basic concepts line and to look forward in the process of upcoming challenges mainly in taking more human resources to manage and maintain the whole programme.

The given answers show demands for more practice in teaching ESD and the structural implementation in higher education and all curricula. Educational trainees and teachers are encouraged to transport ESD into their schools (Fig. 7).

3.3 SWOT Analysis

For quality assurance and self-reflection, we also analysed our team protocols to identify major items of strength, weakness, opportunities and threats for the project. In addition to the likelihood scale, we received valuable written comments. They varied from course to course.

Students attached great importance to a "non-missionary" style of lectures with adequate time for discussion and an appropriate tutor to students-ratio. As a first

Table 2 Statistical data for item "Preferred venue for Lectures and Events", Dataset II

Statistics (*t*-test)		$\bar{x}$	*n*	σ	SE	*p*
Pair 1	Lectures or event better located in higher education	3.63	254	0.639	0.040	**0.003**
	Lecture or event better located in private educational institutions	1.79	254	0.932	0.059	
Pair 2	Lecture or event better located in higher education	3.63	257	0.636	0.040	0.820
	Lecture or event better located in schools	3.09	257	0.880	0.055	
Pair 3	Lecture or event better located in schools	3.10	254	0.872	0.055	**0.002**
	Lecture or event better located in private educational institutions	1.79	254	0.932	0.059	

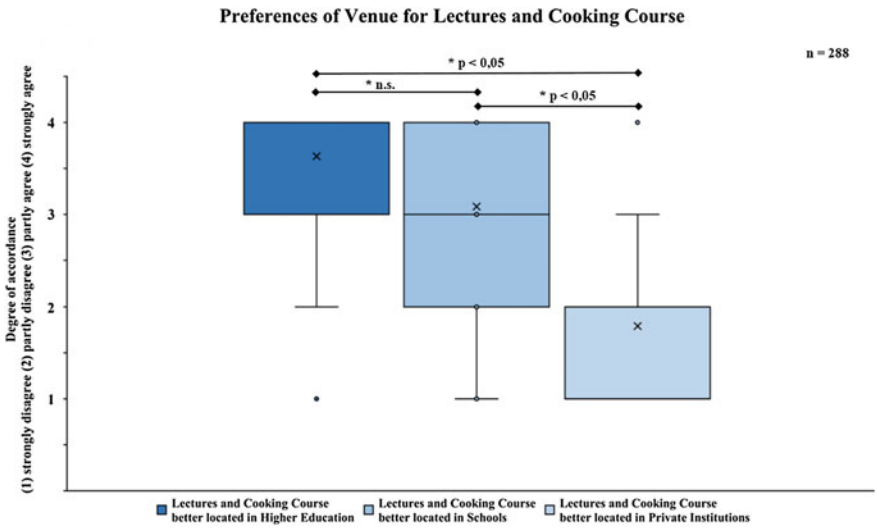

Fig. 6 Box-Plot degree of acceptance for preferred venue of the course

remedial action, we reduced the theoretical part from two to at least a single scientific speaker and took more attention to interdisciplinary exchange.

The supervision by experienced cooks was an essential claim. Beside the theoretical information about edibles, the way of considerable preparation was important. Participants voted very positively about the overall concept and portfolio. At no time, the duration of up to ten hours per day was subject of complaints.

Many of the obstacles we faced. By the end of the day, they made the project more ruggedized and stable and were essential lessons. A valuable asset of the course is the excellent acceptance among students and growing network including other universities, schools and stakeholders $n = 288$ (Table 3).

3.4 Awards

From the very beginning CookUOS received great acceptance and was selected as an innovative concept and "good practice" project for promoting ESD, resource-saving and healthy nutrition by independent juries of German Ministries, UNESCO, Stifterverband, WWF. The awards were of high imaginary value and we understood them as esteem for the teams' efforts and commitment to ESD. They were helpful to raise at least some minimal funding among stakeholders and founders (Table 4).

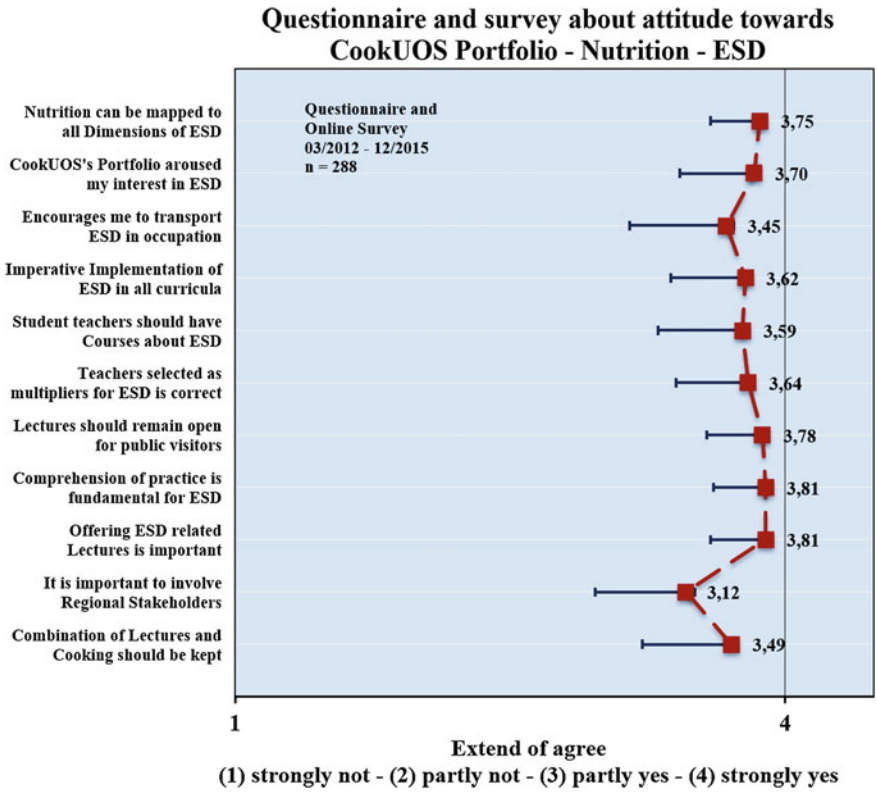

Fig. 7 Overview of results of questionnaire and online survey (Dataset II)

4 Discussion

ESD should be a strategic development objective in Universities. Natural and applied sciences, engineering, architecture as well as medicine discovered the worth and the avenue of cooking (Holzbaur 2013; Plappert 2011; Euler 2007; Holzbaur 2016; Rodman 2013). A few pedagogics see a renaissance of the educational theories of Comenius, Pestalozzi, Rousseau, Montessori and many more reincarnated in Education for Sustainable Development (Kohlberg et al. 2008; Kohlberg and Eichelberger 2007; Becker 2000, 2016).

The kitchen and cooking as a space and method to learn about healthy and sustainable lifestyle or social responsibility offer a wide range of innovative concepts. In accordance with The German Conference of Secretaries of Education (KMK) who advised to embed ESD in all curricula, cooking courses can support their claims.

Table 3 Overview of awards for CookUOS

• UN Decade Project 2012/2013, German UNESCO Commission 1st award (04/2012)[a]
• Ideas for the Germany's Future (04/2012)
• Innovative & New Learning, Young Academy and the Stifterverband (12/2012)
• Fair Trade® Award and Seal (11/2012)
• In-form support project, Germany's Federal Ministry of Health and German's Federal Ministry of Food and Agriculture (BMG/BMEL 10/2012)
• UN Decade Project of the Week 11/2013
• In-Form project of the month 12/2012–01/2013
• UN Decade Project 2014, 2nd award, German UNESCO Commission (02/2014)[b]
• Student prize of the Student Services office Osnabrück (02/2014)
• Identification as a "good practice" project World Wildlife Found (WWF Germany, 2014)
• 06/2014 Identification as a "good practice" project, BilRess, Wuppertal Institute, 2014)
• Citavi Grant innovative project (09/2014)
• "Hochschulperle" of the Stifterverband (09/2014)
• In-form project (permanently), Germany's Federal Ministry of Health and German's Federal Ministry of Food and Agriculture (BMG/BMLEV 07/2016)
• Selected and a good practice model presented at 3rd SISI/FONA Conference of Germany's Federal Ministry of Education and Research (BMBF 10/2016)

[a]Excerpt from the laudation of Prof. Dr. Lenelis Kruse-Graumann, UNESCO Commission, and carrier of BAUM Prize 2012 during the honour-ceremony for selected UN Decade Projects at the Federal President's office Bellevue Palace, Berlin on June 6th 2012. "…[The] project CookUOS has been proposed for the award by the top-class jury, because the interdisciplinary teaching of theoretical knowledge combined with a practical reference in Higher Education curriculum contributes to the obligatory implementation of education for sustainable development and from this, valuable multipliers will raise", so the laudatory speakers unanimously said. "The fact that the University of Osnabrück has succeeded in creating this innovative offer, especially for the courses of study "Education for Vocational Schools" of the Teaching Unit of Health Sciences and the Department of Biology, takes full account of current developments and focuses and therefore, it is a real step at the right time" Lenelis Kruse-Graumann pursued

[b]"COOKUOS has been showing impressively how future-oriented education can look like. The vote of the jury praises the project, because it conveys understandable how people can act sustainable", says Prof. Dr. Gerhard de Haan, chair of the National Committee and the jury of the UN Decade in Germany. *[translation by author]*

Table 4 SWOT-analysis of CookUOS

Strength	Weakness
S 1. Students driven from bottom up S 2. Fast response to changing resources S 3. Interdisciplinary course S 4. Excellent reputation S 5. Important non-material awards S 6. Testimonials proof the concept S 7. Expertise in nutrition—ESD S 8. Link to society and regional partners S 9. Portfolio of project S 10. Scientific advisory board	W 1. No own teaching kitchen W 2. High logistic challenge W 3. No monetary award W 4. No high impact or excellence funding W 5. Human resources need to be increased W 6. Limited time of students W 7. Embedded in a public authority structure W 8. Only few leading characters
Opportunity	**Threat**
O 1. Offer course to external participants O 2. Linking to other universities O 3. Cooperation with stakeholders O 4. Collaboration with NPOs O 5. Activities with UNESCO/UNDP O 6. Getting more scientific reputation O 7. Connection to schools	T 1. Funding is substantial for Implementation T 2. Not enough budget for growing T 3. Competition with private hosts T 4. Hierarchies and responsibility T 5. Leading characters leave the project

CookUOS with its holistic setting opens new sides of view. This is likely the behavioural approach by (Jarpe-Ratner et al. 2016) or the correlation of cooking, emotion and nutrition (Utter et al. 2016). A quiet similar student's-driven project was established at Pomona College (Cyr 2013) describing same incitement and aims as our project. An interesting setting linking cooking to several emotions was presented by Bermeitinger et al. (2012) and Bermeitinger (2016).

Our credo is not to impose one's will on eating right or sustainable, we offer diversity and quality of choice for regional and seasonal food. As the course takes at least four months, time works to internalise the worth of cooking without any pressure. We learned to avoid the critical words "healthy" or "sustainable" because they have been cannibalised for marketing and green-washing purposes.

We ideally see the course as a basic concept, reactivating nutrition sovereignty and more esteem for food. Regularly and permanently implemented there is a chance to develop frameworks for a wide range of target groups, such as schools and non-teaching centres or even companies who want to establish sustainable incentives for their employees (Schockemöhle and Stein 2015).

5 Conclusion

CookUOS as a seminar accompanying cooking course is an interdisciplinary and transdisciplinary method to promote health, nutrition, consumer and environmental education (Neumann 2014). In addition, it initiates, a basic understanding of the natural sciences biology, physics and chemistry and their connections. At the same

time, this opens by means of the reality of life food an ideology-free discussion with meaningful, practical references.

"Even if the linkages of everyday activities, such as food and cooking, with theoretical lectures and seminars are regarded as non-scientific by critical voices, in the future, those with a disparaging attitude towards food and nutrition, as non-scientific and an unethical way of thinking, are sure to be the odd ones out" (Lemke 2016).

Cooking courses in higher education work like situated learning. They arouse the potential of students to approach nature [about the food], to make use of the institution "kitchen" and to create things and values [crafts]. This process begins with the production and availability of the means to life and opens valuable spaces and emergent ideas for new and changing situations while at the same time appreciating our cultural identity.

Students are important and essential in shaping Higher Education towards ESD in the future. As change agents, they stand at the bottom line for sustainable development. (Singer-Brodowski and Bever 2016). There are more and more initiatives or projects which are developed and successfully operated by students (Nadine and Johannes 2016).

Since 2011, CookUOS offers important stimuli to transformation in Higher Education for obligation to ESD. In higher education (for example, in the fields of religious studies, medicine or education of teachers, or a general study) a cooking course provides innovative space for teaching and research and allows networked thinking on concrete practical references (Neumann 2014).

Therefore, one of the most impressive experiences was the overall little waste produced during the course. A first look at the results of an alumni questionnaire shows the willingness to put sustainable issues more often into discussions with family and friends. Their disposition to buy local and seasonal food on the farmers market increased too.

In opposite to a decreasing cooking frequency shown in the federal Nutrition-Report (Bundesministerium für Ernährung und Landwirtschaft (BMEL) Referat L3 2016) there is incidence that participants of CookUOS portfolio more often cook and eat at home. In a next follow up study, we will develop and present a more detailed questionnaire for the participants to identify key indicators of success and pitfalls for the course.

Actually, we intensify collaborating with teachers and more schools to set up projects under the assistance of course participants. During IdeenExpo 2015, we used the kitchen and cooking experiments to transport basic understanding of natural sciences and sustainability to teachers and scholars from vocational schools. Setup for 2017 IdeenExpo in Hannover succeeded with sophisticated *"Kitchen—Cooking—Competence!"* workshops and demonstrations for nearly 1.000 participants within nine days from June 10th to 18th 2017.

We will further encourage other national and international universities to adopt our portfolio. An international summer school with workshops, lectures and an "*international students-sustainable-cooking-contest*" should be a perfect platform to boost practice-based research on ESD (Fig. 8).

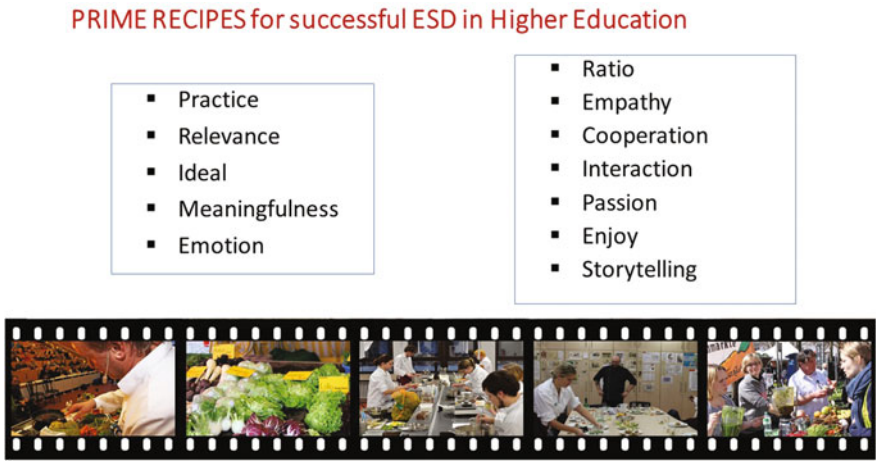

Fig. 8 Receipe for ESD in higher education

Sustainability in Higher Education is like apprenticeship of a Cook. Just reading even the best (cook) books does not teach enough to be a perfect Chef. Necessary beside any theoretical input is, and there is no doubt, practice (cooking) and again practice (sustainability).

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Promoting Education for Sustainability Through Game-Based Learning: Using the Sustainable Strategies Game to Improve Students' Knowledge and Skills of Sustainable Business Practices

Kay Emblen-Perry

Abstract

The need to ensure that learners acquire the knowledge and skills required to promote sustainable development and evolving preferences for experiential and collaborative learning within higher education are reshaping approaches to education for sustainability. In response the sustainable strategies game seeks to provide experiential game-based learning and teaching for business sustainability within Worcester Business School. The sustainable strategies game aims to stimulate collaborative engagement in business strategy making that promotes sustainability literacy skills, the adoption of sustainable practices, the sustainable use of common resources (freshwater) and encourages students to explore the equitable sharing of benefits gained from the use of this generic resource. This paper presents qualitative evidence from research conducted into student perceptions' of the effectiveness of SSG as a new way to learn and think about business sustainability. It utilises the HEA framework for engagement through partnership and the framework for engagement in game-based learning and teaching to explore the value the sustainable strategies game has for experiential and collaborative learning for education for sustainability and its ability to engage students in the complexities of integrating social, environmental and economic impacts of consuming natural resources within business operations. The findings suggest that the sustainable strategies game provides an entertaining learning environment that challenges sustainability thinking and behaviours and encourages students to engage with the key principles of business sustainability and investigate business strategies that carry less impact on society and the environment.

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Student engagement · Education for sustainability · Game-based learning
Experiential learning · Business sustainability

1 Introduction

Learners' preferences for interactive, experiential learning are now rapidly evolving in higher education (HE) environments. This, coupled with the need to promote literacy skills in sustainability to prepare students for the workplace, are reshaping the practice of education for sustainability (EfS) in HE (HEFCE 2013; Higher Education Academy 2015). These trends are moving traditional instructivist approaches to learning and teaching towards participatory user interactions (Conole and Alevizou 2010).

To address these preferences, the author utilises group-based games to offer a participatory approach to EfS learning and teaching for levels 5 and 6 students. This research explores the effectiveness of one of these games in engaging students in learning for sustainability; the sustainable strategies game (SSG). This game underpins the ethos of sustainability taught within the generally instructivist business curriculum: efficient and equitable use of natural resources, environmental and social impact mitigation, collaboration, resilience, etc. Frequently, these require the inclusion of moral and ethical sensitivities. Embedded within the game is the expectation that players will challenge their own, as well as organisational, sustainability values.

SSG is designed to enhance experiential learning and develop student engagement in business decision making within the complexity of sustainability. The game strives to increase students' understanding of the potential impacts that organisations can have on the environment and society and encourage their exploration of alternative strategic responses. This requires them to consider economic growth, prudent use of natural resources, protection of the environment and influence on the neighbouring communities. It also engages students in the softer skills of business management such as influencing, collaboration and negotiation within a safe learning environment.

Student engagement is one of the most important issues currently facing the HE community (Leach 2016). It presents an important learner-centred approach to EfS that is likely to enhance learning outcomes including retention and improved employment prospects (Christenson et al. 2012; Drayson 2015). Research evidence suggests playing games can improve this engagement as well as enhancing students' learning (Cooper et al. 2010; Fabricote and Lopez 2012; McGrath and Bayerlein 2013; Nagle et al. 2014; Cheong et al. 2014) hence SSG has been introduced to the business sustainability curriculum. Tilbury and Wortman (2008) consider that games promote new ways of learning and thinking, which is

fundamental within EfS (HEFCE 2013). SSG seeks to meet Net'geners preferences for collaborative, experiential real-world activities (Oblinger and Oblinger 2005) and deliver student-centred learning for insight rather than learning for technique (Beech and MacIntosh 2012) through problem solving, collaboration, negotiation and peer-to-peer learning. Problem solving within a game requires cognitive investment, emotional commitment and active participation for engagement and deeper learning (Chapman and Dunkerley 2012).

SSG aims to provoke an individual and collective sense of responsibility that Burgess (2006) and Ellison and Wu (2008) consider able to motivate learning for good practice; a fundamental requirement of EfS. Its ability to develop students' self-perceived competence may be a key motivator for engagement (Fazey and Fazey 2001).

The game provides an alternative learning environment from the more familiar instructivist approaches such as classroom PowerPoint slide based lectures frequently used within business management. It provides a distinctive, experiential perspective in which students may engage in deeper learning as they are actively involved in the learning task rather than being passive recipients of information (Armier et al. 2016). Active participation in the game seeks to engage students through education and entertainment, challenge their thinking, and generate an emotional response. These are employed as indicators of engagement within this research.

The research presented here explores students' experiences of playing SSG and assesses the game's ability to engage students in EfS. This level of engagement is evaluated in two dimensions: firstly, students' perceptions of the game as an engaging, educational and entertaining learning experience and secondly, students' suggestions for future developments of the game that are an indicator of their cognitive investment and engagement. The framework for engagement in game-based learning and the HEA framework for engagement through partnership (Higher Education Academy 2016) are used to discuss the research findings in more detail to assess the scope and strength of SSG in engaging students in experiential and collaborative sustainability learning.

This paper contributes to the debate over pedagogical approaches to EfS and provides an insight into experiences of students engaged in game-based sustainability learning, which may be of use to others considering similar gamification of learning and teaching.

2 The Game and Its Game-Based Learning and Teaching Context

2.1 The Sustainable Strategies Game

SSG is a paper-based game in which groups of students (self-selected) represent the management team of one of a series of manufacturing organisations based around a

fresh water lake. Several hundred thousand people also live in close proximity to the manufacturing plants and rely on this common water source.

The game, based on fictional locations and outcomes, provides a structure for exploring how organisations may deal with this complex environment for strategic decision making. During the game, the teams explore a number of problems including how to operate their plant profitably whilst considering the prudent use of the shared natural resource and impact on the local communities and the environment. As each plant operates, it abstracts water from the common water source and discharges pollutants back into it. No regulations exist to control plant emissions, water use or discharge. However, the successful operation of each manufacturing plant, and therefore profitability, depends on the quality of the water.

SSG is played over a series of rounds during which the students make strategic operational decisions: to limit their emissions and therefore limit pollution or continue to pollute as business as usual. The payoff from their decision is their income which is related to the quality of the water. This is determined by the strategic choices made by all management teams. If the water quality declines production processes are negatively impacted and costs increase so that income falls. The income available in each round is determined by the number of companies choosing to pollute the water or to limit pollution. Decision making involves each group considering their potential income, the risks and rewards of their chosen strategy and the choices of the other teams. These decisions are taken within the game environment of others' behaviours and players' personal perspectives on sustainability.

After the eighth round teams are able to collaborate and/or negotiate with other management representatives. In addition, they can choose to fund a prosecution of the most polluting company (a one off payment). In line with the general success rate of environmental lawsuits in the UK, teams have a 1 in 3 chance of being fined. If successfully prosecuted the guilty party is financially penalised.

At the start of the game the students are given game playing instructions which provide cues to learning along with details of their company including its' social, natural and economic environment. Players are also advised of a prize for the winners, that is, the company with the highest bank balance at the end of the game, but are not told what the prize is.

2.2 The Wider Context of Game-Based Learning and Teaching

The value of games as tools to generate positive effects on learning outcomes has been is widely recognised (Gee 2007; Davis and Sumara 2006; Annetta et al. 2009; Katsaliaki and Mustafee 2015). Cheong et al. (2014) and Nagle et al. (2014) highlight the capability of games to engage and motivate students who no longer find traditional learning and teaching styles engaging. Cooper et al. (2010) suggests this is due to their ability to harness collective problem-solving skills. Consequently, games provide a valuable learning environment for EfS as they engage

students in cognitively demanding activities that involve problem-solving and decision-making skills (Fabricatore and Lopez 2012).

Games within EfS are able to shift players' ideas through increasing their awareness of their personal values and environmental behaviours (Dieleman and Huisingh 2006). Kafai (2006) reinforces this, and deems the quality of engagement in a game a significant indicator of its ability to stimulate behaviour change. This research, therefore, explores the ability of SSG to challenge students' thinking.

Game features are able to generate adaptive responses by challenging individual and group behaviours if they are specific problem-solving activities (Schell 2008). Gee (2007) considers in-game contextualisation of these features will generate experiential learning that is able to provoke players to rethink game playing strategies. In addition, unexpected events introduced into a game during play may inspire students to understand and alter their behaviours (Miller and Page 2007). Such 'mutual adaptions' may affect players' objectives and challenge thinking by encouraging behaviours to be re-evaluated in response to unexpected events. These unexpected events may require adaptive responses to cope with the added complexity introduced (Bloom 2010). Therefore, this research uses the potential interventions identified by students as indicators of active participation, emotional response and cognitive investment, to explore student engagement in SSG.

In-game features offer opportunities to change behaviours and develop learning (Fabricatore and Lopez 2012). These include uncertainty, i.e. the inability to fully predict or control the outcomes of actions within the game, and non-linearity, i.e. the interaction amongst game elements that can generate different outcomes. Lizzio and Wilson (2008) consider such game-problems are valuable as they deliver opportunities to develop ideas, promote collaboration and change behaviours in the safe environment of the game.

Ellison and Wu (2008) also highlight the value of game-problems and suggest they can drive learning for good practice as they are able to generate both an individual and collective sense of responsibility within players. Annetta et al. (2009) suggest this sense of responsibility comes from employing game features that challenge or reward behaviours to achieve compromise between stimulating engagement and maintaining focus on learning.

Whilst supporting this view the author considers that learning for good practice also needs to address the learning expectations of students and their future employers as well as to engage students in sustainable futures and advocacy for sustainability within the workplace. Rather than provide the frequently accepted instructivist environment in which students employ just in time learning to obtain a passport to employment (Zepke and Leach 2010), SSG attempts to engage students with EfS and challenge their thinking to develop learning for insight (Beech and MacIntosh 2012), sustainability literacy and awareness and the adoption of sustainable practices.

2.3 Influences on Students' Gaming Experience

Frymier and Schulman (1995) propose that students must recognise the relevance and value in the learning to engage with it. Pelozi and Shang (2011) define this value for consumers as their perception of the return from interactive and relativistic experiences. As students are consumers of educational output (Vanderstraeten 2004) they can be considered to act as customers showing an evolving preference for interactive and relativistic learning and teaching experiences, i.e. interactive, collaborative, experiential learning activities. Students respond to the learning and teaching experience, mirroring a customer's reaction to a product or service, i.e. they appraise whether to engage or not depending on their perception of the value the experience will offer. Students' experience from and engagement with game-based learning and teaching may, therefore, depend on their level of education, familiarity with edutainment, and their experiential exposure to the issues existing within the game.

Interacting in-game processes inherent in a game may influence the students' gaming experience (Iten and Petko 2016). For SSG these may include the introduction to the game, the game process itself players' confidence in their understanding of the game and the debriefing. When introduced to the game students are provided with both written and verbal game play instructions to ensure different learning styles are addressed as recommended by Kolb (1984). At the end of the game students are debriefed, which Krause and Coates (2008) suggest provides an opportunity to use a constructivist approach to learning that allows them to construct knowledge through reflection on game play experience. This debriefing may help students to engage in a community of learning that enables them to share and explore group generated strategies and provide and receive peer reflection and feedback which promotes student engagement (Kuh et al. 2006). In addition the individual and group expectations and behaviours generated within the game may contribute to players' experiences; for example, the potential status rewards from winning, team members' willingness to cooperate and collaborate and team members' personal beliefs in business responsibilities. The opportunity to collaborate after round eight of SSG may present challenges to groups' and individual players' behaviours and encourage the development of alternative and/or combined operating strategies.

During each round of SSG the groups evaluate the encountered and perceived risks and rewards within the game, which Wang and Sun (2011) suggest affect players' gaming experience and encourage behaviour changes. Rewards include maximised financial returns generated through the students' strategic choices and individual groups' decisions to spend capital to increase future returns through investment for technological improvement or to potentially penalise others. Game risks encountered by each group are affected by external factors such as the other groups' strategies that may influence the income received and the players' perception of the likelihood of being fined for operating as the most polluting company.

3 Research Methodologies

This paper presents the findings from the initial cycle of action research to investigate the value SSG has for generating student engagement through experiential game-based learning and teaching within business EfS. Action research provides a route for progressive problem solving (Riel and Lepori 2011) and offers a systematic approach to identifying innovations (Braun and Clark 2006) which provided opportunities to improve learning and teaching practice (Riding et al. 1995). The paper combines participants' responses from a survey conducted with levels 5 and 6 students with reflections from the author to critically examine intellectual and emotional engagement engendered by the game.

The author implemented a qualitative survey to explore the nature and depth of engagement with SSG and EfS which allowed students to reflect on the quality of their learning experience. Obtaining qualitative feedback within deductive research encourages participants to process external information and develop understanding and productive thinking, rather than just the reproduction of information (Mayer 1996). Students participating in this research had a range of knowledge of business sustainability. Some Level 6 students (third-year undergraduates) had taken a business sustainability module at Level 5 (but had not played SSG previously); no Level 5 Students (second-year undergraduates) had previously studied business sustainability within WBS or played the game.

The survey collected evidence to explore two indicators of engagement: firstly, students' testimonies as to SSG's ability to provide both learning and entertainment and secondly students' recommendations for enhancements to SSG. This research does not discuss the content of the suggested interventions; rather it uses the fact that students have responded as an indicator of their intellectual and emotional engagement. These two evidence bases will establish the potential for SSG to educate, entertain, challenge thinking and elicit an emotional response, which demonstrate students' cognitive investment, emotional commitment and active participation.

The questionnaire was distributed at the end of the game following the debriefing session. This emphasised reflection on action (Schön 1987) and asked students to mentally revisit their personal feelings and events to gain insights into their intellectual and emotional engagement with the game and EfS. All student responses were given participant numbers and are used in the analysis of findings below. Codes P1–P19 identify Level 6 students and P20–P31 Level 5 students. The author's reflections on game play interactions, outcomes and student behaviours are also included. Proposals for game developments may be incorporated in future iterations of the game if appropriate, which is outside the scope of this article.

This qualitative, reflective data gathering approach also encouraged students to more deeply engage with nebulous concepts of sustainability, which are frequently ethical and moral in nature, and to think about their learning. Barnett (2007) suggests that such complex open-ended ideas, perspectives, values, beliefs and

interpretations require students to engage emotionally as well as intellectually, which will generate both engagement and deep learning.

Thematic analysis was employed to explore the participants' responses as it enabled qualitative analyses of responses to questions related to students' experiences, views and perceptions (Burns 2005; Braun and Clark 2006) which were the key target of this research. It provided a realist-deductive approach to the analysis; realist as it focused on the assumed reality evident in the responses and deductive as the labelling and themes used were directed by established ideas. Initially students' experience of the game's values for teaching and learning were used to explore levels of engagement with SSG. This was established using core words related to learning (e.g. 'educational' 'insightful' 'informative') and entertainment (e.g. 'fun', 'enjoy') to define a patterned meaning to the responses. Findings were collated both qualitatively and quantitatively and where appropriate, findings were related to the students' level of study.

Evidence for an emotional response to playing SSG was provided by classification of the content of the players' feedback based on indicators of their cognitive investment, emotional commitment and active participation. This deductive reasoning identified comments that indicated a student's reaction to, or feeling towards the game, that was based on more than entertainment. Recognising whether SSG is able to engage students through their emotions as well as through learning and entertainment is valuable within EfS as emotional triggers are able to induce sustainable behaviour (Scott et al. 2016) and potentially develop much-needed advocates for sustainability.

In addition, the framework for engagement in game-based learning and teaching was created to assess the strength of students' engagement. This bespoke framework utilised the three dimensions of student engagement proposed by Chapman and Dunkerley (2012); cognitive investment, emotional commitment and active participation. By assessing players' feedback against these dimensions the depth of student engagement in game-based learning for EfS was established. Students' responses were located on the framework according to the degree of engagement indicated by expressions of commitment and participation.

Finally, SSG's performance against the HEA framework for engagement through partnership (Higher Education Academy 2016) was established. This framework was used to assess the game's ability to enable and empower students through learning, staff engagement and sustainability to create deep engagement; the aim of both the HEA framework for engagement through partnership and EfS. Research findings were mapped against its four overlapping dimensions of engagement: learning, teaching and assessment; subject based research and enquiry; curriculum design and pedagogic consultancy and scholarship of teaching and learning. By comparing the students' learning experience to these four factors the value of SSG for engagement can be established.

4 Results, Analysis and Discussion of Student Feedback

4.1 Students' Experience of Playing

Participants' responses to the survey indicate that the majority of students consider SSG both educational and entertaining; 96% of students confirm that playing SSG engaged them in learning for sustainability and 77% confirmed that they found the game entertaining. For example:

> It was a good way of understanding the point of sustainable thinking (P26, Level 5)

> I learned companies that have concern over resources, environment and pollution usually lose out in terms of profit (P6, Level 6)

> I had a fun experience playing the game, trying to suss out what other groups responses would be in order to choose our answers (P11, Level 6)

> The game was enjoyable (P4, Level 6)

Over two-thirds of Level 6 students and 62% of Level 5 students use core words for both education and entertainment in their survey responses. For example:

> Eye-opener, enjoyable, educational (P1, Level 6)

> I really enjoyed it and found it informative (P15, Level 6)

> I learned new things by enjoying a team game (P30, Level 6)

> Fun interactive experience which enabled me to think about how sustainability would impact businesses in real life situations (P22, Level 5)

Charsky (2010) considers that if education and entertainment can be seamlessly combined with learning and teaching the resulting experience is 'edutainment'. The findings of this research suggest that students consider SSG offers 'edutainment' that engages them. For example, one student considers SSG to be,

> An excellent game that kept me fully engaged (P31, Level 5)

The survey responses indicate students develop high levels of self-perceived game competence when playing SSG, which Fazey and Fazey (2001) consider a key motivator for engagement. For example:

> It was fun and a different experience to the lecture. I enjoyed working with my team to make conscious sustainable decisions (P24, Level 5)

> It was good working together and coming up with a strategy (P11, Level 6)

These examples of self-perceived competence also suggest SSG is able to enhance learning for sustainability through collaborative engagement in the in-game sustainability practices which explore the equitable sharing of the use and benefits of generic resources. The author notes that SSG unleashes some students' competitive nature and it appears that success in the competitive elements of the game (particularly if their competitors were penalised by their actions) enhanced their self-perceived competence and enjoyment of playing.

When explored in more detail the research findings indicate both Levels 6 and 5 students recognise SSG as a valuable opportunity to develop knowledge of the tensions inherent within business sustainability whilst being entertained. 100% of Level 6 students and 92% of Level 5 students indicate that they engaged in sustainability learning whilst playing; 74 and 83% reported being entertained. More Level 6 students recognise the learning delivered through SSG than Level 5 students which the author considers may be due to the students' level of education and familiarity with game-based learning.

However, more Level 5 students identified their enjoyment, suggesting that this cohort were more engaged in the entertainment of game playing. This may be due to differences in students' academic experience, exposure to EfS and business strategy making and/or experience of game-based learning. The author notes that five weeks after playing SSG (which included the Easter break) Level 5 students were still talking about their enjoyment of it and how they would respond differently if they were to play again, e.g. collaborating earlier in the game to influence behaviour change, adopting different business strategies, etc. Level 6 students asked to play more games and some even brought their own games into the taught sessions.

The research findings demonstrate that more than two-thirds of students at both Levels 6 and 5 felt that playing SSG had challenged their sustainability thinking, both as individuals and with regard to business behaviours. Students' responses suggest that 68% of Level 6 and 66% of Level 5 students engaged cognitively with game-based learning and teaching. For example:

> Positive and insightful [experience] about other people's behaviour and business (P13, Level 6)

> [It] made me think about the needs and wants of the game in comparison to individual versus collective rationale (P12, Level 6)

> [It] made me understand that it is so complex to act sustainable for a company thinking about profit and environment at the same time (P26, Level 5)

> [It] taught me the complexity of making such decisions within a real life study (P28, Level 5)

Whilst the majority of students confirm that playing SSG had challenged their thinking, fewer appear to have developed an emotional response to the sustainability topics within the game or to the game itself. However, although this impact is lower, SSG has still managed to emotionally engage almost 50% of the players which Barnett (2007) suggests may promote deep learning.. Examples of evidence for this emotional engagement include:

> It made you think about the importance of sustainability, and whether the prize was more important than being sustainable (P4, Level 6)

> We made the most profit out of all the businesses—so as a business perspective we were successful. However, from someone who is concerned about the environment then the 'limit pollution' action should have been considered more often (P6, Level 6)

> It was difficult to make the 'right decision' based on what we thought other groups would do (P10, Level 6)

> Helps boost understanding on what the actual effect on businesses, locals, etc., of pollution and regularly how business can get away with doing their own thing (P18, Level 6)

The author notes that tensions over willingness to 'do the right thing' at the expense of foregoing potential maximum short-term returns emerged within and between groups. The research findings indicate that some students also recognise this and have highlighted the conflict between their desire to win the game and the knowledge that their group is not behaving sustainably. This aspect of the game playing experience will be explored further in future research to maximise the opportunities it presents to enhance engagement in sustainability learning.

To further understand the level of students' engagement with EfS created by SSG players were asked to suggest game changes and/or additional game features and in-game challenges that could be incorporated to enhance their experience of playing the game. This reflection on playing helps to cognitively and emotionally embed the processes taking place within the game and makes them more relevant to the participants, which Wolfe and Byrne (1975) suggest further develops engagement.

The analysis of survey responses highlights the fact that 94% of students made at least one suggestion for a potential development of SSG, with 45% suggesting two or more opportunities for enhancement. This emphasises students' engagement with the learning outcomes, purpose and rules of SSG as well as the interactions facilitated and problems to be overcome during the game sufficiently to be able to recognise potential improvements.

4.2 Discussion of Findings

The research findings suggest that SSG is a cognitively demanding environment that provides an opportunity to engage students with learning and teaching for EfS. It also promotes the development of sustainability literacy skills through game-based edutainment and participatory interaction which the author considers an encouraging sign for future advocacy for sustainability. Two models are used to assess the extent of this engagement; firstly, the Framework for Engagement in game-based learning and teaching, and second the HEA Framework for Engagement through Partnership (Higher Education Academy 2016). Mapping research findings against these models allow the strength of student engagement, sources of engagement and outcomes of the game play experience to be explored further.

The framework for engagement in game-based learning and teaching (Fig. 1), based on the dimensions of engagement identified by Chapman and Dunkerley (2012), suggests students have actively participated in SSG and engaged strongly with both the game play experience and the concepts of sustainability embedded within it to cognitively invest in their learning. The interactions facilitated by the game between individuals, within and between groups and between students and the key principles of business sustainability (efficient and equitable use of natural

resources, environment and social impact mitigation, collaboration and resilience) also emerge as strongly engaging the research participants.

Although fewer comments indicate an emotional response to the sustainability concepts in the game, those students commenting on this demonstrate high levels of engagement.

Mapping the research findings against the HEA Framework for Engagement through Partnership (Higher Education Academy 2016) (Fig. 2) suggests that being involved in game playing, participating in in-game interactions, demonstrating sustainable approaches and reflecting on game playing experiences has provided

	Weak engagement	Medium engagement	Strong engagement
Cognitive investment		It was an interesting game It was valuable to see the results Don't think it is exactly how real life would go	Eye-opener… Insightful… It was valuable… Fun and challenging… Helpful and challenging… Helps to boost understanding Made you think… It opened my mind… Very challenging game… Taught me… The game was highly educating… I learned new things… I learned a lot…. You understand how… Educational…
Emotional commitment			Great experience… Good game even though we lost I enjoyed working with my team to make conscious sustainable decisions Excellent game that kept me entertained and fully engaged It is a shame destroying the environment is a profitable activity
Active participation		A different experience to the lecture	Using our tit-for-tat strategy…. It was good working together… Fun, interactive experience… Engaging experience in comparison to normal lectures as it required me to be more involved Played in class as a group I really enjoyed playing the game and I would be interested in playing more games like this The game was easy to understand Enjoyable… An engaging experience… Challenging… Different to normal lecture and more understanding…

Fig. 1 Framework for engagement in game-based learning and teaching

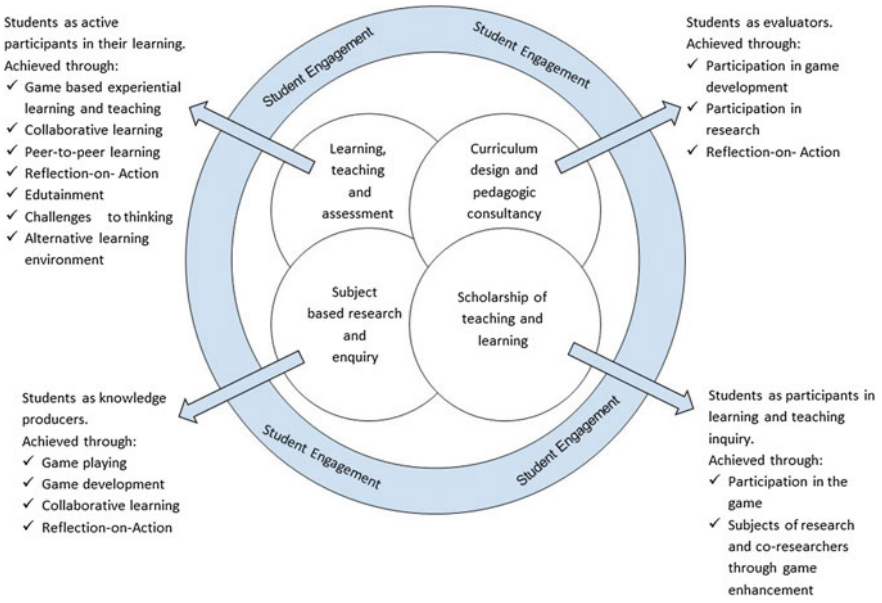

Fig. 2 SSG's effectiveness in meeting the HEA framework for engagement through partnership (Higher Education Academy 2016)

learning and teaching outcomes that allow both students and staff to reflect on, inspire and enhance practice for learning, which is the objective of the framework.

The intrinsic and extrinsic value identified by the framework highlights SSG's ability to generate active participation in EfS through the edutainment of game-based learning, collaborative learning and reflection on action, all of which challenge sustainability thinking within an alternative learning environment. This may inspire sustainable behaviours as advocated by Scott et al. (2016) and awareness of personal sustainability values (Dieleman and Huisingh 2006) both of which promote new ways of thinking and learning which are fundamental within EfS (HEFCE 2013). Game playing and game development appear to engage students as producers of sustainability knowledge and co-researchers who contribute to scholarship, rather than as receivers of information.

This research has also offered students roles as co-researchers, game participants and game developers which have allowed them to evaluate the lecture content and participate in future curriculum design thus achieving the constructivist approach to learning. These activities, along with the post-game debriefing, encourage experiential learning and reflection on action that allow students to construct knowledge through critical reflection on game play experience recommended by Krause and Coates (2008) and Bonwell and Eison (1991). These learner-centred activities also offer the constructivist methodological approaches to EfS recommended by Sterling (2012) and demonstrate the drivers of engagement incorporated within the HEA

framework. All of these inputs and learning outcomes captured within the framework provide students with the opportunity to shape their own learning experience.

5 Implications for Practice

The results of this research confirm that using SSG as an alternative approach to learning and teaching to business sustainability is able to positively influence students' engagement, which HEFCE (2013) considers fundamental within EfS. Thus games, if appropriately designed and implemented, can cognitively engage students and make a difference to sustainability learning outcomes and the value of students' learning experience. The fun, interactive and experiential nature of the game appears to generate this value whilst the game play experience and interaction with the key factors of business sustainability encourages the creation of a learning community, and as the research shows, some emotional involvement. Interaction within the student cohort encourages the players to become a community of competition which further engenders engagement and collaborative learning for sustainability.

This research suggests that investing in games can make a difference to levels to student engagement which repays the investment in EfS curriculum design. This may be because games are able to address learning expectations of students, develop a focus on learning for insight within EfS which are valued by Beech and McIntosh (2012) and highlight the real-life tensions between profitability and good practice faced by businesses. The research also suggests SSG provides a valuable learning environment for EfS by engaging students in problem-solving skills and sustainable decision making which is valued by Fabricatore and Lopez (2012). These game-based learning outcomes may, in turn, stimulate a sense of personal and business responsibility within players; a vital requirement for sustainable business futures. Games appear to provide an opportunity to provide learning support without simply providing information, which Armier, Shepherd and Skrabut (2016) consider a potential driver of deeper learning.

Many businesses claim possession of a range of skills for sustainability to be important when recruiting graduates (Drayson 2015). This research has identified that SSG can contribute to the development of such skills, including an understanding of how business decision making is frequently in conflict with the most environmentally and socially sustainable actions. SSG appears to present a learner-centred approach to EfS that engages students in both hard (e.g. financial management and strategy making) and soft business skills (e.g. negotiation, influencing and collaboration) whilst challenging their thinking in a safe learning environment. Christenson, Reschly and Wylie (2012) suggest this provides an opportunity to enhance learning outcomes including retention and improved employment prospects. Participation in the game may, therefore, enhance students' employability skills.

In order to progress this research, additional cycles of action research will be implemented to obtain specific suggestions for interventions and further explore the benefits of game-based learning and teaching to student engagement within EfS. Additional interventions may be incorporated into SSG to provide an enhanced collaborative and experiential learning experience.

6 Conclusions

The research presented here suggests that strong student engagement has been obtained from the cognitive investment, emotional commitment and active participation in the game-based learning and teaching offered by SSG, one of the group-based games utilised as a participatory approach to EfS within Worcester Business School. This strong level of engagement appears to have been generated by the entertainment and interactive experiential learning encapsulated within the game play experience. The framework for engagement in game-based learning and teaching confirms the value students have placed on the learning experience offered by this approach to sustainability learning, a feature supported by the thematic analysis of survey responses. Post-game reflection has helped students recognise that playing SSG has provided an opportunity to participate in an experiential, active, collaborative learning experience that enhances self-confidence in sustainability including the consideration of business strategies that promote appropriate, fair, shared access to generic resources.

The game appears to challenge students' thinking and provide experience of softer skills required for a business career, including negotiation, collaboration and influencing. These have been practiced in the safe environment of the lecture room. Group interaction (including the community of competition created by students) and learning support experienced during game play may have contributed to the high levels of strong student engagement highlighted by the research findings. The framework for engagement through partnership (Higher Education Academy 2016) has proved valuable in scoping the source of SSG's in-game, learner-centred approaches to EfS and reinforces the value of the entertainment and experiential and collaborative learning provided by the game.

This research into game-based learning has offered an evidence-based, practical and theoretical understanding of students' preferences for experiential activities. This is now influencing the author's design and planning of learning activities to support student learning, both in existing modules and potential new programmes for EfS. Additional action research into the effectiveness of this innovative approach to sustainability learning and teaching will allow further consolidation of research and scholarship into the professional practice of EfS.

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A Summer School for Sustainable Management as a Strategy for Fostering Collaborative Competencies to Be Able to Build Multi-Actor Partnerships

Ingrid Molderez, Karen Brabant and Wim Lambrechts

Abstract

Business schools are more and more thinking about innovative ways to integrate sustainability into the curriculum. The Summer School Sustainable Management was developed by the close collaboration between three Belgian organizations, i.e., KU Leuven, a university, Odisee, University College, an institution for higher education of professional level, and VOKA Oost-Vlaanderen, a chamber of commerce, with that particular aim. Participants came from institutions of higher education, companies, and non-governmental organizations (NGOs). The delegates were especially attracted by the format of the summer school, i.e., people coming from diverse backgrounds working together on a sustainable challenge formulated by SMEs. The most important conclusion is that solving real-world learning cases by a diverse group composed of students, managers, and NGOs representatives is helpful for fostering collaborative competencies, on the condition that the group is as diverse as possible. Moreover, students are eager to attend when they can add this experience to their academic portfolio or when they can gain credits. Managers and NGOs representatives will be

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motivated to participate when the summer school is limited in time and when the sustainable challenges are of relevance to them. When several alternative learning approaches are integrated, a summer school can also stimulate the competency for creativity, critical thinking, and interdisciplinary work.

Keywords
Summer school · Sustainable management · Collaborative competence · Passion

1 Introduction: Competences for Sustainable Development

The complexity and uncertainty of sustainability issues require a different approach towards learning. Within the international literature about Higher Education for Sustainable Development (HESD), specific attention is given to so called competences for sustainable development, more specifically to their definition (e.g., Rieckmann 2012; Wiek et al. 2011), integration (e.g., Lambrechts et al. 2013), operationalization (Wiek et al. 2016), relation towards other competences (e.g., Lans et al. 2014; Lambrechts and Van Petegem 2016), and assessment (Cebrián and Junyent 2015).

Since the launch of the United Nations Sustainable Development Goals (SDG), the seventeenth goal, i.e., partnerships for SDG goals, has received a lot of attention. Individuals or organizations cannot achieve sustainable development goals on their own. Collaboration is needed between civil society, the private sector, and governments. In a world that is becoming more and more individualistic, a competence for collaboration cannot be taken for granted. When thinking about "Transforming our world," the importance of education in human behavior should always be considered of vital importance. Wiek et al. (2011) define five key competencies in sustainability as being critical for graduating students to acquire: systems-thinking competence, anticipatory competence, interpersonal competence, strategic competence, and normative competence. A competence for collaboration fits within their normative and interpersonal competence. Rieckmann (2012) developed a list of 12 key competences for SD: systemic thinking and handling of complexity, anticipatory thinking, critical thinking, acting fairly and ecologically, cooperation in (heterogeneous) groups, participation, empathy and change of perspective, interdisciplinary work, communication and use of media, planning and realizing innovative projects, evaluation, ambiguity and frustration tolerance. Blok et al. (2016) focus on the importance to define the normative competence and action competence from a virtues perspective. They present one virtuous competence with two mutually related aspects: a normative and an action related one. This virtuous competence for sustainability allows to deal with the "wicked" character of sustainability issues (Blok et al. 2016).

The definition of new competences for SD also leads to discussion about their relation to other competences, already integrated in educational settings. Wiek et al. (2011) state that so-called "general" competences, such as communication, could help in acquiring sustainability competences. Lans et al. (2014) interlink sustainability competences and entrepreneurship competences, and conclude that normative competence was not valued in entrepreneurship education. Lambrechts and Van Petegem (2016) explore the interrelations between sustainability competences and research competences. They conclude that a thorough holistic approach is missing, and that research competences ideally should be framed within a context of sustainability.

This leads to different approaches that can be applied in higher education, in order to help students to acquire the sustainability competences (Tilbury and Mulà 2011). On a general level, education should be oriented toward interactive and participative methods, action-oriented methods, and research-based methods (Lambrechts et al. 2013). Different initiatives and case studies have been presented in the literature, focusing on introducing real-world problems in the curriculum (e.g., Brundiers et al. 2010; Steiner and Posch 2006), using the university campus as a living laboratory (e.g., Lambrechts and Van Liedekerke 2014; Lambrechts et al. 2015), and development of specific sustainability courses (e.g., Ceulemans and De Prins 2010). Wiek et al. (2016) present different methods and pathways for the operationalization of sustainability competences in higher education curricula, with specific attention toward the concepts and methods that are recommended to enhance the integration of the five key competences as defined by Wiek et al. (2011).

Business schools have to think about how to engage with real problems (Mingers 2015; Holgaard et al. 2016; Brundiers et al. 2010). According to Mingers (2015, p. 328) they are part of the problem because of the "lack of engagement with external organizations, irrelevance of research, inappropriate teaching curricula, little concern for pressing social issues and questionable ethical commitment." Mingers (2015, p. 327) sees an important role for the introduction of critical realism in business schools because of the "complex, multidisciplinary and resistant to easy, technocratic solutions." A critical realism perspective also helps to develop competences such as critical thinking and critical consciousness because its main characteristics are "multidisciplinary teams, transdisciplinary thinking, a willingness to develop perhaps unorthodox and radical ideas, and a continual commitment to put the interests of ordinary citizens and society as a whole above those of corporations, political parties or even nation states." The same stance is taken by Holgaard et al. (2016, p. 3479) who argue that when engineers are expected to be able to provide sustainable innovations for future societies, they should also be able to think "beyond pure technical competence." There exists a diversity of alternative learning activities, such as community-based projects (Clevenger and Ozbek 2013; O'Brien and Sarkis 2014), project-based learning (Brundiers et al. 2010), internship (Brundiers et al. 2010), simulation (Lean et al. 2006), and problem-based learning (MacVaugh and Norton 2012). Community-based learning or service-learning is a learning activity that starts from the needs of a community that will be met by the

work of students. Brundiers et al. (2010, p. 311, referring to Ward and Wolf-Wendel) urge for a transition from "for the community" to "with the community". In this respect, mutual learning is central. Students and non-academic experts cooperate in all the phases of the research project. By cooperating together, students will be able to "explore, recognize and synthesize different knowledge claims and ways of knowing (Brundiers et al. 2010, p. 312). Moreover, the knowledge generation is two-way because interaction will also stimulate the learning process for non-academic experts. They will interact with youngsters who have a different view on how the society must evolve and radically change toward sustainability.

2 Case: Summer School Sustainable Management

Odisee University College and KU Leuven Faculty of Economics and Business, two institutions for higher education in Belgium, Brussels, and VOKA Oost-Vlaanderen, a chamber of commerce located in Ghent, opted for a summer school as a combination of community- and problem-based learning activity. The problems were more formulated as a sustainable challenge, allowing participants to have a positive view of what they can change for the best in the future. Most of the time summer schools are something extra students can opt for during the summer period. In this case, it was the aim to perceive the summer school as a valid part of the curriculum. Students could opt for credits if they were interested or could add their participation to their academic portfolio. The delegates were selected on the basis of a motivation letter. More students were willing to participate than the available places. The group of 25 delegates was composed of 12 students, 8 representatives of NGOs, and 5 representatives of companies.

The summer school formed part of a bigger Erasmus + project, i.e., Hecos for Ethics or Higher Education and Companies Fostering Ethical Skills. The project had partners from diverse countries in Europa, i.e., Italy (AICCRE VE and OIKOS Onlus, Belgium (VOKA, Odisee); Hungari (Uniflex); Slovakia (TUK, PRSCCI), Sweden (STOCKHOLMS UNIVERSITET), and Portugal (ROSTO SOLIDÁRIO). This project had three aims. First, enhancing the role of ethical competences for managers by developing an innovative and attractive training format to hit, assess, and recognize learning results and fix common learning results standards related to ethical competences, as well as organizational skills, in non-formal and informal training contexts. Second, facilitating the enrichment of managerial curricula, of today and tomorrow, also with ethical skills and foster the promotion of Corporate Social Responsibility (CSR) in the higher education sector and companies, by raising awareness of production companies on the issues of human rights, respect for the environment and the consumption of land and resources. The third aim was to create a network of companies interested in experimenting with innovative training methods of nonformal and informal education for adults on the issues of environment and human rights aimed at improving the organizational and

management skills through the adoption of positive actions in the field of CSR and international solidarity. Despite the clear goals, there was still a lot of freedom in the project such as developing a summer school.

Having three different actors participating in the Hecos for Ethics project, i.e., higher education, representatives of employers and NGOs, facilitated a specific format of the summer school. It was organized as an intensive 3-day training course for delegates from universities, enterprises, NGOs, and grassroots organizations. To be able to see it from a practical side, they were brought together with the aim to foster their sustainable thinking and to increase their collaborative competences. The first edition of the Summer School Sustainable Management took place in September 2016 and had a unique training format, taking competences for collaboration into account. Three small and medium-sized enterprises (SMEs) from Ghent-formulated sustainable challenges relevant for their organization: OR Coffee Roasters, Magelaan and Zonen O9. The choice for SMEs was a deliberate one. SMEs often neither have the time, nor the resources to spend time on a sustainable challenge that is vital for their organization. OR Coffee Roasters is a Belgian Coffee Roasting company working from bean to cup. They start at the plantation level, source directly, import, roast, train and serve coffee in their own coffee bars or deliver the coffee to other coffee bars and restaurants. The challenge they were interested in was the relevance of sustainable labels. Magelaan is a full-service marketing and communication agency committed to integrate sustainability in its entire organization. They wanted to know how to motivate customers to buy sustainable products and why companies still feel restrained to communicate on their CSR-activities. Zonen 09 is a one-man business specialized in designing sewing patterns and organic fabric for boys and menswear. The founder is confronted with the guarantee of sustainable resources and wonders how one can be sure of sustainable sourcing. During a study visit at the site of the companies, the participants of the summer school got an overview of their vision and mission and were given the opportunity to ask questions considering the sustainable challenge. Different expert sessions were given in Brussels to help participants to select appropriate frameworks to analyze the ecological challenge. Because of the link with sustainable labels, sustainable marketing, sustainable sourcing, and how to make a sustainable transition, the expert sessions were related to these topics. Because the sustainable challenges of the companies were central in the format of the summer school, they determined the content of the expert sessions. The challenges will change each year, and as a consequence also the expert sessions.

The specific selection of the companies and the sustainable challenge is not important in itself, although very vital for the attractiveness of the summer school. Nevertheless, the representatives of the selected companies (managers or owners) must have an interest in sustainability. Moreover, they must have an open attitude toward a diversity of people taking a look at the challenge that is of interest to the company. The most important element with regard to the summer school was precisely the diverse composition of the participants. Each group consisted of students, representatives of employers and NGOs. They had to work together on the sustainable challenge of their choice. The results of the group work were presented

during the last day. Representatives of the three companies gave immediate feedback. Thanks to virtual technology it was not needed for all of them to be present at the site of the presentations. From the presentations, it became clear that the participants were able to strengthen their strategic, practical, and collaborative competencies.

In line with Shrivastava's (2010) urge for a pedagogy of passion for sustainability, an emotional engagement formed part of the content of the summer school, apart from an intellectual understanding. A session on creative presentations was included to give the participants the opportunity to discover their own drawing capacities as a way to present meaning. The sustainable cooking workshop aimed to combine knowledge about sustainable food and working together to cook a meal, with the least possible negative impact on the environment. The rationale behind this workshop went deeper than just offering a social activity. It emphasized that management education should be connected with the rest of the day (Shrivastava 2010, p. 446). Because of a diversity of requirements, i.e., appointing a leader per subgroup, deciding in community about the concept of the meal and working together to cook the meal with the available vegetables and within a time constraint, the cooking workshop gave opportunities toward learning about leadership, human behavior, goal formulation, strategic implementation, and flexibility.

3 Conclusion: Reflection on the Format of the Summer School

Participants were given the opportunity to reflect upon the format of the summer school at the end of the three days. They especially valued the participants coming from diverse sectors; the company visits; the variation in the program; the different approaches to foster sustainable competencies; the diversity of the speakers; the business cases and the limited amount of students participating in the program. The format of the summer school fitted in a critical realism approach (Mingers 2015). By solving a sustainable challenge formulated by companies, institutions of higher education in management engaged with real problems. The diverse composition of the groups was an illustration of transdisciplinarity because delegates came from inside and outside the university. They learned from each other and built respect for other opinions, visions, and values that were collectively crafted (Wiek et al. 2011). The summer school also added to the development of critical thinking: why are sustainable labels needed, how is the value chain adding to sustainability, how to motivate for sustainability, how to create a sustainable attitude?

Because the summer school formed part of a bigger network, it was not difficult to find participants from companies and the NGO-sector for this pilot project. This strength was at the same time a shortcoming. Representatives from companies are difficult to motivate to cooperate during three days because of time and budget

constraints. According to the participants, the diverse and multidisciplinary composition was an important value of the summer school. This diversity was needed to be able to foster collaborative competences. Managing wicked problems like sustainability requires the active involvement of stakeholders (Blok et al. 2016). There are mainly two reasons for this. First, external stakeholders can look at the sustainable challenge from a different angle. Secondly, working on a deep change towards sustainability, i.e., a radical change (Wheeler 2007) may not be reached by only one person, but by acting together. This also creates a sense of joined ownership. Everybody has participated in the process and feels committed toward the outcome.

Despite the positive elements there were also some negative aspects. First, one has to think of different strategies to motivate representatives from companies and NGOs to participate during the whole process. Having a challenge formulated by them or being relevant to them was clearly not enough. Companies did not see the relevance for them of participating in the entire process. They perceived the challenge from a traditional educational point of view, i.e., others coming up with solutions and afterwards managers from companies reflecting upon it.

Secondly, the roles NGOs wanted to play can also be an obstacle for this type of summer school. Although more and more emphasis is on the collaborative role of NGOs with companies, NGOs still think they must be able to hold their independent position in relation with companies. Too much emphasis on collaboration might have a negative impact on the critical position they want to take.

Thirdly, the intensity of the summer school prevented participants to integrate academic articles and to rely on profound research. The tight schedule did not allow for enough time to do some research although the aim was to reach an academic standard. This shortcoming can be solved in the future by integrating the summer school in a longer track of the specific course that is already providing the credits. A presentation of the solution can then be integrated into a research paper. The reason behind a summer school of 3 days was to be able to attract business people. Three days is the maximum for them leaving their company. Nevertheless, the next summer school will be organized during five days to be able to give more free time slots for the participants to do research and to write an academic paper.

The next edition of the summer school will closely collaborate with a Belgian NGO who has many contacts within the NGO-world. This will allow us to get more participants from NGOs. Efforts will also be made to formulate a sustainable challenge that links companies with NGOs. In the pilot project, the challenge was only formulated from the point of view of the company. This could explain the limited number of NGOs participating in the summer school. Another change will be related to the students. The pilot project only attracted students from the own campus. Future cooperation with other institutions of higher education will enlarge the diversity of the students and the diffusion of the format.

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Recognising Beach Kindy as a Pedagogical Approach for *Critical Agents of Change* Within Early Childhood Education

Diane Boyd and Nicky Hirst

Abstract

Research (Davis, Elliot, Hagglung, Johansson, Ritchie, Miller, Inoue, Chua, Sageidet, Young, Cutter-Mackenzie, Ji, Stuhmcke, Mackey, Ohillips, Enggahl, Arlemalm–Hagser, Barrat, Barrat–Hacking, Black, Chawla, Rivkin, Gorman, Sundberg, Ottander, Gilbert, Fuller, Palmer, Rose, Farrell, Danby, 2014) has indicated that very young children are capable of supporting the Agenda for Global Action through transformative and creative pedagogical approaches utilised through their environments, that are informed and practiced by knowledgeable early education practitioners and leaders. The early years offers multiple opportunities to surround young children with the awe and wonder of their world, linking to their local cultures, as they seek to question, challenge and access possibilities to transform their families and communities. Beach Kindy utilises the natural environment of the coastline, at sites that demonstrate the biodiversity of the planet. Water, for example, is recognised not only as an effective medium and tool for education *for* sustainable development but also its immense capacity to support holistic, interconnected areas within early childhood education. However, it is acknowledged that this approach is not without challenges. The four home nations that make up the United Kingdom (England, Northern Ireland Scotland and Wales) have distinct early years curriculum frameworks and this paper focuses on the English framework, The Early Years Foundation Stage (The Department of Education (DfE) (2014). The DfE (2014) imposes what is perceived by many as a linear statutory framework and policy makers must try to move towards embedding education *for* sustainable development and encourage more flexible, creative approaches to

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learning. The English Early Years Foundation Stage (EYFS, DFE 2014) statutory guidance focuses on three Prime areas, (Communication and Language, Personal, Social and Emotional Development and Physical Development and four Specific areas including, Understanding the World (UW). This Specific area (UW), presents a renewed emphasis on a 'concentric approach to learning' (Tickell in The early years: foundations for life health and learning (Tickell review), DfE, London 2011, p. 104) where children are guided to 'make sense of their physical world and their community through opportunities to explore, observe and find out about people, places, technology and the environment' (DfE 2014, p. 8). Children can become young scientists, utilising the coastlines and becoming "ocean literate". Early education practitioners can thus provide "a platform to channel their infinite capacities for activism into the creation of a better world". (2015, p. 12). This paper seeks to explore how Beach Kindy can help implement both the Sustainable Development Goals and the scientific approaches embedded within UW, whilst also recognising the challenges that it may bring.

Keywords
Education for sustainability · Early childhood care and education for sustainable development · ECCESD · Beach kindy · Ocean literacy

1 Introduction

Sustainability is defined in the Brundtland report—*Our Common Future* (1987, p. 41) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The report highlighted the need for awareness around the "so called free goods like air and water" and that "sustainable development requires that the adverse impacts on the quality of water, and other natural elements are minimised so as to sustain the eco systems overall integrity" (1987, p. 43). Furthermore, the scientific importance associated with the ocean was characterised in "the earths wheel of life" (1987, p. 217) and more recently in the Ocean Literacy Framework (2002–2010, 2013) and the Ocean Literacy Framework UK and Europe (Savage 2014), for providing balance and sustaining the earths vital life support systems. In 1996, Elder (p. xxii) noted how "a balanced ecological identity encompasses both scientific awareness and reverence for the processes of life, both personal stories and the responsibility of a citizen". The idea of world citizenship was considered in the Brundtland report (1987, p. 9) with recognition that all "citizen groups" should, and must play an "indispensable role in the creation of public awareness" around sustainable development. The authors postulate the value of transformative education when working with young children, as one of these citizens groups, exemplified by Davis' (2014) assertion

that early childhood education has a vital role to play in "societies' transitions to sustainability" (2014, p. 21). She comments that young children are citizens within "an expanded rights framework" with a focus on "foundational rights, as promulgated by the UNCRC, agentic participation rights, collective rights, intergenerational rights and bio-ecocentric rights" (Davis 2014, p. 23). 1987 was also the European Year of the Environment which coincided with the development of the European Blue Flag scheme for beaches. This blue flag idea was later adopted by the Foundation for Environmental Education (FEE) which developed the International Eco-School Programme to support the implementation of the key aims and objectives of the Earth Summit 1992. The Earth Summit recognised the need for all citizens to recognise "new forms of participation" especially in regard to decision making "which potentially affect the communities in which they live" (1992, p. 270). This opens up the possibilities for young children to be recognised as agentic citizens. Additionally, in 1991 most countries of the World signed the United Nations Convention on the Rights of the Child, which established children as participants in decision making on matters that affect them. However, Strang et al. (2007) argue that the development of scientifically literate citizens is not enough as children need to be familiar with "ocean issues that may or may not be happening in their own backyards" (p. 7). The Ocean literacy framework (USA, 2002–2010) was devised to readdress the lack of ocean related content in science education and the Ocean Literacy framework (UK and Europe, Savage, 2014) cites how an ocean literate child "is able to make informed and responsible decisions regarding the ocean and its resources" (p. 1).

At the Johannesburg World Summit on Sustainable Development (2002, p. 6) there was a "collective determination" to highlight not only environmental concerns but wider issues that had previously been neglected. Moreover, the Declaration noted how "the children of the world spoke to us in a simple yet clear voice, that the future belongs to them" (p. 7). The Declaration recognised the need to manage and protect the earths' natural resources, "ensuring the sustainable development of the oceans requires effective coordination and cooperation" (2002, p. 30). The authors highlight the Ocean literacy framework: UK and Europe (Savage 2014) as a useful pedagogic tool to build coherent and conceptually sound scientific learning experiences for young children. Whilst this framework is noted as an instructional tool, it shows how educators can help learners build their understanding of the seven Ocean literacy principles. The guidance can be considered by early childhood educators with an emphasis on the Characteristics of Effective Learning noted in the English Early Years Foundation Stage (DfE 2014). These characteristics highlight *how* young children learn, through playing and exploring, active learning and creating and thinking critically (DfE 2014, p. 9). This paper explores an integrated holistic approach to sustainability through "sustainability science" (Clark 2003, p. 3). UNESCO highlights the power of social transformation as a driver of environmental change and clarify it further as "science *about* sustainability" and "science *for* sustainability". It defines science about sustainability as understanding "how complex physical, biological and social systems function", whilst science for sustainability is "to support sustainable policies and positive social transformations"

(UNESCO). Wals and Leij (2009, p. 18) highlight that the challenges of transforming societal sustainable change are complex and require a new type of thinking. They advocate that applying a "routine problem-solving approach falls short" and instead emphasise that "transitions require a more systemic and reflexive way of thinking and acting with the realisation that our world is one of continuous change and ever-present uncertainty". By strategically utilising the principles of "co-learning" (collaboration, team work, democratic dialogue) and sharing knowledge across disciplines (science is one) will effectively build capacity in three key areas: "critical evaluation of existing knowledge and problems, knowledge generation and penetration, and application of this new knowledge to policy, practice, and everyday life". (Glasser 2009, p. 52). The involvement of challenging diverse views and disciplines should ultimately encourage "building a common language, transparency, tolerance, mutual trust, collaboration" (Glasser 2009, p. 52) and to a more sustainable future. Indeed, Wals et al. (2014) highlight the potential for a convergence of environmental education and science education. The interdependency of an ethical foundation recognised in the Earth Charter Initiative (2012) is mirrored in the principles of the Ocean Literacy framework promoting the four dimensions of respect and care for the community of life; ecological integrity; social and economic justice and democracy, nonviolence and peace. UNESCO and the International Oceanographic Commission are developing a learning tool utilising the seven essential principles of the Ocean literacy framework too. It aims to "sensitise and enable" educators to develop marine citizenship. In September 2015, the new sustainable development goals included recognition of early childhood education; however, this is framed within the paradigm of 'readiness' for primary education (SDG 4; target 4.2) and caring for the ocean and its ecological systems (SDG 14).

2 The Foundations of Early Childhood Education

Barratt et al. (2014) highlight that the open air schools' movement in the 1900's was a response by early years pioneers, such as Margaret and Rachel McMillan, to public health issues and this emphasis on outdoor provision resonates with current early years practice. The Global Education Monitoring report (2016, p. 41) suggests the need for a "shift from a view of child development based exclusively on health related indicators". However, historically the pioneers of the Kindergarten philosophy for example, Pestalozzi and Froebel, were grounded in science and nature (Joyce 2012). In England early childhood pedagogy is founded on the belief of child centred and self-directed learning (Kwon 2002). Whilst the sociological idea of agency is considered within Education for sustainability, the idea of children as agentic in their own learning was captured by Pestalozzi who evoked the notion of child self-activity or sensorial learning. In this context, the role of the teacher was seen as a mediator who linked learners through their senses with the outside world. Dewey's theory of experiential learning is captured by Horvath (2016, p. 26), where

young children learn, "not through being mechanically drilled in prefabricated material, but by doing work, experimenting with things, and changing them in purposive ways". Dewey's philosophies can be seen in current practice with young children, especially in terms of engaging in field trips and longitudinal community based projects, where young children become familiar with their local environments.

In England and elsewhere, play is an integral element of the curriculum, founded on the belief that children learn through child initiated learning (Jarvis et al. 2014). In 1967, the Plowden report (CACE 1967) gave play a strong endorsement noting that within play "children gradually develop concepts of causal relationships, the power to discriminate, to make judgements, to analyse and synthesize, to imagine and formulate" (p. 193). This discovery learning is exemplified by Oates and Grayson (2004) who consider how reproductive learning is comparable to learning facts but generative knowledge allows children to come up with answers for things that they have not been taught. Witt and Clarke (2015, p. 131) consider the power of an Eco-playful early childhood pedagogy as this takes "a more hopeful perspective, inviting openness and honesty" (p. 132) with dialogue with young children. Elliott and McCrea (2016) draw interesting parallel developments associated with the emergence of theories around the new the sociology of childhood (Corsaro 1997), that viewed young children as social participants and the promotion of children's rights to participate in decision making about matters that affect them (UNCRC, UNICEF 1989).

In 2009, Davis conducted a literature review of research centred on Early Childhood Care and Education for Sustainable Development; (ECCESD), where she highlighted an extensive research hole with a lack of research around this area. She explored the research in this domain with a distinct rationale for the compartmentalised results, with studies focusing on young children's relationships with nature noted as "education in", and research related to children's understanding of environmental topics as "education about". The void was most prominent with "education *for*" which is defined within the sociological concept of agency.

Davis (2014) also highlights Education for Sustainability as a "relatively new field that has become a global movement in the space of a decade" and those working and researching within early childhood education are cognisant of the need for international dialogue to "strengthen the argument for investment, research and action" (Davis 2014: forward). This is further substantiated by Hedeflak et al. (2014) who highlight the 1990s as a period where explicit connections were made between early childhood education and environmental education with a swathe of research related to children's engagement *in* and *about,* with little recognition of children acting as agents of change. Models of participation have gradually developed, for example Hart's (1996) depiction of a ladder notes different degrees of participation starting from manipulation of children by adults to authentic child initiated shared decisions *with* adults. Beach Kindy offers opportunities for adults to co construct different meanings with children, thus "higher rungs of the ladder, carry the potential for creative transformation from the grass roots up, which is essential to ecological sustainability" (Chawla 2002, p. 3). An alternative model of participation is presented by Shier (2001) with five pathways to participation,

acknowledging the need to meet a minimum threshold (noted as level 4), where children are involved in decision making processes to endorse the United Nations Convention on the Rights of the Child (UNCRC, UNICEF 1989). His argument for involvement beyond level 4, notes the need for children to share power and to be encouraged to take responsibility for decision making. Indeed, it is not mandatory within the UNCRC for adults to allow children to share power, merely to seek children's views, however, the pedagogy associated with Beach Kindy offers a sensitive platform for reciprocal, authentic communication. Davis (2014) expands and consolidates the view of young children as capable agents of change with her argument for revisioning rights to "extend to include collective rights, intergenerational rights and rights beyond those held by humans" (p. 22). This focus on Anthropocene is captured within the case study and Davis (2014) notes that within the context of Early Childhood Education "Eco-centrism goes one step further, also aligning value to the Earth's entire eco system, including elements such as carbon, air and water and their interdependent cycles" (p. 30). Davies et al. (2014, p. 7) highlight, "the younger the child, the greater the emphasis needs to be placed on the procedural, 'doing' aspect, in comparison with the conceptual components of scientific learning". They further argue that these elements cannot be separated, as for young children the *doing* and the *knowing* are fundamentally the basis of scientific attitudes. There is a distinct correlation between the Characteristics of Effective Learning (C of E L) within the Early Years Foundation Stage (DfE 2014) with emphasis on *how* young children learn.

Elliott and McCrea (2016) recognised children as active participants with a focus on health, wellbeing and the benefits of outdoor environmental education, and a research report by Natural England (2012–2016) highlights the need for intentional interactions with nature as a positive pedagogy with "learning that takes place in a natural environment resulting in, or associated with a range of positive outcomes for learners of all ages" (2016, p. 4).

Elliott and McCrea (2016) illustrated how many practitioners were astounded by the complex knowledges that young children often demonstrate and they question "the romanticised notions of children in nature may be thwarting more challenging and deliberate pedagogical discussions" (p. 21). Whilst there is a swathe of research related to environmental/outdoor learning and the Forest school philosophy, the authors note an extended void in the research related directly to the use of coast lines and beaches, with Beach Kindy notably absent. This absence also relates to the cognitive benefits of alternative pedagogies.

3 The English Early Years Foundation Stage

Opportunities for ECEfS are not explicitly specified in the English Early Years Foundation Stage statutory framework (Boyd et al. 2016), however, settings can provide outdoor natural play curricula that focus on children's interests in sustainability (Barratt et al. 2014). A theme resonating from the tenth anniversary of

the Cambridge Primary Review, highlights global learning and sustainability as a vital element of early childhood education in the primary years. Bourn et al. (2016) assert "the need to develop approaches to learning which promote children's engagement, empowerment and a sense of agency with regard to their present and future lives as global citizens" (2016, p. 13). However, in 2006 Andreotti coined the term 'soft' approaches to global citizenship, for example charity fund raising with children. She suggested that, whilst this approach emphasises a moral concern related to global issues, such as poverty and inequality, there is also a need for a 'hard' lens, where issues around social justice have a notably longer term impact. Beach Kindy offers an alternative, "concentric approach" (Tickell 2011, p. 104) where children are submerged in an ever changing natural environment whilst developing "process skills" (Evangelou et al. 2009).

The Early Years Foundation Stage (EYFS, DfE 2014) highlights three prime areas including personal, social and emotional development, physical development and communication and language. The four specific areas include "Understanding the world" which involves "guiding children to make sense of their physical world and their community through opportunities to explore, observe and find out about people, places, technology and the environment" (DfE 2014, p. 8). Education for sustainability highlights the need for children to understand community within the paradigm of global citizenship with recognition that our actions have an impact on the environment. The characteristics of effective learning (DfE 2014), note how children learn to concentrate and keep on trying if they encounter difficulties and enjoy achievements. Creating and thinking critically is essential and children need to be encouraged to develop their own ideas, make links between ideas, and develop strategies for doing things. Wilson (2011, p. 2) highlights the Vygotskian and Montessori notion of critical and sensitive periods during child development. She suggests that these critical periods offer "heightened susceptibility to acquiring understandings and skills impacting life-long attitudes, values, and competencies". This resonates with Tilbury (1994) who suggested that these critical periods in early childhood can determine the subsequent development of an "ecological self" (1994, p. 4).

4 Using Beach Kindy as a Pedagogical Approach for ESD

Beach Kinder is a familiar term within Australian Early Childhood Education and various terms capture the use of physical and cultural spaces used within the early years, for example, nature kindergarten, bush kinder, farm kinder. The literal translation of kindergarten meaning the *garden for children* is an idealistic metaphor for outdoor provision for young children to engage with nature (Joyce 2012). The English Beach Kindy approach uses the coastline and associated environment, as a pedagogical tool of ocean interconnectedness and adopts the principles of the world renowned Forest school philosophy which encompasses essential elements, such as use of the environment, which is visited over a prolonged period of time

and the qualification, knowledge and understanding of the early childhood practitioner. The specific forest school training combines practical and theoretical knowledge so that adults and children work together in a reciprocal way to consider the ecological impact assessments of the environment (forest or beach). Of equal importance is the immersive longevity of the approach, where regular visits are conducted over an extended period, which allows children to become familiar with the area and develop a sense of ownership for the environment (Welsh Assembly 2009, p. 8). Barratt et al. (2014) develop this further and argue for the need for young children to explore both familiar and unfamiliar environments in order to challenge and develop meta-cognition and critical thinking. The argument for extended periods within a natural environment also allows adults to build trusting and secure relationships with young children and provides a platform for scientific conceptual development which goes beyond the learning of facts or procedures.

Within Beach Kindy pedagogy, children interact with the physical environment; however the Piagetian concept of the lone scientist, where children discover by themselves, is developed within a socio-cultural framework of learning, where conceptual change is a social process (Oates and Grayson 2004). Hedeflak et al. (2015) argue that there is often a belief by early years' educators that children will simply become agents of change if they are given environmental knowledge and learn facts about sustainability; however, children need to learn how to respond to issues in what they call a "socio-critical" (p. 985) dimension to the pedagogy. Contemporary research has revealed that interpersonal conflict, especially with peers, might play an important role in promoting cognitive change. Elliott and McCrea (2016) highlight the complexities of purposefully framed play as a highly effective approach for ECCESD (2016, p. 86), and this idea of intentional teaching and place-based learning is "premised upon the interactions of people with their locale" (Barratt 2014, p. 231). Indeed, England, as part of Great Britain, is an island nation with dramatic coastlines, rivers and estuaries which connect all inhabitants to the ocean.

The Global Education Monitoring Report (2016) highlights the need to "train and support teachers to enable learners to acquire green skills" (p. 188) and SDG 4.7 of the sustainable development goals highlights the target, that by 2030, "all learners acquire the knowledge and skills needed to promote sustainable development" (4.7) juxtaposed with a substantial "increase in the supply of qualified teachers" (4.7c). Barratt et al. (2014) capture the English context and note how the "demise" of the sustainable schools' framework (p. 231) makes this difficult to justify in an education system focused on goals and targets. Moss (2007) notes early childhood as a site for democratic spaces to discuss serious issues with young children in appropriate ways. The notion of ocean literacy, embedded in an early years' context as Beach Kindy, contributes to SDG14.a, where early childhood educators reach beyond physical interactions within the beach environment, to "an increase in scientific knowledge". This is recognised in SDG 14 thus, "Our rainwater, drinking water, weather, climate, coastlines, much of our food, and even the oxygen in the air we breathe, are all ultimately provided and regulated by the sea" (SDG 14a).

The UNESCO Global Education Monitoring Report (2016) focuses on the 2030 goals and the summary notes the urgent need for new approaches. Beach Kindy as a pedagogical tool for ECCESD, builds upon the ethos of Sandwatch (UNESCO 2010) and "embodies the principles of education for sustainable development and serves as an excellent example of the new and innovative approaches to the kind of education essential for an effective global response to climate change" (p. 4). A repertoire of pedagogical approaches are suggested which Sandwatch noted as "a programme through which children, youth and adults work together to scientifically monitor and critically evaluate the problems and conflicts facing their beach environments and then design and implement activities and projects to address some of those issues, whilst also enhancing the beach environment and building ecosystem resilience to climate change" (p. 9). Hedeflak et al. (2015) and Davis (2009) suggest that early childhood educators often avoid using nature as they consider the physical dangers for children. Additionally, Duhn (2012) suggests that educators see young children as vulnerable and innocent and therefore in need of protection from harsh realities. Beach Kindy consolidates the positive ethos of the Blue Flag award. Blue Flag is a voluntary eco programme that offers practitioners suggestions of how to incorporate environmental awareness into practice through environmental activities associated with sustaining beaches and mariners. "This means that environmental education is not just concerned with spreading messages about the environment, but it also provides opportunities to enhance learner understanding, question environmental problems and take action for environmental change in pursuit of sustainable development" (2013, p. 3).

5 Research Context

The authors have ethical approval for a project to work with practitioners, parents, childminders and children from two early year's settings on the Wirral, due to commence in January 2017. Place-based learning is considered as a pedagogical tool with sustained visits to the local beach. The authors engaged in a pilot phase of the research project during August 2016 and embraced the philosophy of observer participants alongside, two parents, park wardens, and four children aged between 3 years 6 months and 4 years 6 months. Two aspects of the case studies are presented to offer a flavour of the pilot phase of the project based inquiry utilising the Ocean literacy framework: UK and Europe (Savage 2014) which is highlighted as a useful pedagogic tool to build coherent and conceptually sound scientific learning experiences for young children and develop attitudes that foster advocacy for the earth. The purpose of the pilot study was a precursor to the main project where parental perspectives were sought to develop the project during the winter. The use of the beach supported a playful and exploratory lens where children were able to discuss critical scientific issues regarding their local beach, thus acting as potential agents of change within their family and community.

6 Methodology

Beach Kindy also builds on the philosophy and methodology of Sandwatch (Monitoring, analysing, sharing and taking action) and the concept of Water school, noted by Horvath (2016), utilising an early education lens with observation, documentation, inquiry and investigative approaches to scientific learning (Davis et al. 2014), with an emphasis on early childhood education as a site for socio-critical explorations. The tradition of pedagogical documentation as an ethnographic research model in education began to emerge in the 1970s adopting some qualitative methods from sociology and anthropology (Wein 2011). In the early years, a meaningful starting point is from a project based approach and time was a significant factor to enable dialogue and reflection between research stakeholders.

Stuhmcke (2015, p. 245) highlights from an ECCESD lens, "a transformative project approach facilitates children's capabilities in relation to environmental and sustainability issues". The teacher should advocate the co-constructivist theoretical approach or as Rinaldi (2006, p. 126) states a revision of a teacher as a transmitter of knowledge and culture, but as a co-creator. This involves "constant hypothesizing" on possible developments and "listening, observation, documentation and interpretation". Pedagogical documentation is a fruitful and holistic pedagogy within early childhood education and builds upon a collaborative question or inquiry between early years' educators, teachers, children, or others, about the learning of children. It reflects a disposition of not presuming to know, and of asking how the learning occurs, rather than assuming, as in transmission models of learning, that learning occurred because teaching occurred. In essence, the Beach Kindy approach reflects what Rinaldi describes as "learning made visible" or "visible listening" (2006, p. 100).

7 Case Study

7.1 Wirral's Wonderful Waders and Big Seaweed Search

Every autumn and winter, wading birds in their thousands come to the Dee Estuary and the coast of North Wirral to feed on the rich diversity of food to be found on and around the mud and sand of the estuary and beaches. The different lengths and shapes of their bills are used for different types of food, most of them feed on molluscs and worms in the mud. The Dee Estuary and North Wirral coast have been designated internationally important *Sites of Special Scientific Interest (SSSI).* At times of high water, the birds are forced to retreat to the top of the beaches where they roost, waiting for the tide to go out. If they are forced to fly, they use up vital energy reserves, which in the cold winter months, can be dangerous for them.

The roosting wading birds are particularly vulnerable to disturbance from walkers, dogs and horses (Wirralcountrypark@wirral.gov.uk).

During the pilot phase, Beach Kindy was promoted as an explicit approach to support Education for sustainability, including an examination of ethical dilemmas and scientific inquiry. Kuhn (2004) considers how scientific inquiry-based approaches are not merely about children interacting with materials as this is insufficient for the development of process skills including observation, raising questions, hypothesising and predicting. In this sense, the Beach Kindy pedagogy offered opportunities for young children to investigate the properties of the beach (and associated detritus), whilst debating some complex issues, including the notion of rights. Who owns the beach? Why do the birds need to be protected? The Wirral estuary and coastline is also home to a wide variety of seaweeds and plant life and children were familiar with the beach as part of their local cultural identity.

The research group (parents, children, wardens and the authors) were able to engage in some interesting conversations around ownership and responsibility, and patterns emerged related to personal perspectives and lived experiences. Two of the children were familiar with dog ownership and regularly used the beach to walk their dogs with their parents and conversations with the wardens opened up new perspectives in terms of rights. The Beach Kindy pedagogy embraced the social cultural aspect of dialogic teaching (Alexander 2008) and offered opportunities for discussion and debate whilst supporting an interpretation of the theoretical elements of democratic agonism (Mouffe 2000). Beach Kindy offered a contextualised *place* for contesting and challenging critical issues centred on the child's locality and during the pilot, the parents were impressed by the developing sophistication of their conversations with the children gleaned from sketches, photographs and verbal communication.

> "The birds live in the sky and on the beach and Frankie (name of dog), lives at home with us" Jenson aged 3 years 6 months.

> "We have to be careful when the birds are feeding and keep Harvey (name of dog) on his lead" Finley aged 4 years 6 months.

Parents interjected with comments around rights and how they were focused on the needs of their pets and conversations supported different ways of seeing the issues. In this sense, the Beach Kindy embraced the early years' curriculum with an acknowledgement that they (young children) were trusted to make decisions and engage in some complex issues surrounding an "Understanding of [their] world" (DfE 2014). Indeed, Beach Kindy offered a participatory, action based pedagogy focused on real life issues of relevance to young children (Davis 2015). This is underlined by Rinaldi (2006, p. 156) when she states that in early childhood there must be an acceptance of "conflict as part of dialogue" when considering critical and ethical tensions and issues.

As part of the project approach, the parents and children worked with the wardens to sort and classify the different native seaweeds found in a section of the beach, providing rich descriptive language of the characteristics of the varieties. For example, Serrated Wrack is tough, with toothed fronds and olive brown in colour

and is found growing on the rocks. In contrast, Bladder Wrack and Knotted Wrack have bladders not fronds and the bladders on the Knotted Wrack are difficult to pop. These differences generated the 'why' and 'how' questions necessary for scientific thinking and investigation. For example, why is the Knotted Wrack difficult to pop? These observations were documented in a shared thinking book and the children took photographs which they later used to prompt further discussion.

With the help of the wardens, the parents and children were able to document and use the correct terminology and Lemke (1990) highlights the importance of children needing to learn to use the specific scientific language and to be able to make casual connections.

> This is great stuff, I wouldn't have considered using the terminology with Finley, but I can see he is fascinated and I'd like to learn more about this
>
> Parent

However, the purpose of the research was not just to highlight species but to recognise and understand their importance within the ecological system. Ecologically, seaweed impacts upon the community in many ways, for example, it creates underwater habitats for thousands of sea creatures and it protects our coastlines from storm damage. Research (Natural History Museum) suggests that there has been a 2 °C increase in sea surface temperature around Britain over the past 40 years. The data suggests as a consequence of this rise, that cold water seaweeds are now having to move even further north and that the distribution of warm water seaweeds is expanding because of rising sea temperature. Beach Kindy provides an opportunity for children to understand and connect to their world, to love and respect the earth, and through this Wilson (2012, p. 87) notes how this "develops the essence of an environmental ethic". Rising sea temperatures and climate change resonates with principle six of the Ocean Literacy Framework: UK and Europe (Savage 2014) and these issues become real and children can see it impacting locally and in a real life context.

8 Conclusions and Challenges

This transformative project approach in Beach Kindy can develop both locally and internationally with settings and schools linking up and creating maps of seaweed and wading birds around their islands and coast lines. This aligns Science and technology as mutually supportive and interconnected disciplines. Science requires children to test, analyse, question knowledge, whilst technology supports children to feel empowered to advocate for their world. Davis et al. (2014, p. 10) suggest that "science is a desire for understanding (Why are the seas getting hotter? Or charting the arrivals of new species of seaweed and considering the impacts of the change) "Whereas for technology it is some improvement in our physical environment". (How can we make subtle changes that help climate change? How have

other communities made changes that have impacted locally?) These complex issues become meaningful and the children can begin to see and understand how climate change and the notion of rights are impacting on their local and global environment and community.

Beach Kindy also resonates with the Ocean Literacy framework: UK and Europe (Savage 2014) and highlights (Principle six) which states the "oceans and humans are inextricably interconnected" and this also connects to both SDG 4 and SDG 14.

The Global Education Monitoring Report (2016) highlights that education as usual cannot continue and this resonates with Davis (2015) who notes how, even within early childhood education, it cannot be "business as usual" (p. 21). The Report (2016, p. 186) asserts that "schools need to be exemplary places that breath sustainability" and the discourse around education for sustainable development has resonated within the dominant frame of school as the primary institution for sustainable education. With its child centred historical roots, Early Childhood Education is a sound platform for Education for sustainability and the research in the field has developed with a number of early childhood practitioners who have driven the uptake of ECCESD. Davis and Elliot (2015) are cognisant of the need for "a more scholarly eye to what is being enacted and to explore approaches and practices more deeply and critically" (2015, p. 2).

Education for sustainability transcends the messages situated in any early years' statutory framework and the English Early Years Foundation Stage (DfE 2014) fails to embrace and utilise the cultural identity within the English coastline. Whilst there is no explicit reference to scientific thinking within the framework, Beauchamp (2013) argues for a cross-curricular lens and Evangelou et al. (2009) note scientific inquiry as a particular form of discourse. Ang (2014, p. 16) notes the unintended consequences of an over prescriptive curriculum may be to 'silence' the child and this also resonates with Malaguzzi's idea of a prophetic curriculum (Cagliari et al. 2016); a curriculum that predicts what will happen even though the future is based on uncertainty, variability and change. In another note, the discourse of the Early Years Foundation Stage (DfE 2014) reflects school readiness. This has developed with the increase in early intervention strategies, in alternative 'stories', in the "game of assessment" (Basford and Bath 2014), thus, contesting the narratives related to the purpose of early childhood education (Moss 2014). Furthermore, there are discussions on whether, and to what degree, the EYFS (DfE 2014) considers children's point of view and how the framework supports young children to develop their own "human sense" (Donaldson 1978) of the world around them. Whilst learning *in* and *about* the environment is embedded into early childhood education, learning *for* the environment helps to lay the foundations for sustainability and to encourage children to explore human/environment interactions as causal in sustainability problems and aspects (Davis 2009). Very young children have been found capable of sophisticated thinking in relation to socio-economic aspects and the earlier ideas are introduced, the greater their impact and influence can be (Siraj-Blatchford et al. 2010). Horvath (2016) notes the ecosystems of water school and provides tacit reference to ECCESD with the assertion that it is important to "keep the habitat healthy and to understand how to sustain them for

hundreds of years" (2016, p. 13); however, within the context of the 2030 Sustainable development goals, a transformative agenda of education for sustainability must take precedence for global sustainable futures (Davis and Elliot 2015) and we advocate Beach Kindy as a pedagogical approach to achieve this.

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Perception Versus Skepticism—An Environmental Communication Issue and Climate Change

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Abstract

'Perception' plays an influential role in policy formulation, implementation, and monitoring. It varies between individuals, communities, and administrative levels, and in degrees of importance. Furthermore, perception can be good or bad, positive or negative, yes or no, right or wrong, belief or disbelief, or even true or false. In parallel to perception, 'skepticism' is referred to in literature and practice, and is a corollary to understanding human interaction in environmental communication. A review of the perception-associated literature and anecdotes collected from researchers and practitioners reveals that there is no clear definition of the remit of these two terms. At least not when it comes down to research and its application in controversial topics and scenarios cropping from sustainable development and climate change, which are two of the most multi- and interdisciplinary fields in their own individual right. The purpose of the paper is to identify and propose the definitional boundaries between perception and skepticism in a systematic manner, and propose a conceptual model in the form of a schematic. Based on illustrative case studies, the paper also paves a path for further research areas in which the conceptual model can be applied to real-world scenarios for testing and sensitivity analysis, whereas such scenarios

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can come from the multi- and interdisciplinary fields of sustainability and climate change. This way, the environmental communication can be rendered more effective and efficient between diverse and wide range of stakeholders, particularly including decision makers. The paper also concludes that skepticism is relatively a newer term as opposed to perception needing to be carefully employed and, not confused and readily interchangeably used with perception.

Keywords
Communications · Environmental communication · Sustainability · Sustainable development · Environmental change · Climate change perception · Climate change skepticism

1 Introduction

Communication is a crucial factor that influences people from any persuasion and any hierarchical tier of a society, whether the subject is one related to physical science, such as climate change, flooding, or waste management, or one linked to the non-physical sciences such as psychology and sociology. Terms and their range of interpretations play an important role in the effectiveness and efficiency of that communication, with context also making a crucial contribution. It is not simply *what* is communicated but *how* a message is communicated that contributes to the building of a perception. Thus, appropriate use of terms and terminologies is a corollary to successful environmental policy and management.

Perception and communication can be seen as two sides of the same coin. They feed on each other. Effective communication can lead to appropriate perception and vice versa. Perception, once established, develops a built inertia. It is therefore a responsibility requiring significant sensitivity to communicate or transfer perception effectively (Leombruni 2015; McGuire 2015) so that a true perception is propagated (i.e., perception epidemiology—incidence and prevalence) rather than a false one, leading to confusion, misunderstanding, disbelief, false ideas, misinterpretation, etc. As a negative perception transfers from one to another, it can snowball, creating a high degree of skepticism which is often resistant to reality (Grimes 2016).

The term 'perception' itself has varying implications and has been used in connection with another term 'skepticism' in a confusing manner, thereby compromising the efficiency and effectiveness of communication. Moreover, it can be seen that in spoken language and written literature, as well as in industry, academe, research, and practice, the two terms—'perception' and 'skepticism'—have been used interchangeably and without clear distinction. A review of the literature associated with perception and skepticism to date (e.g., Lowe 2006; Fieldman et al. 2010; Whitmarsh 2011; Reser et al. 2012) reveals that the relationship between the two is not well understood, either consciously or subconsciously.

This paper focuses on remits, implications, meanings, and semantics of the two terms individually and then in relation to each other. The purpose of this study is to improve comprehension, acceptance, and application of the terms in various sectors and scenarios, whether technical, non-technical, or even bridging the gap between the technical and non-technical.

2 Aim and Objectives

The paper aims to draw an objectively clear relationship between 'perception' and 'skepticism' in order to render communications (in general and the environmental communication in particular) more effective and efficient. This aim is managed via the following objectives:

1. establish the implications of the terms 'perception' and 'skepticism' individually;
2. mapping the identified implications of the two terms on each other, depict any overlaps and separations, i.e., common and uncommon denominators;
3. employing illustrative case studies to achieve objectives 1 and 2 above and, thereby develop definitional boundaries of the two terms; and
4. investigating other terms such as belief and disbelief; positive and negative; certainty and uncertainty; sure and unsure, etc., and systematically determine how these can be related to 'perception' and 'skepticism'.

3 Perception

Perception is the ability to see, hear, or become aware of something through the senses. In other words, it is the way in which something is regarded, understood, or interpreted, or the act or faculty of apprehending by means of the senses or of the mind. Another way to describe perception is immediate or intuitive recognition or appreciation, as of moral, psychological, or esthetic qualities; insight; intuition; cognition; understanding; realization, thoughtfulness (Dictionary.com 2016a; Oxford Dictionaries 2016a).

The use of the term has been on the increase over the last two centuries (Fig. 1). There may be a number of reasons for that increase, such as advancement in knowledge of quality concepts, business growth, and globalization. For instance, the quality of a product or service is regarded as a multidimensional entity and one of these dimensions is perception, hence known as 'perception quality'. When a product or service is marketed to enhance the sale, advertisement and promotional activities are fundamentally contributing to escalating the perception quality of the

product or service. Additional contemporary reasons for the increase in the use of the term are indicated in Sect. 4 below, and equally apply to this section.

4 Skepticism

Skepticism means doubt (as to the truth of something), doubtfulness, dubiousness; lack of conviction; cynicism; lack of surety, unsure; distrust, mistrust; suspicion; disbelief, misbelief, unbelief, non-belief, lack of belief; and atheism (Dictionary.com 2016b; Oxford Dictionaries 2016b). Antonyms of skepticism are: conviction; belief; faith; sure (Dictionary.com 2016b; Oxford Dictionaries 2016b). The graph in Fig. 2 shows the use of the term since 1800. The escalation of the use of this term in various ways and contexts can be interpreted by, or deemed to be due to, a number of contemporary factors occurring in modern societies, such as mechanization, industrialization, urbanization, computer-aided modeling, and growth of human knowledge in various old and new fields of sciences (which are increasingly becoming multi- and interdisciplinary in a complex manner). Climate change science, environmental risk management, pressure groups, economic stresses, and business continuity issues are some additional examples.

5 Perception Versus Skepticism: And Other Synonymous Terms

5.1 Innovative Concept

Although there is a steady increase in the use of the two terms 'perception' and 'skepticism', there is lack of appreciation of their differences and implications of them when communicated. With reference to Sects. 3 and 4, this section of the paper captures the relationship between perception and skepticism, as the two terms

Fig. 1 Use of the term 'perception' since 1800 (Google Ngram Viewer 2013a)

Fig. 2 Use of the term 'skepticism' since 1800 (Google Ngram Viewer 2013b)

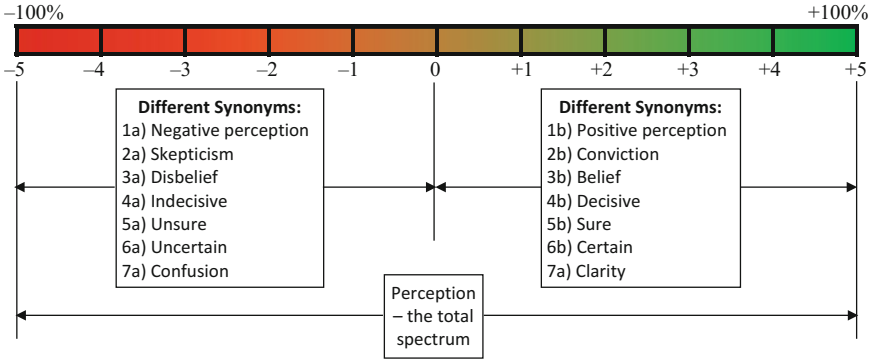

Fig. 3 Proposed perception scale (indicating various degrees/levels from full negative to full positive)

have been used interchangeably without much realization of the conceptual differences between them. Figure 3 maps this relationship and demonstrates that perception is scalable, from belief to disbelief. Benchmarks can be placed at various divisions on the scale representing degree of understanding or interpretation.

The negative half of the scale is referred to as skepticism and the positive half as the conviction. However, they are both forms of perception, irrespective of whether that perception is right or wrong, or true or false. It is perception (whether positive or negative) which influences the behavior of an individual or a community overall. In a decision-making process, whatever the scientific fact(s), eventually it is perception that guides the decision, whether coming from an individual or an authority, a member of the public or an official, a pressure group or a parliament. This supports the saying 'What matters is not what is true but what is believed'.

5.2 Case Studies as General Examples

5.2.1 Climate Change: Occurring or Not Occurring

Climate change is happening or is not happening! Irrespective of what scientific facts conclude, there is still a spectrum of beliefs (Poortinga et al. 2011; Spence et al. 2011; Lewandowsky et al. 2015; Grimes 2016). However, there may be levels of disbelief and belief, as shown in Fig. 3 by scoring from −5 to +5 or from −100 to +100%. It all lies within the perception spectrum, no matter where an individual or a group of people is on the scale.

5.2.2 Climate Change: Natural or Anthropogenic

People still debate the relationship between the natural and anthropogenic forces of climate change (Lewandowsky and Whitmarsh 2014) and even treat the concept as a conspiracy, which is counterintuitive to the scientific consensus (Grimes 2016). Again, regardless of the degree of belief or disbelief (or positive or negative perception), it all lies within the spectrum of the perception scale.

5.2.3 Climate Change Manifestations

Climate change is manifesting itself via its impacts, such as flooding events being on the increase, rainfall escalating in both frequency and intensity, heat waves becoming more common and intensifying, etc. With varying degrees of conviction, there are people who have the positive perception (i.e., conviction) that these phenomena are related to climate change and that humans need to change their ways of life to mitigate and adapt to climate change. At the same time, there are others who perceive such intensifying and escalating events as not due to climate change (i.e., demonstrating skepticism) (Lorenzoni et al. 2007; Connor and Higginbotham 2013; Capstick et al. 2015). Again, both, conviction and cynicism along with their varying degree of intensity fall in the span of perception.

6 Concluding Remarks

For the first time in the reported literature to date, this paper has explicitly mapped common and uncommon denominators between the two terms ‘perception’ and ‘skepticism’. The two terms are found to be used unknowingly interchangeably, both in research and practice, and in academe and industry. This can create confusion, compromising the effectiveness of communications and decision accuracy, and even more so when a diverse range of stakeholders are involved with varying backgrounds, expertise, and interests. Dissemination of knowledge can help switch from skepticism (i.e., negative perception) to positive perception in any field of study or business (House and Phillips 2012). The same principle applies to any level of a society from mandarins to the general public in influencing decision

making (House 2010; House et al. 2011) especially for multi- and interfaceted concepts including Sustainable Development/Sustainability, Climate Change (drivers, impacts, mitigation and adaptation), ecological footprint, carbon footprint, socioeconomics, sustainable and/or renewable energy, etc.

A comparison between Figs. 1 and 2 indicates that the term 'perception' has been in use for much longer period of time than the term 'skepticism', as the graph in Fig. 2 is nearly approaching zero on *y*-axis which represents the use of skepticism over time. Based on this, it can be concluded that the term 'skepticism' is much younger comparatively and, therefore, a recent development. Another important point is that the misuse of and interchangeable use between the two terms is not only already occurring, but may also be on the increase as the two graphs in the figures indicate. However, this idea of increase in the misuse and interchangeable use, and the corresponding impact of consequent miscommunication, requires further investigation and research.

This paper does not imply that the way in which the remits (including both overlaps and separations) of the two terms have been defined must be applicable in exactly the same way in each and every scenario. However, the innovative concept of common and uncommon denominators of the two terms, as raised here, can help to provide better definitions in the glossaries of research projects, government documents, guidance notes, etc. In addition, this can help to bridge gaps between scientific/technical and non-scientific/non-technical communities, be it about a sustainable development scenario, climate change issue, an environmental concern, or decision making by a panel of wide and diverse stakeholders. This paper may also generate more streamlined vigorous debate on the implications and remits of these two terms (and other associated terms as indicated in Fig. 3) among researchers and practitioners from both the physical sciences and the non-physical sciences such as sociology, psychology, economics and management science.

Once the conceptual model reported in the paper is advanced via research in terms of applications to wide range of scenarios, it can bring up results proving further that the two terms need to be more carefully applied both when gather information from the associated diverse and wide range of stakeholders about an environmental issue (or any other issue) and when interpreting the information for deriving results and decision making. This can help most especially those concepts and philosophies which are most multi- and interdisciplinary such as Climate Change and Sustainable Development/Sustainability. The conceptual model reported in the paper has, therefore, a great potential to help to disentangle the vagaries of perception (with respect to skepticism) and relies on the fact that clear communication is the conduit through which effective decisions are made, especially for concepts and philosophies as complicated as Climate Change and Sustainable Development.

In summary, the model can facilitate the appropriate use and application of these terms to enhance the productivity of communications between diverse stakeholders at various tiers of a society in decision making and policy formulation around

controversial issues such as climate change, sustainable development/sustainability, environmental protection, and enhancement. The paper can ignite a debate among sustainability practitioners in industry and commerce, and highlight areas for further research and development for researchers in academia.

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"Do What I Say, Don't Do What I Do": Challenges on Education for Sustainability

Fernanda Frankenberger, Janaína Macke and Laurelena C. Palhano

Abstract

Since the concept establishment of education for sustainable development, many higher education institutions are challenged to change their curriculum from a profit maximization to a triple bottom line paradigm. This paper aims to discuss the different strategies that universities adopt to encompass sustainable development into business curriculum. This analysis will provide key elements for a theoretical framework building. Considering the Six Principles for a Responsible Management Education proposed by the United Nations Global Compact, a comparative case study is designed with two Brazilian universities: PUCPR and IMED. In-depth interviews, direct observation and formal documents were used, and data analysis were performed through content analysis. Results show that in business schools, "sustainability" still has some weaknesses in relation to the understanding about the synergy of management and sustainability. In sum, this work analyzes the dimensions of management education focused on sustainability; provides a broad understanding of the main drivers for a sustainable perspective adoption; and offers significant insights for universities to perform sustainability in a holistic way. Our theoretical framework may guide future studies by understanding connections between

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dimensions and components of management education, from a sustainable perspective.

Keywords
PRME · Education for sustainability · Business school · Curriculum

1 Introduction

In the last decades, society has been faced with challenges toward sustainability (Boström 2012), how to develop, implement and measure, and according to the United Nations (2016), "sustainable development cannot be achieved by technological solutions, political regulation or financial instruments alone". Universities, here also called Higher Education Institutions (HEI), have also taken this challenge, as they "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" (Amaral et al. 2015, p. 156).

Many universities question themselves about the ways they have traditionally operated (Fadeeva and Mochizuki 2010) and some have then embraced the education for sustainability not only by teaching and developing future leaders (Warken et al. 2014; White 2014), but also by including sustainability in the curriculum (Zamberlan et al. 2015) and on daily institution management (Lauring and Thomsen 2009). They need to "go beyond modifying their activities by mainstreaming sustainability components" (Fadeeva and Mochizuki 2010, p. 250).

Mainly in developed countries, higher education is promoted by adjustments in macro-policies (Beynaghi et al. 2014). However, due to several reasons, higher education has a big challenge in developing countries. To work with sustainability and implement it on higher education, represents an even bigger difficulty in such regions. First of all, the HEI have to adapt curriculum and ways of teaching, which demands more investment from the university. Nevertheless, governments, such as in Brazil, have included sustainability as mandatory for all courses in higher education (Brasil 2012).

With this, universities introduced sustainability in curriculum in different ways (Boks and Diehl 2006). Some put it as a discipline, others in a transdisciplinary approach. Either way they implement sustainability in education, HEI are challenged to adapt their curriculum from profit maximization to a triple bottom line paradigm. So, "if management education curricula are to be redesigned, it seems that more debate is needed about which competencies future managers will need in order to deal with complex issues in a more responsible and sustainable way" (Adomßent et al. 2014, p. 3). With this, the aim of this paper is, based on the six principles for responsible management education (PRME), to discuss the different

strategies universities adopt to encompass sustainable development into the business curriculum.

To fulfill this objective, the paper is organized as follows. First topics related to education for sustainability and PRME are presented, then the methodology is explained. In the sequence, an analysis of the researched HEI is done and finally the conclusion.

2 Education for Sustainability

After several environmental disasters, it became clear that our society needs to change to a more sustainable way of producing, consuming, and living. But this knowledge of how to do it comes with an education for sustainability and more specifically with the higher education, as it "serves as the training grounds for future leaders" (White 2014, p. 229), working on the "education of future leaders and on the proliferation of public awareness about sustainability" (Amaral et al. 2015, p. 156).

Countries such as Brazil have included this demand of teaching sustainability as mandatory for all courses. Besides this fact, for business courses, there are at least two relevant reasons to incorporate sustainability. The first one is that future leaders need to "have a good training, which allows broadening the view of the organization and its environment" (Salume et al. 2012, p. 1) as they'll "take decision and define the organization's path" (Frankenberger et al. 2015, p. 173). The second one is that for both public and private organizations, they need to use social, environmental, and financial resources (Barbieri 2004; Mcfarlane and Ogazon 2011).

In this way, it urges that HEI include sustainability in business curriculum, but the problem is that "most business schools appear to have yet to respond in a coherent way to determine what constitutes key competencies in this area" (Adomßent et al. 2014, p. 3) and how to integrate it on curriculum (Rusinko 2010). So, having a strategy to encompass sustainable development into business curriculum supports the HEI to develop the future workforce and "engage with prospective future employees throughout their educational experience" (Plewa et al. 2015, p. 36).

Rusinko (2010) identified that many scholars suggested ways of how to integrate sustainability in higher education. He also developed a flexible matrix which can be used by any course at the university, making possible for all to have learning about sustainability (Rusinko 2010). With this matrix, the next step is to identify which strategies universities adopt to encompass sustainable development specifically into business curriculum, mainly when it comes to countries in development as Brazil.

3 PRME

Responsible models of management are one of the biggest demands on modern society. With this, the Global Compact is a call from the United Nations for "companies to align strategies and operations with universal principles on human rights, labor, environment, and anti-corruption, and take actions that advance societal goals" (Global Compact 2016a). The Global Compact is a major initiative of corporate citizenship and foresees the commitment of the signatory company with 10 principles, divided into four big groups—human rights, labor, environment, and anti-corruption (Global Compact 2016a), and has "frequently been referred to as an important catalyst for the transformation of management education" (Adomßent et al. 2014, p. 3).

With the Global Compact 17 goals to transform the world were defined and the fourth goal is education which targets to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (Global Compact 2016b). Besides the Global Compact, the PRME (Principles for Responsible Management Education) was launched in 2007 with support from the United Nations with the goal to" transform management education, research, and thought leadership globally by providing the Principles for Responsible Management Education framework, developing learning communities, and promoting awareness about the United Nations' Sustainable Development Goals" (PRME 2016). The PRME consists of six principles, as follows (PRME 2016):

1. **Purpose**: develop the capabilities of students to be future generators of sustainable value for business and society at large and to work for an inclusive and sustainable global economy;
2. **Values**: incorporate into academic activities and curricula the values of global social responsibility as portrayed in international initiatives such as the United Nations Global Compact;
3. **Method**: create educational frameworks, materials, processes, and environments that enable effective learning experiences for responsible leadership;
4. **Research**: engage in conceptual and empirical research that advances our understanding about the role, dynamics, and impact of corporations in the creation of sustainable social, environmental, and economic value;
5. **Partnership**: interact with managers of business corporations to extend the knowledge of their challenges in meeting social and environmental responsibilities and to explore jointly effective approaches to meeting these challenges;
6. **Dialogue**: facilitate and support dialog and debate among educators, students, business, government, consumers, media, civil society organizations, and other interested groups and stakeholders on critical issues related to global social responsibility and sustainability.

Besides compromising to the principles, when a university becomes signatory of PRME, it increases the HEI reputation and offers to the HEI better partnership and business opportunities. From the two researched universities, PUCPR is signatory

of the PRME, but IMED is not. In the following chapter, both universities will be presented and points related to the PRME will be highlighted.

4 Methodology

With the goal to discuss different strategies universities adopt to deal sustainable development into business curriculum, the research method in this paper is exploratory with data investigation done through document analysis, in-depth interviews, and case study.

Exploratory studies are those, which situations evaluated, have no clear outcome (Yin 2003). A case study is indicated for studies when mainly the behavior of the involved at the study is not possible to be manipulated and when the contextual conditions from a defined phenomenon will be verified (Yin 2003). For this, documents can be analyzed, and interviews can be performed in order to focus on case study topic and determine perceived inferences (Yin 2003).

In this paper, a case study is performed. Business Schools from two universities were analyzed—IMED and PUCPR. Taking the six principles of PRME, in-depth interviews were conducted with the deans of both universities. The answers to these questions were analyzed with content analysis, so it was possible to identify the topics related to the six principles. Results are presented in the following chapter.

5 Results and Discussion

Before presenting the cases, a short description of both Business Schools is given below.

5.1 PUCPR

PUCPR is a HEI located in the State of Paraná and founded in 1959 by joining some colleges from the Catholic Church. In the beginning, the university was located only in Curitiba, but from 1991 onwards, other cities received also campus from the university. The university's educational proposal is committed to the integral education of students and is based on ethical, Christian and Marist values, which inspire all the pedagogical proposals of the institution. Following the mentioned values, the integral education at PUCPR contemplates the conception of education for solidarity (PUCPR 2016).

Since more than 20 years, the Business School of PUCPR is one of the leading departments at the university. The Business School—PUCPR includes programs of undergraduation, graduation (Masters and PhD.), Lato Sensu undergraduation (Specializations), Executive Education, in company services, and special study

centers. Since its foundation, the school has graduated over ten thousand professionals (PUCPR Business School 2016).

5.2 IMED

IMED is a HEI founded in 2004, which seeks to provide a center of academic excellence in the training of students capable of understanding and transforming the reality in which they live (IMED 2016). Is located in the state of Rio Grande do Sul and has two campuses: Passo Fundo and Porto Alegre.

From the beginning, in 2004, the IMED Business School has offered, besides undergraduation, specializations courses in Administration by preparing leaders able to manage companies in a competent, critical, and transformative way (IMED Business School 2016). With more than 1400 students already graduated from postgraduate courses, the School offers a Master's degree in Business Administration and a MBA in Business Management, accredited by ANAMBA (National MBA Association), among others lato sensu graduate courses.

Following are the results as per the six principles of PRME analysis.

5.3 Case Studies

5.3.1 Case 1—PUCPR Business School

PUCPR Business School offers undergraduate and specialization courses focused on the development of professional and leaders through the implementation of projects and research with standards of excellence at national and international levels. In classrooms, the focus is given to interdisciplinary areas, teaching and developing entrepreneurs, leaders, and managers with strategic vision to innovation. Learning to innovate means to develop technical and personal skills that enable new perspectives, different solutions, and response patterns.

By working these aspects, students of PUCPR understand the business field with a contemporary vision, linked to entrepreneurship as a tool to generate values and sustainability for the results of their actions. At the Business School, human education goes hand in hand with technical training, a perceived difference in the profile of graduates along with their ability to enhance the human capital of organizations within people management policies.

Being international is also present through the offer of more than 10 courses in English. Several students from other countries have part of their studies at PUCPR and vice versa. At the Business School are offered Executive Education Programs, In Company courses, Center of Employability and Opportunities and Center for Entrepreneurship and Innovation.

The stricto sensu at the Business School is composed by two departments—one of Administration and one of Cooperatives. The first one has research groups, some of them are related to sustainability.

5.3.2 Case 2—IMED Business School

According to the coordinator, IMED Business School has sought to offer undergraduate and specialization courses that provide development and improvement for the management of organizations, contributing to the increase in competitiveness, and consequent economic and social development of the region. The link between the Business School and the business environment is an example for the integration of teaching and research actions and the demands of the business environment. As an example, it can be mentioned the involvement of teachers and students in joint work in the elaboration of indicators that provide relevant information to the region and support the organizational decision makers.

Specifically, the Course coordinates the elaboration of the Consumer Confidence Index, which bimonthly assesses the consumer confidence of Passo Fundo and reveals its expectations about the economic scenario for the coming months. This index has been systematically disseminated in the local media and also used by managers of private and public organizations, as well as agenda of meetings of trade associations. In addition to the Consumer Confidence Index, there are a number of partnerships with companies and trade associations. Currently, the Business School has partnerships with 41 companies, associations and public entities.

The processes of evaluation of institutional performance happen through FOCO meetings and meetings of the Superior Council (Consup) and external audit. The performance evaluation of the indicators and strategic goals is done through the FOCO Meetings, held quarterly with the participation of the entire group of managers—academic and administrative of the IMED Business School. The Meetings are coordinated by the Department of Planning and Accounting.

IMED's Corporate Solutions Department proposes to identify specific demands from each client—companies, public, and private organizations, third sector entities and society. Besides it, professors were allocated to research centers, according to their area of research and expertise.

Associated with EFMD (European Foundation for Management Development) since 2015, IMED Business School has six research centers:

1. Center for Competitive Studies—CECOM: aims to promote research on the competitiveness of companies, through scientific and applied research in partnership with organizations. The proposal is to generate synergy between university–business–government on issues related to business competitiveness, especially involving interorganizacional strategy and networks.
2. Center for market studies and consumption—CEMEC: aims to combine the knowledge and expertise of a group of researchers and consultants linked to IMED Business School to enhance relations between organizations, clients, and society, with activities in the areas of applied research and scientific publications, consulting, and events.
3. Center for studies on innovation and environmental sustainability—CEISA: aims to carry out scientific and applied research, as well as consulting services directed at product, process, and organizational innovation, and the environmental sustainability of organizations.

4. Center for studies in governance and finance—CEGOFI: aims to carry out research and provides consulting services to companies of different sectors and sizes with the purpose of contributing to the diffusion and incorporation of the best practices of governance in the organizational processes.
5. Center for Studies and Research in Personnel Management—CEGEPE: aims to carry out scientific and applied research, services, and consulting in the area of people management for companies, cooperatives, and public organizations with a view to producing knowledge and proposing solutions tailored to the needs of these organizations.
6. Center of studies in society and territory—CEST: aims to provide knowledge, through scientific research, and applied solutions for the construction of a common perspective of sustainable future, based on concrete goals of sustainability, social innovation, and citizenship.

Specifically to the six principles, in Table 1, the results are summarized.

6 Conclusion

Sustainability is a major topic nowadays and many organizations question themselves how to implement and develop. Having a trained workforce to work and develop sustainability is a challenge. Therefore, universities implemented sustainability in curriculum, either as a discipline or in a transdisciplinary way.

Either way they have it on curriculum; the universities have to define which strategies they will use to perform well toward its students. Business schools have a big challenge to implement sustainability in curriculum as the students will be future leaders and take decisions based on the available resources.

Having as base the six principles of PRME, a case study was performed with two Business Schools located in Brazil, PUCPR, and IMED. The goal was to discuss the different strategies universities adopt to encompass sustainable development into business curriculum. In-depth interviews were performed with the deans of the two Business Schools, and results show that in some ways sustainability is recognized as a relevant topic.

Nevertheless, there is still a long way until Business Schools understand and define suitable strategies to implement sustainability in curriculum. Some practices from both universities can be used to develop sustainability in business curriculum, such as partnerships with companies, active learning methodologies, and researches.

Future researches could bring more light to this topic by performing surveys with Business Schools located in other countries.

Table 1 Analysis results

	Case 1—PUCPR	Case 2—IMED
Year of foundation	1959	2004
Principle 1—Purpose	"The Business School at PUCPR is participating in some accreditation processes for the school internationalization, which will support the research and student exchange. The goal is to increase the quality, excellence, image and internationalization itself"	"At IMED Business School we are compromised with the innovative research, education of transformative leaders, and services of excellence to promote the sustainable global progress"
Vision	"By 2022, consolidate itself as a world-class institution, with excellence in teaching, in the production of knowledge, in the provision of services and in social relevance"	"We aspire to be recognized globally by our contribution to the management knowledge, education of the future leaders and to the organizational development"
Principle 2—Values	• Leadership • Excellence • Entrepreneurship • Internationalization	• Excellence • Innovation and entrepreneurship • Leadership
Principle 3—Method	Active learning methodologies are used, but no discipline regarding sustainability is in practice. In fact there is a philosophy towards sustainability, applied in a transdisciplinary way	In its relationship with students, IMED Business School uses active learning methodologies as one of the pillars of pedagogical guidance All management decisions are based on the Balanced Scorecard indicators
Principle 4—Research	Several research programs are in place at the university to promote undergraduate research. In addition, several research groups exist and some develop research about sustainability. In addition, visits to companies are organized, so students have the opportunity to understand how their actions contribute to businesses	The Modera project is an initiative of IMED and Lynx Consultoria in partnership with AmBev. The objective is to contribute to the prevention of alcohol misuse among undergraduate students and to reduce risk situations, such as drinking and driving, unprotected sex, involvement in fights, among others
Principle 5—Partnership	From the university perspective, there are partnerships with the city hall, with several universities in Brazil and in Latin America, and with the local community, as the university has a big communitarian project in place since more than 10 years. These partnerships enable that the university participates on decisions taken in the regions where the campus are Besides that, the Business School has partnerships with some international universities and local companies to develop solutions	IMED Business School has partnership with public and private companies The Business to Business Program developed by SEBRAE with the main objective of promoting improvements in microenterprises through free orientation, as well as promoting relationships with new clients that traditionally do not seek the institution. The Program proposes to make, free of charge, a diagnosis of the management, offer solutions for the improvement of small enterprises and follow this evolution. With this partnership

(continued)

Table 1 (continued)

	Case 1—PUCPR	Case 2—IMED
Year of foundation	1959	2004
		between IMED Business School and SEBRAE 2000 companies in the region will be attended
Principle 6—Dialogue	The dialogue is in a way standardized for all schools from PUCPR. This processes offers an internal support to the students with psychological, cognitive and some other topics In addition, in each school a survey with the students of undergraduate courses is conducted to indicate what needs to improve Other relevant topic is the participation of students on governance groups at the different schools	Its results are measurable and provide great geographic coverage. The IMED Facebook page has almost 30,000 followers The effectiveness of marketing and global communication activities are evaluated and measured through: (A) Trademark surveys conducted every two years by the Methodus Institute; (B) Satisfaction surveys evaluated twice a year by graduation, stricto and lato sensu; (C) Research of insertion of students in the labor market; (D) Measurement of media through spontaneous insertions by the Press Office together with traditional and digital communication media

Source: Authors (2016)

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(Inhibiting) Factors for (Un) Sustainable Behaviour in Relation to the Effects of Education for Sustainable Development: The Role of Psychological Constructs, Neurotransmitters and Ideological Impact on Consumer Behaviour

Kristof Dewaele, Daniel Fischer, Patrick Van Damme and Paul Verhaeghe

Abstract

Despite several decades of Education for Sustainable Development, it seems that there is still no massive transition in (individual) consumer behaviour from 'unbridled' to sustainable and thus so that we still notice an absence of widespread responsible lifestyles. It has been documented numerous times that there is a gap between knowledge of and positive attitude towards addressing unsustainable behaviours, and the actual individual's behaviour when it comes to sustainable lifestyles. The question now is: what is causing this gap? Our

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research focuses on the different factors that influence sustainable (consumer) behaviour changes. We will use psychoanalytical models (Lacan) to try and find out how satisfaction of materialistic needs works, the effect of consumption patterns on the brain, the impact of political and ideological influences on behaviour(al changes),… The goal is to create a systems model that would allow us to better understand consumer behaviour and that hopefully will bring suggestions on how to change education models for sustainable development. The research will use a multidisciplinary approach and hopes to explain why behaviour is so hard to change and why current programmes (such as the 4E and 7E-model) based on cognitive behavioural therapy are not as effective.

Keywords
Sustainability · Behaviour · Psychology

1 Introduction

Over the last decades and still nowadays, society is facing an enormous challenge. The need for a transition from unbridled consumption towards a more sustainable and responsible way of living is on top of the world's political agenda. There is a pressing need for more conscious consumers and active citizens who through their daily choices contribute to a more sustainable and responsible society (Jackson et al. 2016). Despite several initiatives towards promoting more sustainable lifestyles, such as the Decade for Education for Sustainable Development (DESD, UNESCO), the Millennium Development Goals (now Sustainable Development Goals), Sustainable Consumption and Production (UNEP), … we can not ignore that the number of people really living in a sustainable way still constitute a rather marginalised group (Johnstone and Tan 2015). We understand 'marginalised' as a phenomenon that is situated at the borders/margins of society. Nevertheless, we must admit that the concept of education for sustainable development is now much more widespread than before (Buckler and Creech 2014). However, the gap between knowledge, attitude and behaviour in relation to sustainable lifestyles remains as wide as before. Many organisations, visions, action plans (i.e. Local Agenda 21 on local policy level) have tried to create a way out of this marginalisation, but most of these initiatives have only brought about a rather limited impact on society (Mölders et al. 2014).

We believe there are several possible explanations. One of the major reasons is a lack of action of and willingness by policymakers to take 'real' actions to lead our society towards a more sustainable future. As an example, we can refer to the 'Klimaatzaak' (klimaatzaak.eu) in Belgium and The Netherlands. Here, a group of opinion makers is dragging national policymakers to court for not taking the right initiatives related to climate change (http://www.urgenda.nl/en/climate-case/).

On the other hand, we see that a lot of people still seem to lack the necessary knowledge that would bring them to change their behaviour. Though when people have the knowledge to live more sustainable, it still seems to be very hard to transform this knowledge into responsible consumer behaviour (Johnstone and Tan 2015).

We will mention only some examples of the efforts taken so far in striving to guide people towards a more sustainable living. Such as 'Thursday, veggie day', which at the onset is an original Belgian but now worldwide campaign to stimulate the large public to eat a least one day a week no meat nor fish and this to the benefit of our and the planets health (http://carbonn.org/uploads/tx_carbonndata/detailed%20information%20veggieday.pdf). Or environmental education such as 'Environment Care at Schools' (MOS, https://www.lne.be/mos-duurzame-scholen-straffe-scholen), where the Flemish government developed (within the Decade for Education for Sustainable Development) environment educational modules that can be used at primary and secondary schools. Despite the little impact within the target groups, there still seems to be no massive shift in people's behaviour.

2 From 4E to Lacan

Many methodologies are trying to bring about a so-called behavioural change as is the case with the 4Es-model (http://www.wrap.org.uk/content/defra-4es-model). This model, developed by the Department of Environment, Food and Rural Affairs as part of the Government of the United Kingdom, is trying to create a conceptual framework in order to develop effective behaviour change strategies. The framework provides insights on the motivations and barriers to actions and approaches to influencing behaviour. The 4Es are standing for: enable, encourage, exemplify and engage. The model states that there is a big gap between current attitudes towards sustainability and actual behaviour. With regard to the model, there are several reasons explaining this gap: structural, cultural and methodologies (routines). The model is correct when it says that structural and cultural-psychological changes need to go hand in hand. However, we do believe it does not take into account physiological and psychological effects of consumption on consumer behaviour (feelings such as happiness, neurological impact, …).

A lot of these behavioural change models are based on cognitive behaviour therapy and mainly refer to the so-called 'stages of change model' (Prochaska and Diclemente 1986). The model states that we need to pass through several 'stages' to transform current/old behaviour into new behaviour. Each stage requires another methodology in order to reach the next level. However, we could conclude that changing someone's behaviour towards a more sustainable lifestyle does not seem to fit into traditional behaviour therapy models since we have not seen any effective, widespread and massive long-term changes over the last decades. Recently, the 7E-model has been launched as an extension to the 4Es-model (http://7e-model.be). Here, 7E stand for: elicit, engage, explore, explain, elaborate, evaluate and extend.

It might be a better model than the 4Es-model but it remains a model based on behaviour cognitive therapy, which includes the same limitations as described above.

One hypothesis why environmental education and models for behaviour change are not as effective as we wish, could lie in the fact that consumption of material goods is having a neurobiological effect. Quartz and Asp (2015) stated that shopping creates a temporary feeling of happiness. They researched how neurological processes are determining our choices as a consumer. They concluded that consuming 'cool products' (such as smartphones, sneakers) makes us feel respected whereby that the decision to consume 'cool' products is mainly associated with certain sub-groups linked to our identity (e.g. iPhone users vs. Android users). As an example, adolescents tend to consume more products of a certain brand because this product is helping them to express and confirm their identity. On the other hand, 'green' people can make a statement by not buying any specific brands. Bartels and Reinders (2016) found that 'multiple social identities seem to play different roles in sustainable different behaviours. Therefore, efforts to enhance different sustainability behaviours are challenging yet promising. Once consumers incorporate a sustainable behaviour, it becomes part of their own identity and could lead to spill-over effects on other closely related sustainable behaviours'. But more about the importance of identity later.

Seeing the criticism of cognitive behaviour therapy-based models, an interesting way to look at this consumption behaviour might be using Lacan's capitalist discourse theory (Olivier 2009). Lacan developed four basic discourse theories, mainly to identify and clarify the relationship of two subjects within a therapeutical setting, and 1 capitalist discourse theory (subject-material object). The discourse between two subjects is typified by the 'lack' of fulfilling each other's desire/needs. Your partner can never fulfil your desire completely by giving you love, attention, … due to your inability to fully express your desire and your partner's subjective interpretation of the expressed desire. All of these 4 subject discourses contain a certain inability/impossibility to interpret and to fulfil all needs. In case of the relationship between a subject and an object (=discourse of capitalism), it is possible to fulfil your desire completely, on the condition that you own money. 'What I want is what I get'—when I buy it. If I really want an iPhone6 and I have the money, I just buy it. On that moment, the acute and instantaneous 100% fulfilment tends to create the false perception there is a possibility to fulfil one's desires completely versus to what happens between two subjects (due to the subjective interpretation and the inability to fulfil all needs). However, it is the lack of fulfilment of desire between two subjects that keeps this desire alive. We keep trying to fulfil the desire, but will only reach it asymptotically. This is part of what, in psychoanalysis, is called a psychoneurotic illusion (Verhaeghe 2003), i.e. the idea that there exists a partner who will bring complete fulfilment. Lacan described this as '*La femme n'existe pas*' (thé ideal, self-fulfilling woman for the man does not exist), whereas Lacan's capitalist discourse model is based on psychological insights, it might be interesting to search for neurological connections as well. The question we can ask ourselves is whether 100% fulfilment of material needs/desires is having the same psychological and physical effect as the

(ab) use of drugs such as alcohol, tobacco, and other products? Most of these drugs directly or indirectly influence the release of neurotransmitters in the synapses of brain cells. In most cases, there is a higher release of dopamine than without any drugs. This neurotransmitter is present in regions of the brain that regulate movement, emotion, motivation, and feelings of pleasure. When activated at normal levels, this system rewards our natural behaviours. Overstimulating the system with drugs, however, produces euphoric effects, which strongly reinforce the behaviour of drug use teaching the user to repeat it (https://www.drugabuse.gov/publications/drugs-brains-behavior-science-addiction/drugs-brain). Blasco-Fontecilla et al. (2016) state that behavioural addictions such as gambling, sun-tanning, shopping, internet use, work, exercise or even love and sex obtain frequently, and share many characteristics and common neurobiological and genetic underpinnings with substance addictions (i.e. tolerance, withdrawal, and relapse). So, the question is if 'normal' consumption shares the same neurobiological effects? This could explain why most of the cognitive behaviour therapy-based models seem to fail to influence consumption behaviour. The relapse rate for people with drug addiction after therapy is about 40–60% (https://www.drugabuse.gov/publications/drugs-brains-behavior-science-addiction/treatment-recovery). If the effects of materialistic consumption are comparable with what use of drugs does with the body, this might clarify why it is so hard to initiate a long-term shift towards a more sustainable lifestyle.

2.1 The Development of the Psychological Identity

In 'On being normal and other disorders' Verhaeghe (2003) describes that an identity is mainly the result of the interaction process between several subjects (i.e. mother–child, …). Within this inter-subjective development of a psychological identity, Lacan describes both the mother's and father's function. This respective 'mother/father' function has no strict relation to the '(wo)man' gender. Rather, it is related to what we see as its function. Both the mother and father function can be carried by a woman or a man. Before a child is able to use real language to express its needs, we see a dual relationship with what we call the 'first other' or the mother function. When the child cries, the mother tries to interpret the crying as a sign of hunger, pain, sadness, etc., in order to fulfil the child's needs. This relationship is called 'dual' since there's only the child and the first other. The 'mother function' is important to create a good and decent self-image and to establish the concept of 'love'. This dual relationship is experienced as a 1-to-1 100% fulfilment of desire and is therefore an overall pleasant phase. In the next step, the child notices that there is also a 'second other', the father function, to whom the 'mother' is giving her attention. From this moment on, we enter a triangular dimension that ends the previous dual 1-to-1 relationship. The father function is restricting the desire between the child and the first other, which will allow the child to develop its self, and so creates what we call the 'lack' 'a'. For the rest of our life, we will try to restore the dual relationship by trying to fill this 'a', both materialistically as in the capitalist discourse of Lacan, and immaterialistically by means of the relationship

between two (or more) subjects. The father function brings us 'the law' and 'the wisdom'. It tells us what we can do, and what we cannot. But at the same time, this father function is a person of trust and wisdom. This father function is not only needed within the family, it is also important for society as a whole, as we will describe in the next paragraph.

2.2 The Triple Orphaned Society

Looking back into history, we can see that religion has always been one of the strongest 'father' functions. But as evidenced by many empty churches, the importance of religion seems to decrease over time (mainly in the Western world). Cases of sexual abuse within the Catholic Church made religion loose its father function, whereas in the last century the Church, embodied by the priest, played its role of advising and punishing, we now see that it has become a marginalised institute that only has mere symbolic functions (Pollefeyt and Dillen 2005).

Next to religion, we can consider politics as the second institute fulfilling the 'father' function in our society. In the specific case of Belgium, where the CVP (Christian People's Party) was in power for 40 years, we can assume that politicians took over that position from the Church. But is documented that confidence in European Union dropped from 50% in 2004 to 33% during Spring 2016 (European Commission 2016). The average trust in National Governments in Europe decreased from 34% in 2004 to 27% in early 2016. So hardly one-forth of the population trusts its politicians. We can say that in accordance with the Church, politics has as well lost its position as father figure. Even more, its seems that politics (un)intentionally strengthen ideological polarisation (into 'left' and 'right') (Jensen and Thomson 2013). This ideological polarisation has shown to be very present when it comes to admitting or denying the current climate change.

The third society father function is presented by materialistic and economic growth, particularly by the type of economy we experienced over the last two decades of the twentieth century (1980–2000). After religion and politics, money and materialism seem to have replaced the position of the 'father.' However, the Asian economic crisis in 1997 (Goldstein 1998) and the great depression in Argentina (1998–2001) started to end this period of economic welfare. The crash brought about by Lehman Brothers in 2008, followed by a worldwide economic crisis, caused the widespread perception that capitalism had also lost its father function. As it is now, there seems to be no father function left in the society. Nothing, except maybe (social) media, is directing us.

At this point, we can reconnect with Quartz and Asp (2015) who state that we spend in order to define ourselves as being part of a specific sub-group. 'We live in a world of conspicuous consumption, where the clothes we wear, the cars we drive, and the food we eat lead double lives: they do not merely satisfy our needs; they also communicate our values, identities, and aspirations'. So, consuming (un)sustainably seems to be related with the expression of one's identity, which leads to the

assumption that cognitive behavioural therapy has no or only limited impact on behavioural change.

3 Consuming Differently Versus Consuming Less

In 1972, the Club of Rome published its ground-breaking study 'Limits to growth' (Meadows et al. 1972), stating that economic growth needs to go hand in hand with environmental protection. But during the last decades, it seems that the economy has been growing faster than environmental protection efforts. We believe that one of the main reasons for this unequal development is the unbridled consumption of material goods. Industry and marketeers successfully created a need to consume. There is a rather continuous pressure to create demand, because if demand goes down, supply goes down, and if supply goes down, economy goes down, followed by a decrease in employment. Needless to say that the world's population increase, going from 1 to 7 billion in approx. 250 years, is not weakening but rather strengthening (or causing) this process. In combination with our addiction to oil and other fossil fuels, we can conclude that we are all consuming material goods which are causing shortages in fossil fuel, water, food, minerals, …

However, we start to pick up signals which prove that we should make the shift towards more immaterialistic growth instead of continuing to emphasise materialistic growth (Bossuyt 2013), such as the 'sharing is the new having' movement (Hamari et al. 2016). Not everyone needs to own a certain material good if we can share it (i.e. buying one lawn mower to share with your neighbours). But the question is if such immaterial growth provides the same feeling of '100% fulfilment' of desire as when you own it? Building on the previous idea, one can wonder what would be the effect of the community on the individual, in the context of responsible living and consumption?

While trying to understand (un)sustainable human behaviour, it seems that polarisation plays an essential role in influencing this behaviour (Farrell 2016). As stated before, we see a political and ideological polarisation between 'left' and 'right', with very often contradictory solutions for the same problem. As an example, in order to eliminate traffic jams, one opinion is to widen the roads, another one to create better biking conditions. Not to mention the vision about a more sustainable future. On the one hand, we have the economic and technological ideologies that state that solutions for a sustainable society lay in technological change, that may either be exogenous or endogenous to the economy, that should be implemented together with sustainable production and circular economy approaches (Hobson and Lynch 2016). The circular economy (CE) (Pearce and Turner 1989) might be seen as the better version of the cradle-to-cradle principle (McDonough and Braungart 2002). The basics of the model is nothing more than closing loops (a product will never become waste, and no external energy and resources are put in the production process) (Witjes and Lozano 2016). In this case, there will be enough of everything as long as we re-use and recycle, and when no

external resource input is needed to create a new product. On the other hand, we see the ecological/social ideology stating that there is not enough for everyone, so that we need to reduce our consumption level. The ecological/social ideology believes that we should consume less versus consuming differently (sustainably produced products) (Mölders et al. 2014). So one paradigma tells us to produce/consume more but in a circular manner, whereas the other says to consume less, two supposed contradictory beliefs and pathways towards a more sustainable future? Where in the latter paradigm (to consume less) it is obvious that the focus is on a transition of (the individual) consumer behaviour towards a more sustainable consumption pattern, it was initially not so clear for circular economy that (individual) transition is needed as well. However, Hobson and Lynch (2016) now state that when bringing up circular economy as the perfect alternative for a (arguably) failed agenda of sustainable consumption/lifestyle, one thing must be taken into account. The circular economy must be aware of its inability to address many deeply embedded challenges around issues of consumption and the consumer. 'If the CE is indeed the next big political and economic project, then the role, potential and place of the citizen—and indeed the economy as a complex socio-political entity—need to be subjected to a further critical consideration, including engagement with more 'radical' ideas about the pathways, aims and roles ascribed to us all within a more circular society' (Hobson and Lynch 2016). Eventually, both paradigms lead back to the same question (and the main topic of our research). What is determining/influencing consumer behaviour and how can we try to understand this behaviour with relation to a more sustainable future?

4 Conclusion and Research Methodology

It seems that many different structures and factors are influencing and determining our consumption behaviour in relation to responsible living. There is the lack of a 'societal' father function, consumption as expression of identity, neurological processes, physiological impact (cf. addiction to drugs), contradictory ideological approaches when it comes to finding a way towards a sustainable future, the impact of marketeers, … to mention only some.

A first hypothesis is that all transition models, whether they refer to a more ecological/social transition, a circular economy model or decisions made by the government, need to involve the role of the citizen/individual.

A second question is: what are the underlying factors that are influencing and determining (individual) consumer behaviour when it comes to sustainable consumption? Can understanding these factors lead to better understanding of the behaviour?

As a logical next step, we can wonder if accepting the idea of the psychoneurotical illusion (i.e. that there exists 'something' that will make us complete) and thus accepting the fact that there will always be desire, can help us to modify consumption patterns? Can mindfulness facilitate this acceptance, and what about

spirituality? Or is nudging the most promising tool (Lehner et al. 2016)? Nudging can be understood as a concept in behavioural science, political theory and economics which argues that positive reinforcement and indirect suggestions achieve voluntary compliance and can influence the motives, incentives and decision making process of groups and individuals, at least as effectively—if not more effectively—than direct instruction, legislation, or enforcement (https://behavioralpolicy.org/what-is-nudging/).

At last, we could research the effectivity of models such as 4E an 7E and we could try to measure if immaterialstic growth has the same effect (on the brains, feeling of fulfilling desire) as material consumption.

As a first step, we will perform a literature survey in order to identify the factors that are influencing consumption behaviour. In a second step, we will try to put all these factors in a systems model to see the relation amongst them and with the consumption behaviour. The third step will, depending on the outcome, consist of in-depth interviews about (sustainable) consumption patterns with individuals, focus groups, … We can develop questionnaires or set up experiments to measure the impact of mindfulness training or nudging and we will research the effectivity of cognitive behavioural-based models. Finally, we hope to make a link with existing methodologies for ESD and formulate recommendations for a more effective transition pathway.

> Most of the dreams people go through in their day-to-day life are because there is unbridled sense of desiring. If people look at something, they desire that unconsciously. If they look at something else, they desire that. The desires build up in a huge way. If they all have to be fulfilled in your life, you would need a hundred lifetimes. Unfulfilled desires getting fulfilled in dreams is what 95 per cent of human dreams belong to, I would say. But if you go on trying to sieve every dream that you get, you will waste your life and time. So don't pay attention to dreams, pay attention to life. (The Sunday Magazine 2016)

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Aligning Sustainable Development Principles and Sectoral Education

Pinar Gokcin Ozuyar and Tugce Baykent-Beyhan

Abstract

The competitive environment for new graduates to acquire a well-paid and satisfying job position and the long-standing gap between recent university graduates and business requirements as to the skills of these graduates, lead to the creation of a Sectoral Education Program model, involving seven different courses with various learning methods ranging from guest speakers, industry analyses and case studies to company practicum projects. The Sectoral Education Program model is a mandatory part of the curriculum for business students and electives for all other students university wide. Emphasized by the launch of sustainable development goals and trying to find complementary and comprehensive examples of innovative tools for private sector–university partnerships, this continuously developing model accepted one of the foci of the program as sustainable development and devised solutions that embed the teaching of sustainable development principles aligning them with concerns of business. In the embedded approach, the curriculum regarding local sectoral expertise, the crosscutting issues for all sectors from population dynamics, resource scarcity to climate change and even big data are being discussed. Over the three semesters of teaching local sectoral expertise in the light of crosscutting issues, students' feedbacks have been recorded. Main results show that for university students the phrase sustainability is being overused but still the connotation to the real-world cannot be established. By embedding sustainable

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development principles directly aligned with the concerns of business sectors, majority of the students think that this know-how would be a skill for them in their future prospects.

Keywords
Sectoral education · Sustainable development education · Sustainability University

1 Introduction

The skills gap between higher education institutions and business life together with the unreadiness of the new graduates is a concern for both academic and practical sides in the recent years. In their studies, Barber et al. (2013), Barton (2012), Jackson (2009) and Mourshed et al. (2014) underline the mismatch between new graduates and business life in terms of skills. One of the concepts related to this concern is 'employability'. As a critical issue, employability is defined in many ways by highlighting gaining employment of the graduates. As a core notion, Harvey (2001) defines the concept as "the propensity of students to obtain a job". However, getting a job requires a detailed understanding of professional life and the skills needed for the industry. In this context, Yorke (2004) suggests the definition of The Enhancing Student Employability Coordination Team (ESECT) and explains the concept as:

> a set of achievements—skills, understandings and personal attributes—that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy (Yorke 2004, p. 7).

Concerning the set of achievements stated above, a recent research specifically claims five skills that the employers expect from the new graduates as assuming responsibilities, ability to pursue and achieve goals, communication skills, ability to work under pressure and team-working skills (Pârvu et al. 2014). In as a separate set of skills, Renzulli (2003) explains the characteristics that predict excellence in professional life as intelligence, creative thinking, openness to experience, desire to learn, drive to excel and persistence.

The expectations of the employers from university graduates bring the significant question to the table: What is the role of universities in this respect? Moreau and Leathwood (2006)'s UK-based research suggests that universities need to provide employable graduates who should develop their personal skills permanently to compete in graduate labour market and to survive in "knowledge-driven" competitive economy. A university degree without the required skills is not enough for starting a career (Harvey 2000). However, there may be several models that can be applied at the university or at the work environment in order to integrate

professional life and university education (Matai and Matai 2010). One of the solutions that can be provided by the higher education institutions is work-related learning in curricula that will play an important role in developing the skills needed by the industry (Yorke 2004). A type of curricula which is created with the contributions of executives from the sectors and which includes courses that coincides to the needs of industry can establish relevant work experience for the students (Purcell et al. 2002). Thus, the related knowledge of the industry and the work-engaged experience can be provided by the universities through academic curricula (Patrick et al. 2008). The innovative approaches in academic curriculum is a way to solve the concerns regarding the skills gap and employability problem for both higher education institutions and the business world as Pârvu et al. (2014) write,

> The employability of higher education graduates is a responsibility of all universities nowadays, and this is also confirmed by employers' assessments that a good university/college is concerned with the employability problem and with the integration of its objectives into the curriculum design. Consequently, employability should be integrated into educational processes through the academic curriculum (p. 245)

2 Sustainable Development Education

Sustainable development (SD) has been on the agenda of different stakeholders since it was first coined in the Brundtland Report. Only after the millennium, United Nations have clearly decided to emphasize the education aspect by the United Nations (UN) Decade of Education for Sustainable Development (2005–2014). Sustainable development is and will continue to be a matter of substantial international interest and concern globally, initiatives on Sustainable Development Education (SDE) became a higher priority especially for the higher education institutions (Filho et al. 2015).

Reviews on country level SDE education are especially sparse. In one of the studies, Niu et al. (2010) analyzed the significance of developments across Chinese higher education in the field of education and learning for sustainable development (SD) and to assess the relative impact of these initiatives. Selected educational and operational activities in different universities were presented for analysis and contextualized in relation to the SDE movement. The results indicated that teaching about SD has been integrated into technical fields, especially at universities in major cities, and research has been undertaken to develop economically effective and environmentally friendly innovations. However, resources and capacity were still very limited which was in line with the ambitions associated with SD in China. They further concluded that National and international networks and collaborations must be promoted, and curricula and research need to be reoriented.

2.1 Competency Factors in Sustainability

In the context of the United Nations decade of education for sustainable development (DESD) and higher education for sustainable development (HESD), a highly complex nature of the conceptualizations of competences for SD and their articulation in educational programs (Mochizuki 2010). Process of developing key competencies for SD should be based on cognitive and non-cognitive dispositions and include for multiple contexts. Barth et al. (2007) have concluded that using an explorative, qualitative study based on focus groups from formal and informal learning settings, within higher education—as part of a new learning culture—a variety of contexts can be given and competence development can be enhanced. However, the interdisciplinary approach and its dependencies were still elusive.

2.2 Perception and Understanding of Students

Perception of sustainable development by students has been somewhat under researched. Taking students from only thinking sustainability is 'a good thing' to particularly understanding that the concepts of sustainable development and sustainability do not only have environmental associations but also economic and social aspects. The importance of ESD curriculum development that more explicitly addresses the interconnectedness of different aspects of sustainable development and which also employs pedagogies that help students to take action towards realizing their preferred futures (Kagawa 2007).

Owing to its complexity, sustainable development (SD) cannot be simply integrated as a supplementary course within a university's curricula. In a study, Lourdel et al. (2007) focused on how to reflect this complexity pedagogically. A method of analysis of a student's sustainability comprehension, based on cognitive maps, has been developed and students were asked to write and connect by arrows all the terms that they associate to the concept of SD. The results mainly focused on environmental and economic aspects. An interdisciplinary SD course increased the level of associations. In a different analysis, Zeegers et al. (2014) investigated whether a course which focused on raising students' awareness of sustainability, from a balanced perspective, that is, one which gives equal consideration to the social and economic aspects as well as the environmental would produce graduates with the knowledge and commitment required to drive the sustainability agenda forward. Initially, students having an enviro-centric approach had been challenged by encouraging discussion, debate and reflection and which provided what was considered to be a balanced view of sustainability, many of the students still leaned towards an environmentally focused perspective of sustainability.

In a research conducted by Newman (2005), distinguishing sustainable development education from environmental education and stressing the importance of problem-based interdisciplinary learning to sustainable development education, reconciling sustainability and development requires a complex interdisciplinary approach beyond that found in some areas of traditional environmental education is

necessary. Taking a different route, Podger et al. (2010) explores the education of sustainability from a 'whole person approach' focusing on persons' identity, motivation and higher order dispositions bearing psychological research on the development of critical moral consciousness, research on dispositions for learning in higher education, and field research on spiritually inspired service-learning.

2.3 Engineering and Management Programs Approach in SDE

Research into including SDE to engineering or management curricula outlines the types of changes needed, needed, both in respect of approaches, visions, philosophies and cultural change. Students of both engineering and management have to learn to think long term and position their activities in a pathway towards long-term sustainable solutions. This also should be devised separately for undergraduate and graduate students. For engineering students, a new pedagogy for dealing with changes from the quantitative to the qualitative is required. On the other hand, for management students a deeper conceptual and theoretical scrutiny will have to be provided (Mulder et al. 2012; Balbinot et al. 2012; Fenner et al. 2005). Biswas (2012)'s approach for engineering students was to facilitate the achievement of sustainable development through incorporating industrial ecology into curricula. This approach can further be studied for management students as well.

2.4 Opinion of Business People

Even though the plurality of understanding surrounding sustainability held by those working in the business sector exists (Byrch et al. 2015), organisations will benefit from leaders who have the competences necessary to ensure the sustainability of the company. For businesses, in this era of sustainability, inevitable change in traditional methods of operation with due concern on environmental consequences should be kept ongoing continuously. In addition to the traditional approach of leadership such as authoritarian versus democratic, people versus task orientation and contingency approaches, charismatic leadership embedded with systems thinking is the added ingredient (Evia 2003).

Hind et al. (2009) conducted a study by an initial survey and a consequent in-depth interview with European based multinational companies. It considers how whilst the qualities and skills of responsible leadership can be identified, a further mediating concept deemed to be 'reflexive abilities' is posited as required to explain their translation into individual managerial behaviours for the understanding and practice of responsible leadership that is enhanced by defining the competencies for integrating social and environmental considerations into business decision-making processes.

3 Definition of the New Model Approach

Incorporating the sustainable development principles to sectoral education is still challenging and new models should be developed. The model developed here is based on complementing sectoral education with crosscutting issues regarding sustainable development. Crosscutting issues are all sustainable development issues that would have a direct impact on the business sectors regardless of the sector specifics. These crosscutting issues can involve different factors as classified below:

- environmental factors like natural capital, environmental pollution and natural resources scarcity,
- social factors like the change in population dynamics, i.e. migration,
- economic factors like the global or country level economic crises.

This classification is based on the classic understanding of the term sustainability and not a rigid one since the interaction between environmental, social and economic factors are a key in the approach. In an example, natural resources scarcity will have an impact on all the sectors in varying degrees. Discussing and understanding the crosscutting issue in particular to a certain sector will assist in abridging the gap between the so called 'theoretical' sustainable development education and the very pragmatic sectoral education. The approach defines that a third aspect must be considered which is the localisation of the approach since all the factors interacting with sustainability in general, stems from global issues but is developed locally. The main steps of the model are given below:

- Developing sector-based know-how.
- Developing crosscutting issue based know-how.
- Focusing on local content deriving from global considerations.
- Devising the analysis of the former three phases.

It is not possible to analyze all the sectors and their interactions with the crosscutting issues in a time- and scope-limited training. To overcome this problem, each time the model is exercised, a different list of crosscutting issues should be selected based on the imminence in the global or local agenda. For example, migration, big data and natural resources scarcity can be the three crosscutting issues chosen for a given training unit. For the huge range of business sectors, each student is expected to research a sector of their choice disseminating the results in class as well as publicly.

4 Case Study: Ozyegin University (OZU) Sectoral Education Program's Sustainability Component

The model approach defined in this study has been exercised since the academic term Fall 2015/2016 and going on for four terms in a specific course, SEC 302: Local Expertise, in the OZU Sectoral Education Program.

Concerning the expectations of the industry and contributing to the employability of its graduates, Ozyegin University created a supra-program called 'Sectoral Education' in 2009. Sectoral Education Program is a unique model which is designed to build on academic and professional development of students, prepare them for their future careers in the best way possible, and increase their awareness of sectors. The program is engineered in line with Ozyegin University's experiential educational philosophy; 'transformational education'.

Starting from their first semester at the university, OZU students take Sectoral Solutions courses (Fig. 1). The first course of the program 'SEC 101: Introduction to University' helps students' adjustment to academic, social and cultural life of the University with several seminars and events such as faculty academic seminars, student development trainings, peer advising events, library activities and so on. The course contributes to the university's unique culture by offering an easy start to the newcomers and providing a strong foundation for the rest of their education.

Fig. 1 Sectoral education program

The program continues with two distinctive courses in the sophomore year; "SEC 201: Introduction to Sectors" and "SEC 202: Skills Management". These courses aim at informing students about different sectors, professional life requirements and transferrable skills while enhancing their current knowledge and enabling them to improve their personal and professional competencies via guest speakers from the sectors, videos with the top executives and various online sources. Within the framework of the courses, students are expected to know about dynamics and trends of the certain sectors, the insights about the future of the sectors, the concept of employability, the skills that will render them even better in professional life and the competencies that sectors look for. After completing the sophomore SEC courses, students become ready to get to learn more about the global and local dynamics of the focal sectors. "SEC 301: Sectoral Solutions: Global Expertise" is designed to indicate the global perspective on the sectors with the help of case studies.

Complementary to SEC 301, focusing on sectors in Turkey, the course discussed in this paper is SEC 302: Sectoral Solutions: Local Expertise. The overall educational objective of SEC 302 is to develop a solid understanding of the structural, economic, political, social and technological dynamics of different sectors in Turkey. It is a 4 ECTS course designed to promote an in-depth understanding of the dynamic evolution of leading sectors in Turkey. It emphasizes various forces that shape the functioning of all sectors in general as well as those that are unique to particular sectors. Integration of the principles of sustainable development is one of the key items aimed to be delivered by taking an embedded approach and including these principles to the extent possible. The course also conducts crosscutting issues that will have an effect on the future of the sectors. For the terms Fall 2015/2016 and Spring 2015/2016, the crosscutting issues discussed are; Population dynamics and migration, resource scarcity and big data. As a learning outcome, students are expected to excel in a sector of their choice and the crosscutting issue's current and future impacts on the sector. Thus, students take one step further towards the sector in which they aspire to participate in future by studying and researching the sectors in conjunction with crosscutting issues.

Regarding the method used, one of the courses of the program "SEC 401: Sectoral Practicum Projects" attempts to create a bridge between theory and practice. For an academic semester, teams of 4–5 senior year students tackle with a specific need or problem brought by a client company under the guidance of their academic advisors in order to develop creative and functional solutions and add value to the client (Baykent-Beyhan 2014). As a project-based course, it suggests an alternative approach to university—sector cooperation to create experience for the new graduates who can differentiate themselves in business world with their specialization in various sectors and professional skills. Sectoral Education Program is completed with a simulation course "SEC 402: Business Integration" in which students join in a global simulation challenge in teams, manage a company and try to improve their company's current position in the respective sector with the managerial decisions they make.

The Sectoral Education Program integrates university life with professional life to contribute to the holistic development of OZU students. The first three of the courses in the program are offered as mandatory for all the students whereas the rest of them are mandatory for the Faculty of Business Administration and elective for the other programs at the university.

5 Methodology

5.1 Data Sample

Over two terms from Fall 2015–2016 to Spring 2015–2016, a total of 240 students signed up to SEC 302: Sectoral Solutions; Local Expertise. The distribution of the students according to programs is as follows, 12 Engineering, 22 Civil Aviation, 7 Tourism and 199 Business. As SEC 302 course is a third year course with pre-conditions SEC 201; Introduction to Sectors and SEC202; Skills Management courses, around 80% of students are third year students.

5.2 Measurement

In the beginning of each term, students were briefed on the approach about the education of the local sectors in accordance to crosscutting issues. Around midterm, recalling the understanding of the course, students were introduced to the survey.

Initially, survey questions were distributed by using an online survey tool but responses received were only around 30% of the first group of 80 students. A different method for survey was developed as hardcopy distribution of the survey in class as an in class exercise. There were no names or any other identification requirements.

In an initial trial questionnaire there were 16 questions and it turned out that students find 16 questions on this type of survey boring and was reluctant to really think about them. Class discussion suggested their willingness in reading and replying around 10 questions. Before the questionnaire was distributed in class, a brief on the reasons for the survey was given. The main reason identified to students was to improve the quality of sustainability education not only in the context of SEC 302 course but also a valuable input to the sustainability education for the whole of the university by understanding students' sustainability-related thinking.

The questionnaire used in the two terms is listed below in Fig. 2. All the questions were relevant to the Ozyegin University case and this was specifically mentioned as an explanation. The questions were all regarding the students' point of view on three distinct headings; availability of the means for sustainability understanding in general, the efficiency of the course content on sustainability, and relevance of the course content in respect to their future careers. It is important to note that although the terms 'sustainable development' and 'sustainability' do not

Do you think there should be more courses available on sustainability?
Do you think you understand the term 'sustainability'?
Do you think you can explain the term 'sustainability' to someone?
Do you think sustainability is relevant to business sectors?
Do you think that there is an overuse of the term 'sustainability' in the university?
Please mark the sustainability relevance for business; *environmental pollution, citizens' quality of living, governmental policies, natural resources availability, finances, social concerns, i.e. migration.*
Do you think having crosscutting issues in the course scope is beneficial?
Do you think the course goal of 'expertise on a crosscutting issue's impact on a selected business sector' will be significant when you apply for a job?
Would a company's sustainability be a criterion for you in applying for a job?
Are you planning to work in a business focused on sustainability?

Fig. 2 Questionnaire for in class hardcopy survey

connote the same meaning to the experts in the field, the term 'sustainability' was used as a general expression.

The response style chosen for the survey questionnaire was 1–5 bipolar scale with a neutral point and the two ends of the scale were at opposite positions of the opinion providing a measurement of interval levels.

6 Results

The results of 240 surveys over the two terms were analyzed per question basis below. Questions are grouped under three headings; availability of the means for sustainability understanding in general, the efficiency of the course content on sustainability, and relevance of the course content in respect to students' future careers.

6.1 Availability of the Means for Sustainability Understanding in General

Do you think there should be more courses available on sustainability?

Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
11.25	20.83	29.17	32.50	6.25

Currently Ozyegin University has around 30 courses in various schools either focusing directly or covering sustainability as one of the teaching areas. Only 31% of students think the course numbers should be increased. This is considerably lower than those 39% thinking there are enough courses. The results of this particular question indicate the need for further investigation into the issue and causes, especially availability of courses in different schools on different levels.

Do you think that you understand the term 'sustainability'?

Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
11.25	81.25	3.75	1.25	2.50

The majority of students state that they have an understanding of sustainability. As sustainability is one of those terms that may have a range of definitions, this 91% share does not prove that the students are actually understating the term. To make it more clear, the following question has been prepared.

Do you think you can explain the term 'sustainability' to someone?

Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
5	27.50	0.00	50.00	17.50

The concepts of knowing and teaching in the two previous questions, reveal an important result indicating that the students have a clear idea that they cannot go into detail on their knowledge of sustainability. This clearly states that to bridge that gap between having an idea of one term and actually knowing the term requires more effort and better means. Further study needs to investigate the possible means for students in successfully achieving this expertise.

Do you think that there is an overuse of the term 'sustainability' in the university?

Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
11.25	16.25	58.75	2.50	11.25

This question is to indicate the comparison between the sustainability-related SEC 302 course work to all kinds activities including, policies, other courses, events and research going on at the university. The neutral 59% yields the result that although sustainability in the course work in relevance to business sectors is more familiar or accepted; the concern for the remaining efforts throughout the university and their relevance to course content is still lacking. Further study should

be for creating this connection between the two aforementioned sustainability globes.

6.2 The Efficiency of the Course Content on Sustainability

Do you think sustainability is relevant to business sectors?

Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
18.75	68.75	1.25	7.50	3.75

The 87.5 % of students think that sustainability is relevant to business sectors, confirming that one of the main outcomes of the SEC 302 course has been achieved. Once the students get to this understanding, it is easier to develop the sustainability and business sectors affiliation and once graduated students can have substantial input in transforming the way business acts.

Please mark the sustainability relevance for business: environmental pollution, citizens' quality of living, governmental policies, natural resources availability, finances, social concerns, i.e. migration

	Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
Environmental pollution	6.25	76.25	6.25	8.75	2.50
Citizens' quality of living	5	73.75	17.50	3.75	0.00
Governmental policies	5	83.75	8.75	2.50	0.00
Natural resources availability	12.5	77.50	1.25	7.50	1.25
Finances	5	55.00	28.75	6.25	5.00
Social concerns, i.e. migration	15	75.00	0.00	7.50	2.50

Except 'finances' all the topics listed, *environmental pollution, citizens' quality of living, governmental policies, natural resources availability and social concerns,* are being discussed during the coursework in correlation with sectors. The ratio of students who can observe the relevance to those who cannot is 9:1, indicating the positive direction to the approach. It is noticed that this ratio creates a diversion for 'finances' since this topic is not covered in the course content directly. This shows

that more distinct topics of sustainable development should be eventually introduced to the course work.

Do you think having crosscutting issues in the course scope is beneficial?

Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
28.75	40.42	19.58	8.75	2.50

It is important for students to think of the objective for the course and really understand it. The result indicates that almost 70% have agreed with the approach. The neutral 20% should be the ones targeted to initiate their acceptance by finding new exercises and examples.

6.3 Relevance of the Course Content in Respect to Students' Future Careers

Do you think the course goal of 'expertise on a crosscutting issue's impact on a selected business sector' will be significant when you apply for a job?

Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
13.75	42.50	36.25	6.25	1.25

In the beginning of each term, students are being informed in detail why this new approach about the course content is taken in teaching local sectors. In this respect, results indicate that 56% of the students have understood this approach and can predict its future positive effects in contrast to the approximately 9% of sceptical students. However, the significant neutral 36% is especially important and states that new means of explaining the course concept should be further developed.

Would a company's sustainability be a criterion for you in applying for a job?

Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
5	13.75	68.75	2.50	10.00

The question indicates that finding a job and being employed is still more important than the sustainability level of any business. Further in-depth study should be on the inclusion of the list of criteria that is significant for the students, i.e. wages, work safety.

Are you planning to work in a business focused on sustainability?

Totally agree (%)	Somewhat agree (%)	Neutral/have no idea (%)	Somewhat disagree (%)	Totally disagree (%)
5	27.50	40.00	21.25	6.25

Sustainability is a field that is not generally related to business or expressing in extreme, money making. This question refers to the ratio of students having a positive attitude for sustainability focused companies. The high ratio of 40% for neutral thinking, in other words indifference towards such companies, is an affirmative sign that sustainability focused companies are being accepted as any other company, changing the long-standing view that only sustainability and profit are contradictory. The ratios of those students that would be willing to be employed by suitability focusing companies and those that are against are only slightly different.

7 Conclusions

The Sectoral Education Program of Ozyegin University has been developed to abridge the skills gap between higher education institutions and business life together with the unreadiness of the new graduates which have been a concern for both academia and business world alike. Over the years, sustainable development principles and their projection as sustainability know-how on the competence skills of students have led to the approach of teaching business sectors in light of those crosscutting global sustainable development issues.

The available research in the literature for the skills sets of sustainability know-how for university students is not satisfactory. The results of the survey is only valuable as an initial outcome of basic questions on students perception of sustainability, their feedback to a new approach of sustainable development education and finally being able to associate what's learned in class and their long-term individual employment targets.

The two-term survey study with 240 students indicated that once the reason is clearly identified to students, students are more likely to own and identify themselves with the approach. Study should be carried in a larger group, providing comparison between students that have taken the SEC 302 course and those that have not. Furthermore, the survey should be carried out with more questions in multiple times for a given student group.

Among many results of the study, one forthcoming outcome is that there is a current indifference to sustainability. This outcome may be result of different factors and need more investigation into the issue. Various efforts as research, education and social activities on suitable development exist in the universities but majority of the students may still find that sustainability is not a skill set or understanding that needs to be embedded to life rather that an external and extra endeavour. To change this, it is very important to create a sustainability framework in universities including all the aforementioned aspects from research and education to social

activities and within this sustainability framework list out all the efforts as student will encounter from the first day till the graduation.

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Teaching to End Hunger: Critical Analysis of Food Systems and Poverty

Beth Choate, Eric Pallant and David Shipe

Abstract

The 2030 United Nations Agenda for Sustainable Development lists ending poverty and hunger, achieving food security and promoting sustainable agriculture as its first two goals for transforming our world. The accomplishment of these goals requires individuals who can think critically about our current food systems. Since 2013, professors at Allegheny College have taught a food and agriculture course entitled *Soil to Plate* to address questions related to agriculture and food security. The 15-week course covers sustainable farming practices, soil fertility, pest management, and the factors that influence access to high quality food. Methods of introducing content are multi-modal: field trips, lectures, discussions, guest speakers, cooking lessons, and skype sessions with experts around the world. Weekly field trips are taken to small, medium, and large-scale farms, food processing facilities, food pantries, community gardens, and grocery markets. The course addresses issues of nutrition, food security, food production, poverty, and environmental sustainability applicable to rural Pennsylvania, the nation, and the world. This paper describes our methodology and the tangible outcomes students and graduates have achieved in support of the 2030 Sustainable Development Goals.

Keywords

Food systems · Agriculture · Sustainability · Hunger · Course

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1 Introduction

In 2012 The World Bank, and its associates, assessed global poverty [at $1.90 a day (2011 PPP)] and malnutrition rates at 12.73 and 11.40% respectively (World Hunger and Poverty Facts and Statistics 2015). Therefore, it is of no surprise that the United Nations' 2030 Agenda for Sustainable Development cites both of these critical issues as key challenges to global equality and prosperity (Transforming Our World 2016; Patel and Agnetta 2016). To address these issues it provides a series of goals and targets directed at national and international governing agencies (Miller 2012; Page and Simmons 2000), while also acknowledging the importance of participation from civil society and the private sector (Freeman 2015; Karnani 2007; Krishnamurthy 2015; Rubenstein 2013). These latter groups require guidance beyond the 2030 agenda, primarily through the education of individuals (Imran Sharif et al. 2010; Leclerc 2009).

The need to provide a cadre of groups and individuals with strong skills in critical thinking about food systems will be met, in part, by institutions of higher education whose networks, perspectives, and resources make them ideal patrons of the broader agenda (Leal Filho 2011; Pallant et al. 2015). Preparing young people to face and resolve these broad issues will require an interdisciplinary approach, as is evident by the scope of the Sustainable Development Agenda and its predecessor the Millennium Development Goals (We Can End Poverty: Millennium Development Goals and Beyond 2015; Besley and Burgess 2003). In addition, experiential learning will prove a vital asset within this progressive education program (Bernik and Žnidaršič 2012; McCarthy 2010). Experiential learning outside of the classroom when incorporated into a multimodal instructional model has been shown to greatly improve student engagement and learning outcomes (Brundiers et al. 2010; Diaz and Woolley 2015; Littledyke et al. 2013; Wiek et al. 2014).

The Environmental Science Department at Allegheny College has a rich history of teaching environmental sustainability and promoting a green campus through laboratory work, community involvement, independent study, and collaborative research projects involving students, faculty, staff and administrators (Boulton et al. 2017; Eatmon et al 2015; Pallant et al 2012).

The purpose of this paper is to describe a course designed to teach undergraduate students critical thinking skills necessary to tackle the United Nations' 2030 Agenda for Sustainable Development. Following a full description of the class, there is an analysis of the short-term and slightly longer-term outcomes for students that have taken the class with special attention to how skills acquired in this class could be applied to combating global poverty, inequity, and malnourishment.

1.1 Soil to Plate

Environmental Science 230: *Soil to Plate* was developed in 2016 to fulfill the increasing student and faculty interest in food systems (https://sites.google.com/a/

allegheny.edu/soil-to-plate-spring-2016/). It is a sophomore level (2nd year) course taught for 15 weeks in mid-January through late-April. Four iterations of the course have been taught to date. The course meets three times throughout the week. Tuesday and Thursday sessions meet for 1.25 h with a 3 h session on Wednesday afternoons that is used for field trips or laboratory exercises. Each topic will be described in detail below. Course grades are comprised of participation, field trip and laboratory reports, three major assignments and one final assignment that asks students to identify "the best thing to eat" and cook it.

The schedule of the course follows the trajectory of a crop plant: plant the seed, protect the plant, harvest, process into food, and consume. The course is thus divided into four main topics: How we plant and grow crops; How we protect crops; How we process and transform crops into food; and How we eat and distribute food. Because the course material is designed for students in their second year of college, we introduce a variety of topics from soil science and entomology to food policy and security. Our focus is not simply the science of growing crops and crop management. Instead we integrate these topics with the social aspects of food, including policy, food security and food access. Students are then encouraged to further their knowledge in favored topics through specialized, upper level courses.

2 Course Description

2.1 How We Plant and Grow Crops

The class begins with the interaction between seed and soil. In the winter, before fields are prepared for planting, farmers must select from a seemingly dizzying array of seed characteristics that are available as a result of plant breeding and genetic modification. Farmers must select seeds based on their days to maturity, requiring them to estimate the length of the upcoming growing season. Will the spring be too wet to plow until late in the season or will the first killing frost of autumn continue to be later than average because of the creeping impact of climate change? Should he or she pay a higher price for a crop variety that has been genetically modified to be resistant to pests or herbicide applications, or purchase a seed coating that increases resistance to soil fungi (see Monsanto's webpage for seed sales, http://www.monsanto.com/products/Pages/monsanto-agricultural-seeds.aspx)?

Thus, less than a week into the class, most students are recognizing for the first time several new features regarding farming. First, agriculture is a business. Regardless of whether the farm is a family-run operation in rural Africa or an incorporated farm with thousands of hectares in the American breadbasket, the operation has to balance expenses with projected revenues. Second, agriculture is a very risky business. Pay too much for a herbicide-resistant variety of seed, but avoid the premium necessary to buy the drought resistant hybrid and a farmer could

be facing a huge loss in yield if the upcoming year is a dry one. On the other hand, should conditions turn out to be perfect for growing during the upcoming year, chances are they will also be excellent for neighboring farms. Everyone will have burgeoning yields and prices will drop when supply outruns demand.

To reinforce the notion that agriculture is a business, and a complicated one at that, the first field trip of the year is to a large, highly mechanized farm, though probably any farm will serve the purpose. While at the farm, the farmer shares with us how she goes about deciding which seeds to purchase, her budgets from the previous year, and her rationale behind various decisions. If field trips are not an option, bringing a farmer to class would help demonstrate that all farmers need to be adept at business, entomology, soil science, mechanics, meteorology, marketing, and increasingly, climatology.

Having set the stage with the choices necessary to select seeds, we move on to the role of soil in agriculture (Kohnke and Meier 1994), describing the primary functions of soil: physical support for plants, plant nutrition, and a balanced supply of water and air to roots. This leads to class discussions of the role of fertilizers in replacing nutrients that have been harvested with plants for consumption. We explain how fertilizers are manufactured or mined, the large amounts of energy required to do both, and the high price of these manufactured nutrients. This is a price that can be readily borne in developed countries, but may be out of reach for subsistence farmers in poor countries. We also discuss the environmental impacts of fertilizers: eutrophication, high energy inputs needed for manufacture, and interactions with climate change (Daniel et al. 1998; Tirado et al. 2010; Gerber et al. 2016).

2.2 How We Protect Crops

Now that students understand the science behind growing crops, the class transitions into the science of how farmers produce maximum crop yields when competing with insects, diseases, birds and mammals for food. Because the class can not be comprehensive, the focus in this section is on insect pests, not weed pests. The first lecture defines a pest and brings to light the danger of large monocultures. For an insect that eats only corn, a farm with field after field of corn is an ideal habitat. We discuss the problems with pesticides, such as killing non-target organisms, development of resistance and health concerns of workers, as well as the similarity between pesticides applied to crops and antibiotics given to livestock.

Many environmental science students enter the course aware of the negative effects of pesticides and it is important to remind them of those issues; however, they have not always considered the ultimate goal of farming, to make money. To demonstrate the economics of pest control and how farmers decide when to apply an insecticide, class lectures cover field sampling methods in which farmers look for specific pests throughout their fields. Using efficient sampling, farmers are able to estimate the number of pests in a field and determine when it makes monetary sense to spray a pesticide. This decision is based on a variety of factors including

the market price of the crop, the amount of processing that will occur after harvest, the amount of damage that the pest will do to the crop and the cost of the chemical pesticide. For example, if the crop is to be sold as fresh fruit, farmers are much less likely to risk any damage that makes the fruit look less appetizing for consumers.

Plant diversity is presented as a non-chemical pest management strategy. With increased diversity the manipulated landscape starts to act more like a natural ecosystem with various predators keeping "pests" in check. A second non-chemical method of pest control is the introduction of predatory insects, which like all agricultural decisions has economic pros and cons. The primary advantage of large monocultures where pests are controlled with applications of synthetic pesticides is that fields of the same crop are easily planted and harvested with large machinery, pests are controlled with the same insecticide and the nutrient needs allow for a single application of fertilizer. Again, it's a business and comes down to money.

A multi-day experiment is used to demonstrate the variation in pest management when using beneficial insects and pesticides. Students plant fava beans in the first week of class. Once those plants are large enough, they are infested with pea aphids (purchased through eNasco). A third of the class sprays their infested plant with insecticide, a third of the class adds lady beetles and the other third does nothing to their plant. It immediately becomes evident that the insecticide acts quickly to kill many of the aphids. The lady beetle requires a few days before it is able to locate the aphids and even then, it may only consume a few. Once the aphids start reproducing, the lady beetle is often incapable of keeping up with increasing numbers and sometimes the lady beetle dies or flies away. Both are situations that can occur in large fields. Those individuals that have plants with no treatment see the damage that can result from a pest infestation that is ignored. The experiment has never worked perfectly, but neither does pest control on a farm. Sometimes the insecticides don't kill the entire population of aphids and another application is necessary, and other times biological control agents fly away.

Because the number of potential pest organisms along the agricultural commodity chain is too extensive to be covered in class with lectures, students prepare posters for specific organisms, including birds, rodents, weeds, fungi, and diseases that attack seeds, crops, livestock, and post harvest fruits and grains. Students visit one another's posters during an in-class poster session to learn about the damage done by these pests and the methods used to eliminate them.

2.3 How We Process and Transform Crops into Food

The section begins with a map of corn and soybean production in the U.S. More than fifty percent of all harvested cropland in the United States is covered in these two crops (Farms and Farmland 2014). Many students don't realize that neither of these crops are edible in their raw form. Instead, corn and soy are processed into a variety of foods including high fructose corn syrup and soy oil. Understanding the affinity for crops that cannot be consumed without processing and energy use requires a discussion of U.S. farming and food policies and their history. While the

prominent crops grown in a country vary, understanding the history and the policies that result in crop preference are essential to understanding the availability and costs of foods throughout a country.

During this section, the class visits a local food processing plant that produces a variety of frozen foods including pizzas and breakfast sandwiches. The mass production of these food products, that look nothing like what is growing in fields, begins the conversation on what goes into processed food, as well as food access and availability. Access is a topic that is discussed in further detail during the last section of the class, but in many cases this is the first time students are faced with the idea that not everyone can afford or has access to fresh fruits and vegetables.

Through a Skype discussion with a food scientist, students learn about the role of unknown ingredients in creating uniform food products that have a longer shelf life and contain increased nutrient content. While many environmental science students question the motives of food additives, it soon becomes clear that the goal of a food scientist is not malicious, but instead to produce nutritious food products. The next field trip is to a large scale egg producer. This allows the class to observe the mechanized process of gathering, washing, and weighing eggs, then placing them in their cartons for distribution to markets nationwide. During this field trip, the farmer discusses government regulations on egg prices and the wide distribution of his product.

The large project during this section is to develop "Sustainability Standards." In the U.S., the government strictly regulates products labeled "organic"; however, through critical analysis students quickly realize that organic standards are not always the most sustainable (Organic Regulations 2016). For example, organic certification does not consider water use or worker rights, meaning organically labeled foods might have been irresponsibly irrigated or harvested by unfairly treated farm workers. Students are then tasked with writing standards that farmers should follow when considering animal inputs and outputs, animal lifestyle, seeds, carbon emissions, irrigation, land management and erosion, GMOs, pest management, soil fertility and the treatment of workers. Groups of students are given a blank webpage and asked to develop that page with images to discuss how farmers should manage each aspect sustainably.

When reviewing the webpages of other groups, it also becomes evident that what is best practice for animal outputs may conflict with issues of carbon emissions or soil fertility. For example, the group charged with managing animal manures might recommend application of manures onto fields to build soil fertility whereas the group in charge of managing carbon emissions from American agriculture might propose a limit on the size of herds and flocks. Furthermore, the group in charge of land management and erosion might recommend forbidding the distribution of manures onto frozen ground creating a headache for farmers that would have to store manure through the winter months. Manure stored in large piles or ponds will be opposed by the carbon emissions group worried about releases of methane. Here students grapple with how to create policies that will ensure environmentally friendly practices they support while allowing the farmers to run their business profitably.

2.4 How We Eat and Distribute Food

The last quarter of the class is dedicated to issues of food marketing, distribution, and access. A visit to the regional food pantry provides the main lesson for this section. Here, students observe the quality and quantity of food available to families in need. They learn how food is acquired by agencies that provide food aid and learn what requirements must be met by low income families in order to receive free food. Poverty and the concomitant issue of food security in our community become less abstract and more personal (Martin et al. in press).

To reinforce student comprehension of obstacles faced by low income families in need of food, the role of national politics in establishing the Farm Bill, which in the United States includes provisions for food assistance as one of its largest financial outlays, is explained (The Secret Life of a Food Stamp 2014). Students are required to construct a shopping plan for 1 week of meals not to exceed the budget received by the average recipient of food assistance. Experiences as shoppers on limited budgets helps drive home to students the limited number of options available to low-income families.

Field trips include visits to a variety of food markets to compare prices, availability of organic foods, number of choices for each item, advertising, nutrition, and access for low income families. Thus, the class visits community gardens, fair trade stores, locally owned supermarkets, convenience stores, and big-box, chain supermarkets. One primary lesson aims for students to understand the illusion of choice presented by large supermarkets. Students must count the number of options available when purchasing commonly acquired household foods: pre-made pizza, chocolate chip cookies, granola bars, bottled water, macaroni and cheese, and bread. In an average American grocery store, there are more than one hundred choices for each of the aforementioned items. Students must then find the version of their food product containing the greatest number of ingredients on the label. Many processed or premade foods contain ingredients that you wouldn't buy at the store and put into the homemade version of the food, for example to increase shelf life or enhance color. Students must identify 3 of those ingredients and determine their purpose.

A homemade version of the food is then prepared, so that students identify the variation in the number and type of ingredients. Additionally, they calculate the cost per serving to make the food item with conventional and organic ingredients and then compare the cost of homemade to the pre-made version. Students must include the amount of time needed to prepare their homemade version and tabulate the potential trade off for a low-income wage earner: work an additional hour and purchase pre-made options or forego the wages in order to make a home cooked meal. The power associated with economies of scale becomes apparent when comparing the quantity and resulting low cost of food produced in factory settings compared with what can be made by a single person cooking for a family. This exercise helps magnify the comparative ease associated with purchasing low cost, low nutrition, high calorie foods that are heavily advertised in stores and in fast-food operations.

This segment of the class, and its focus on the impact that poverty has on food access, food selection, and food security, is used as a launching point for discussions of food security in countries where large proportions of the population are living in poverty (Conceição et al. 2016).

3 Multi-modalism

A large reason for the success of the class is that agriculture and foodways are displayed through a variety of venues. Of particular value is the opportunity to meet food producers and farmers. Preconceived notions generated by textbooks and articles often imply that farmers, especially on large farms, are not environmentally conscientious or concerned with animal welfare. Meeting with farmers helps personalize the people doing the hard work. Students no longer find it easy to group all producers into an abstract cohort. Students are also working in the campus garden to evaluate soil variability and several times throughout the semester they actually produce their own food in the teaching kitchen. Learning is occurring in a variety of settings outside of the classroom which increases student investment and enthusiasm for the topic.

Of critical importance is the opportunity for class discussion. Because the objective of the class is to teach critical thinking about the food and agricultural system as well as to elucidate the connection between poverty, hunger, and in many cases obesity associated with poverty, the need to process and create dialog is essential. Frequently, students accepted farmer claims of environmental stewardship without critique. For example, students inevitably became enamored with all the animals they saw on farms, so during class discussion we made certain to challenge cuteness with realities of the amount of food that is fed to animals that could be fed instead to humans, the amount of land required for the production of animals that could instead be conserved as natural ecosystems, and especially since dairy cows are so predominant in our region, the hidden cost of milk production in terms of water use and climate change.

4 Outcomes

The initial outcomes achieved from taking this course are collected on the final day. Students are asked to work in groups to summarize what they learned. The list provided in Sect. 4.1 is an abstract of what they have compiled over the four years the class has been taught. Additionally, through tracking of students several years after completing the course, an analysis of the outcomes generated following the completion of the class could be generated these findings are described in Sect. 4.2. This research is limited as a result of the short time period during which the course has been taught, as well as a lack of statistically analyzed qualitative data.

These outcomes do demonstrate that the course is effective in developing students who can think critically and creatively about creating sustainable food systems.

4.1 Course Learning Outcomes

The following bulleted list summarizes the material that students learn throughout the course.

- Agriculture is complicated and farming is a risky business.
- All individuals in our food system are trying to make money and support themselves. No one is malicious in the work that they do.
- Farmers must be educated in a variety of topics.
- All farmers care about their land and animals.
- Linear agriculture is inherently unsustainable.
- American agriculture is very productive, but may not be producing the correct amount of each crop or producing the crop in the most appropriate locations.
- Small and local is not necessarily more environmentally friendly.
- Government policies directly affect what we consume. Despite concerns over the current American food system it does not appear to be changing due to lobbyists for large scale agriculture.
- Education is not the solution to altering food choices. Teaching people what they should eat does not change what they eat.
- The ability to be selective about your food is a privilege. The current food movement is accessible to a very small, elite, wealthy group.
- The goal of community gardens is about food production, as well as empowerment of individuals in those communities.

4.2 Long Term Student Outcomes

Even though *Soil to Plate* has only been taught for four years, students are already taking lessons from the course and applying what they have learned to create solutions for the 2030 United Nations Sustainable Development Agenda. Several students that took the class in their first and second years selected senior thesis topics that addressed issues of food justice and poverty.

One student created a manual for adapting to climate change for African vanilla growers. Her report was distributed to NGOs in Uganda and to managers at the American ice cream firm of Ben and Jerry's. A second student is working alongside undocumented migrant workers picking cherries and apples in the Pacific northwest of the United States. She is recording stories of abuse and hardship endured by the people that harvest produce in America.

Americorps Vista is a domestic service organization that encourages its participants to build capacity for NGOs and non-profit organizations. A recent graduate is

working as an Americorps Vista project leader at the area shelter for abused women. At the shelter she has constructed gardens to teach women how to use local, fresh produce to create healthy meals for themselves and their children. Moreover, she is performing outreach to the community explaining that communities with a greater number of gardens and greater food security enjoy decreased levels of domestic violence. Several students that have taken *Soil to Plate* are involved in a large scale research project to launch a food hub for western Pennsylvania. Having had considerable experience already with the full commodity chain from farmer to consumer they are well positioned to continue their work interviewing farmers, food processors, marketers, and consumers.

What all these students have in common is that once having taken the course they are prepared to think critically about food, justice, poverty, and equity. They understand that recommending adaptations to climate change for farmers in Africa requires cultural sensitivity and awareness. Similarly, growing food adjacent to a shelter for abused women is not sufficient for changing diets or lowering instances of domestic violence. Some women need to acquire confidence in the kitchen, especially after having suffered physical and emotional abuse, often in relation to food preparation. In addition, many women must first learn how to prepare foods from fresh ingredients and expand their palates to include new tastes.

One student came to the class after having already had considerable work experience on organic farms. She had learned one approach to vegetable production and animal rearing, but after seeing how small-scale organic farms fit into the larger, more global nature of food systems, hunger, and poverty reported, "I learned more in this class than in any other class I have taken or expect to take while in college."

5 Conclusion

The primary goal of offering *Soil to Plate* is to teach students the complexities inherent in delivering food to a global population. Throughout the term there are discussions pertaining to food quality, availability, nutrition, and environmental trade-offs required to produce food. Many students express frustration that there are no "right" answers for agriculture. They struggle when asked whether organic food production can feed the world and at what cost. They have great difficulty answering the sole question that makes up the final exam. "What is the best food to eat? Cook it."

In conclusion, *Soil to Plate* teaches students to think critically about food systems and to understand that ending poverty and hunger in the world and in their backyards will require creativity, flexibility, and perseverance. Analysis of student learning outcomes reveal that at the conclusion of the class, student comprehension of issues relevant to the 2030 United Nations Agenda for Sustainable Development are deeper and embedded in a more global context. Moreover, following completion of the class, several students have already demonstrated their ability to apply

the lessons learned about food production, preparation, and distribution to issues of food justice. This is a fairly new course therefore the analysis of outcomes provided here follows students who only recently graduated from the institution. Future research following their careers as they relate to issues of food sustainability will allow for a more critical analysis of the success of the course.

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Rethinking Post-occupancy Evaluation for Sustainable Learning Environments

Andrea Wheeler, Hina Illahe and Rucha Newalka

Abstract

Green or sustainable schools are an important building type from which to explore questions of changing social behaviors and the often overlooked social dimensions of sustainable development such as equity and inclusion. Building performance studies, including post-occupancy evaluations (POE) are increasingly taking into account behavioral and social dimensions of the build environment, as well as the more common objectives of reductions in energy efficiency, and adopting ethnographic and art-based research methodologies to examine building users' interaction with their environments. In this paper we examine contemporary evaluation methods in the context of school buildings to explore how some popular POE approaches imply only superficial objectives for green building. The need to create new habits of living and the role of the built environment in this task goes without question; but confronting scientific methods and engineering perspectives typical within the industry, meets professional barriers. In order to improve commonly adopted POE methods in the context of sustainable building, it is important that we are able to contest the meaning of sustainable design and include evaluation tools that have radical educational and transformative objectives, in particular those that allow communities to explore futures that demand both social and technical change. This paper suggests that through user feedback, architects and other building professionals have not only important tools to improve the performance of sustainable buildings, but also to confront the limited expectations of architects

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and engage users in a sustainable future. POE tools are educational and in listening to users, co-researching ways to transform environments, architects can transform their approaches to sustainable design.

Keywords
Sustainable design · Post-occupancy evaluation · Methodology

1 Introduction

Post-occupancy evaluation (POE) is not a new process, and the desire for feedback over history and methods adopted by architects has been discussed. While post-occupancy is generally considered to have developed as a field in the 1970s, historical research throws new light into this discipline. Interest in research in this area is growing, especially in terms of the actuality of the performance of sustainable architectural design. Moreover, ethnographic approaches to understanding performance and behaviour are also gaining greater interest from within the profession, as a way to challenge linear, systematic, and scientific ways of knowing. This direction is inspired by socio-material discussions of architectural practices and work within Science and Technology Studies (STS) as well as the recognition that architecture is a collective practice shared with various human and non-human actors. New ethnographic approaches that are seen in developing post-occupancy research follow principles of no-hierarchy and pay attention to not only words, but also gestural, non-verbal and visual language. There is also a current suggestion of an ethnographic turn in architecture, reflecting further on architecture as a social practice. The question of new methods of evaluating the built environment thus has some relevance to improving contemporary POE practices.

2 Post-occupancy Research and New Social Science Methods

This paper refers to two research projects. One project examined post-occupancy evaluation in school buildings (carried out between 2010 and 2011) in the UK and the second, theoretical study explored the potential to commercialize new approaches to post-occupancy evaluation (POE) funded by a special grant from the Iowa Energy Center. The objectives of this latter project were to develop a tool or method for post-occupancy evaluation of school buildings that could provide a marketable and commercially viable approach that would allow architects and other stakeholders to reduce energy use of buildings, specifically in Iowa schools. The first project thus provided the foundation to research questions in the second.

Very early on in the project, the questions that arose about commercialization and practicalities of marketing were considered to be more theoretical than practical. The questions, which were focused on a series of approaches to engage young people in the evaluation of their own school buildings developed by Wheeler and Malekzadeh (2015), inquired about the ways in which contemporary scholarship can inform current approaches to POE rather than the ways in which commercialization could be identified and overcome. Current and growing field of literature, especially in Europe, has reassessed the value of post-occupancy tools for architecture, especially in relation to the actual energy performance of buildings. However, the pertinent contemporary questions raised by consulting academics and professionals in the field in the early stages of the project asked how research focused on how the feedback and processes of post-occupancy can, or could, in themselves, be socially transformed and how communities could adopt sustainable energy technologies. The key problem, as it was identified, was how such building assessment and post-occupancy evaluation methods could be utilized to embrace the sustainable energy design approaches of new buildings to engage communities with the pressing questions of sustainable living, and at the same time acknowledging the developing nature of the conversation of sustainable development. That is to say, the question was how to engage a community in an evaluation of their building based on sustainability design features while acknowledging that the field itself, with its priorities and values, is subject to change. In designing sustainably, just as in the rapid growth of unsustainable development, we make decisions about technology without being able to fully test that technology on communities over time. These issues presented the greatest difficulty in the process of commercializing a tool and required the research team and its research assistants to examine some of the philosophical biases of the approaches that have been developed in the name of viability and marketability.

The latter project was carried out between June 2015 and December 2016 with the aims to: (1) Consult with professionals in Iowa about the feasibility of the existing building assessment tool and modify the methods, practices, and test (see Wheeler et al. 2011; and more recently Wheeler and Malekzadeh 2015); (2) Network with academics and professionals who are known to the researchers, such as the creators of the Soft Landings tool in the UK (a widely utilized method) and those who are new to the field and offered new perspectives, such as the academic, Henrik Schoenefeldt; and (3) Develop a program towards commercialization.

Academics in the field that the project team consulted were enthusiastic to share their insights on the importance of this research direction in our current context of Iowa. However, others purposefully warned against the overly ambitious aims of commercialization, advising us to re-examine and re-evaluate the potential of post-occupancy tools or feedback mechanisms for the communities of new sustainable buildings, like schools. Moreover, the issues surrounding the commercialization and protection of intellectual properties within a small program of research that aimed to facilitate communication between scholars and practitioners were indeed not only onerous early in the project, but in fact overly time consuming and almost insurmountable for the team of academics and professionals who

originally gathered to collaborate on the research. After these early difficulties, it was decided that the project would address the methodological questions regarding post-occupancy in sustainable design, as was suggested by the consultants, rather than the direct testing of a method, which, it was argued, required theoretical review in terms of its qualitative approaches and its suppositions, anyway, before testing.

The qualitative and quantitative dimensions of the POE tool in general, and the necessity to include innovative ways of collecting qualitative data (see Wheeler and Malekzadeh 2015) in post-occupancy evaluation, posed the greatest concern in terms of examining method. These two seemingly distinct methodological approaches are nevertheless both foundational to the development of post-occupancy evaluation and highly relevant to the current trajectory of research on post-occupancy evaluation in art-based and ethnographic approaches.

3 Methodology

The difficulties encountered with the research team demonstrated the need for the research but also the importance of the new ways of collecting the qualitative data. The dissolution of the partnership with the industry collaborator and tensions with other co-investigators over intellectual property and collaboration agreements (questions about who would own the tool once it was developed and could all data be brought to the table) all added to a conscious decision to maintain the theoretic dimension of the research. Furthermore, the PI had successfully applied for, and been awarded, additional 'seed' funds to support this project. Thus, due to an overly ambitious research aim to commercialization and the needs identified by the academic community, important theoretical dimensions of the project were acknowledged. The development of scholarly work and the cutting edge of post-occupancy research in the UK proved successful also in terms of the networking objectives of the grant. Research Assistants maintained a series of discussion workshops and email and Skype contacts with international academics in the field, and they presented research work at International conferences in the US. The need for research in the area of post-occupancy evaluation of sustainable buildings, in terms of education and agency for communities, and in the area of science, technology and society is significant and was emphasized by international academics in the work carried out in the project. While the objectives towards a plan for commercialization were not been reached by the project, at least not yet, and the commercialization direction was put on hold, the theoretical work was significant. This research project work thus provides the preliminary research vital to any program of testing that may be carried out in the future. The members of the research team as well as research assistants (who left the University for other ventures) changed significantly over the course of the project. Nevertheless, the parallel 'seed' funds allowed a much greater wealth of student time to be devoted to the project. When the dissolution of the agreement with the industry partner came over the difficulty of intellectual property and effective academic and commercial partnership, and the

testing program of the refined method would not be implemented, the modified objectives and deliverables of the project were achieved. This was possible, in part, with intense research assistant effect and outputs from the project in the form of conference presentations.

3.1 Research Program

The project aimed to address critically the problem of qualitative assessment in sustainable architecture, and the student and faculty research team were able to consult with, and interview through Skype, international academics working in this field. These included Bill Boardass from the Soft Landings team in the UK, Thomas Berker from the Norwegian Institute of Science and Technology in Trondheim (with whom the PI had presented research findings at the *Nordic Environmental Social Sciences Conference* 2015 ahead of the IEC grant application questioning methods in sustainable design and its evaluation from an STS perspective), and Henrik Schoenefeldt from the University of Kent, School of Architecture. Schoenefeldt's pioneering work has addressed the history of building assessment through historical archive and case study at the Houses of Parliament, UK, offering a particularly valuable perspective to the project (Schoenefeldt 2016).

Through consultations, questions arose first about the beginnings of the post-occupancy method and about the role of the qualitative, which had been central to this history of building assessment. Building assessment methods have been used as "troubleshooting" methods in the past, uncovering the causes of both technical and operating problems associated with user discomfort. But an early reason for post-occupancy evaluation concerned the development of the agency of the building users' community to empower them to solve comfort or other building problems and to engage them willingly in the questions of sustainable development. This latter dimension of the research was particularly important to the question of sustainable learning environments.

Hence, in consultation with professional and academics a series of objectives were identified, and a literature review carried out in the field. The modified objectives of the project, examined through literature, were thus to:

- Investigate the importance and the potential of innovative approaches to post-occupancy evaluation of sustainable learning environments.
- Examine how post-occupancy methods could be modified to meet the real and actual needs of designing sustainable learning environments.
- Identify design approaches that have improved information feedback in POE to guide designers in developing new methods to designing sustainable learning environments.

A literature review was conducted to engage with these questions and to critical investigate some of the most current approaches to post occupancy.

4 Results and Analysis

While the team looked at specific strategies and solutions to overcome the limitations of current methods in post-occupancy evaluation, the concern identified early in the project was how to design a holistic post-occupancy method that addressed some of the undervalued dimensions of sustainable design. These place increased value on user experience and user agency, including within the school community. Narrative methods were of the immediate interest in this respect to the research team, but the research also explored the educational potential of post-occupancy tools in particular (the question was whether a POE method could be developed specific to schools) by critically investigating various programs of sustainable schools' design. The broader intention was to find ways to highlight the social aspect of sustainability, the physical and psychological health aspects of sustainable design, and the ways in which architects present the social, emotional, and intellectual development of children in the spaces they design. From the start, the creation of a post-occupancy tool indicated the need to integrate holistic paradigms of sustainability in educational built environments to better address understandings of sustainable design.

4.1 Understanding an Integrative and Holistic Paradigm in Post-occupancy Evaluation: The Relation of Child and Outdoor Learning Environment

Research presented by a group of psycho-analysts of the built environments from the Universitat Munchen, Germany, examined the psychological aspects of an outdoor science teaching program (Dettweiler et al. 2015). The group investigated the motivational behavior of pupils during outdoor science teaching using self-determination theory and revealed a number of advantages of open outdoor spaces that motivate students to learn. The study showed that student's motivation to study science decreased from adolescence onwards but after a week at an outdoor science center, the courses taught under the general heading of eco-climatology in an outdoor camp atmosphere fostered the sense of community, personal discovery, and personal responsibility. The quantitative research findings and students' responses indicated a positive psychological effect of outdoor environments. Albeit that some students found it difficult to adapt to extreme weather conditions. The study concluded that outdoor teaching could offer practical knowledge to children along with the scientific general application to be learned in a better way. However, children were more engaged with nature, and they displayed high motivational behavior. Irrespective of gender, the overall benefit from outdoor settings was greater than just improved learning. Along with higher activity levels compared to those conducted inside the classrooms, outdoor environment promoted a sense of wellbeing. While this study and many like it suggests the value of outdoors education for children, there are nevertheless limitations to teaching outdoors.

It connects students with the natural environment, allows space and time for 'free-play,' and allows students to discover vital dimensions of curriculum outdoor space is not the only type of space that has to be provided for children. A question about the sustainability agenda amongst architects has to be raised here in relation to the educational benefit of outdoor learning, and its increased value but nevertheless, specific questions about how sustainability is perceived and envisioned and how it is manifested (the focus of current post-occupancy evaluation interest) remain. The social dimension of sustainable development tends to be under investigated amongst architects. Our research question was how not only how to reevaluate the natural environment but to include in the post-occupancy tool developed during the course of the project, methods to increase the agency of school communities to change school environments and liberate the community at an educational level to consider the critical perspective of the sustainability agenda.

4.2 Understanding an Integrative and Holistic Paradigm in Post-occupancy Evaluation: The Relation of Child and Natural Environment

A joint study conducted by researchers from the University of Copenhagen (Bentsen et al. 2010) on the extent and dissemination of Outdoor teaching strategy 'Udeskole' in Danish schools also revealed improved concentration, high levels of physical activity, and improved motivation to study among students who studied in outdoor teaching environment. According to this study, 87% of 98 municipalities practiced 'Udeskole' by joining with the local government to increase the utilization of green space and subsequently found better results. Many other Danish schools are in the process of implementation of the 'Udeskole' strategy. 'Udeskole' can be conducted in both natural and cultural settings, including forests, parks, local communities; and yet, there are some disadvantages, like concerns with safety, the cost for extra teachers or transportation, presence and distance to green space, and resistance from unfavorable climatic conditions. An interview with a teacher at Indian Prairie School-Naperville (Middle school) who adopted such an approach conveyed similar concerns. The teacher complained about the safety and huge responsibility of taking care of every child since the school did not have fences, and it surrounded by busy roads. Extreme weather conditions, which limit outdoor teaching for almost quarter of the year, was a huge concern. Additionally, smart classrooms that transform the conventional teaching methods are becoming a norm in American schools today. The priority is being placed ever more on communications technology education, and bringing technology out to the open air can be very difficult. *Teaching lifetime pursuits* (2010) discusses outdoor school environments and acknowledges benefits of outdoor schooling. But outdoor schooling in itself while it is argued does induce self-confidence and helps students develop new skills, learn values of mutual support, fitness, communal enjoyment, and appreciation and respect for nature.

Some children can feel inhibited from experiencing or benefiting from outdoor spaces, and adults also express fear of outdoors and child's safety.

Outdoor educational experiences can occur in outdoor learning environments and can instill activities that connect young people and place but also in the school environment. Activities that expose children to weather, seasons, clouds, soil, gardening, plants, and water can all happen within the school environment and grounds. Outdoor school spaces can enhance child's fantasies, curiosity, and creativity, building in their minds a sensitive appreciation of earth but this can also start in the classroom environment. Outdoor spaces provide for authentic natural experiences because direct contact with the environment can foster an appreciation for nature that leads to care and stewardship, but so too a well-designed sustainable school.

4.3 Understanding an Integrative and Holistic Paradigm in Post-occupancy Evaluation: Designing a Post-occupancy Tool that Engages a School Community in the Questions of Sustainable Design—The Question of Agency

So can outdoor teaching be possible, irrespective of climate conditions, and can the need for sustainable school environments be solved simply—both educationally and environmentally—by integrating the outdoors more within school campus? The book "A practical guide to planning, construction and using school courtyards" extensively discusses courtyards as a sustainable way to create outdoor teaching climates (Bansbach et al. 2012). School gardens are used as vegetable gardens and to grow food. Promoting the importance of agriculture also improves student learning. Additionally, exposure to nature and outdoor habitats can improve children's physiological health, improve attention span, and promote psychological health; thus, a constant connection with nature can protect children against stress (Browning et al. 2014). Access to natural daylight and better ventilated breathable spaces have positive effect on the learning of children (Canton et al. 2014). These arguments support the motive of sustainability in the real sense. However, school environments are typically enclosed spaces, they depend largely on mechanical systems of heating, ventilation, and often artificial lighting. Furthermore, pupils and teachers alike can have little control over these environments in terms of temperature, air quality, noise, or lighting levels, and the like. Questions of agency in school, at the level of individual control, are significant at this level, but so is the engagement of the whole school community in affecting change in that community, especially in the context of sustainability or sustainable development.

Furthermore, various organizational efforts to integrate sustainable schools in the local community have already expanded with impressive outcomes. The USGBC created guiding principles to integrate sustainability in school organizations by establishing the 'Whole school Sustainability framework.' The framework focusses on organization culture through shared values and social norms, physical place

through energy efficiency, and active engagement with environment and Educational Program by incorporating principles of social justice, respect for limits, and local and global citizenship (Barr et al. 2014). The Program on Educational Building (PEB) encourages the use of school grounds as a teaching resource to raise the awareness of the natural environment, its complexity, and its vulnerability.

Architects in the US and Australia teach sustainable design in schools to increase teachers and students' awareness of nature through a program called Learning by Design and the Schools Environment Assessment Method (SEAM) significantly contributed to the environmental effects of the building. SEAM was intended to be used by designers of new schools, by users of existing school, and as a part of national secondary curriculum. The notion that designers can both engage the school community in sustainable architectural design as well as build the community and its agency is well discussed in the field. An interesting case study of Ofsted schools in the UK was helpful also for investigating real case scenarios for sustainable strategies implemented in schools. In these schools in the UK, sustainability was to be achieved through principles laid out by the authority (Moncaster and Simmons 2015). Most schools had limited knowledge of sustainability, and teachers tried to use imaginative skills to improve practical knowledge. Schools tried to integrate sustainable development plans and ensure the availability of resources and training. This was done by identifying one key person to manage and coordinate sustainable development. Sustainable development of schools in Ofsted terms was thereby defined as a place and school culture where each learner could be healthy, safe, joyful, and accomplished to make a positive contribution and achieve economic wellbeing all within the earthly environmental limits.

Nevertheless, the various initiatives taken by the schools in these instances were supporting mostly environmental and economic sustainability, ensuring recycling, energy savings, and water efficiency for example. Teaching on sustainability addressed eco-friendly tourist resorts, problems of droughts in less economically developed countries, and science covered issues of environmental sustainability, such as renewable energy, global warming, and biodiversity. Students were encouraged to discuss and find solutions, reminding them of their responsibility towards the environment but from the literature, it was clear that Ofsted schools did not address issues of political and social injustice.

The lack of a critical perspective on sustainability has led to a haphazard development of the principles of sustainability in education but this extends to tools and methods. The eight doorways of Ofsted, which were the principles used, focused mainly on the environmental and economic aspects of sustainability. Though a small aspect of inclusion and participation was included, this approach did not explore the depth of social sustainability in a wider context, the perspective is of environmental and economic sustainability.

These questions raised issues about both the design of school environments and the education of sustainability in school in relation to the school environment, and they illuminated the problems at hand when developing a post-occupancy framework. Attempts have been made to simplify and depoliticize the discourse on sustainability for schools and for designers and to turn it into a technical issue.

However, the school with its function to house the education of young people reveals, by its nature, demands the social dimension of the sustainable design to be taken into account. A post-occupancy tool needs to address this social dimension both in the assessment of the actuality of school buildings as places for communities to work together and to learn and as places of the discovery of and interconnectedness with the natural environment.

4.4 Understanding an Integrative and Holistic Paradigm in Post-occupancy Evaluation: Designing a Post-occupancy Tool that Engages a School Community in the Questions of Sustainable Design—The Status of Post-occupancy Methodology in Building Design

Post-occupancy evaluation (POE), defined as a process of evaluating buildings in a systematic and actuate way after they have been occupied for some time (Gonzalex et al. 1997), has been traditionally aiming for continuous improvement in design (BRI 2001; Zimmerman and Martin 2001); hence, it has been an important factor in the building process (Preiser 2002). The feedback characterizes the logic of the process, and the purpose of the POE is also described as to help practitioners avoid mistakes. Current questions nevertheless generated by critical conversation within the profession emphasize the questions about the methods of approaching this feedback process, about the quality of information to be obtained from the user about their experience.

In its own way POE is an innovative departure from dominant methodologies of construction rooted in the positivist tradition offering limited researchers abilities to grasp the meaning of social action from the perspective of actors involved. Nevertheless, a constructivist epistemology underpins most traditional post-occupancy evaluation and assumes that people of different backgrounds, while experiencing the same situation differently, will arrive at a common problem (Pink et al. 2010, 648). Ethnographic approaches propose more sophisticated ways of understanding building users' interactions with the building and the potential of their feedback to architects. Moreover, more recent and innovative approaches to ethnography have sought ways to understanding user's engagement with their environment, that are participatory and collaborative. These are designed to enable ethnographers to 'share' other people's experiences in order to better understand their experience in recognition of empathic and sensory dimensions of our relationships with environments and community (Pink 2007, 2009). Nevertheless, ethnographic research remains unconventional and little understood in the context of the building industry and further issues, for example, how can a community be educated about sustainable design and what pedagogic attitude or philosophy shapes such 'teaching' approaches, remains in part governed by ideas about what constitutes a sustainable building or a sustainable school from educational authorities and academic and professional discourse in general. How can post-occupancy methods, seeking to engage communities to participate in research in a critical and authentic manner,

develop responsible relations to build natural environments? This question exceeds most contemporary approaches to designing sustainable schools. Current methods typically include surveys to collect the quantitative data, and open ended questionnaires, but can also include building walk-throughs, facilitated discussions, energy use data, and the performance of systems. Research projects have recently adopted these methods to evaluate contemporary school buildings (Ahmadi et al. 2016; Choi et al. 2012; Sanni-Anibire et al. 2016). Furthermore, user participation or involvement methods have been reviewed recently to provide a clear framework for user involvement in architects' design activities, including at the level of post-occupancy (Kim et al. 2016). However, the POE method can indeed also include ethnographic methods, including video ethnographic, and visual data collection methods. These assessment methods can be used to collect information from the very often missed sensory dimensions (Pink 2015). It is this dimension that is mostly missing from our evaluation of sustainable architecture and yet it is the aspect of our engagement with environment that has such potential to motivate change in community. Nevertheless, as Pink et al. (2010) stated, 'Ethnography is a serendipitous craft: Ethnographers often expect to learn precisely when they are least expecting to… what is learned goes beyond what could be said in an interview and can only be known by being there, as events unfold' (Pink et al. 2010, p. 658). Moreover, she further wrote that '…ethnographic methods in building design research can make visible informal worlds of actions, interactions and ways of knowing that can easily slip under the industry (or official) horizon of notice' (Pink et al. 2010, p. 258). These methods have significant potential in the context of sustainable design, for building community knowledge, for engaging architects and communities, and for building community. Furthermore, ethnographic perspectives offer an educational potential to reconnect children and the school community with the natural environment through the senses, this is a powerful way to reevaluate and address our human connection to the built and natural environment but it is one also how the built environment is conceived by building professionals.

4.4.1 Barriers to Adopting Innovative Methods

The barriers to adopting innovative methods that question how user experience is captured, such as sensory ethnography and visual methods, are difficult from both institutional and professional perspectives. Evaluating the performance of a building and user satisfaction in ways that are open to elicit information beyond traditional confines risks professional reputation and possibly even financial loss. However, various issues concerning the appropriate method and the validity of user data in the architectural and architectural engineering context (as described by those professionals in early project meetings) must emerge if sustainability in the build environment is to progress. Social data is seen of at best as benefitting 'marketing' purposes from the point of view of the architecture or to appease clients who want their voice to be heard. Confronting the dominant methods of scientific and engineering norms of research in architecture, thus poses a significant challenge, despite a growing body of criticism in method. Nevertheless, the academic and research field has a responsibility to present the case to the profession. Innovative

approaches have the potential to address the "green wash," of many sustainable buildings by engaging with the actuality of designs but the question is whether architects or other building professionals could or would use a post-occupancy tool to elicit such information.

4.4.2 Communicating the Benefits

It is crucial that we are able to contest the meaning of sustainable design and sustainable lifestyles. Evaluation tools that include radical educational objectives that allow communities to explore futures that demand both social and technical change have potential, through their feedback, to significantly transform the ways in which architects design.

5 Conclusion

In this project, we examined how contemporary evaluation methods indicate different perspectives on improving the environmental performance of buildings. Research method always contains within it philosophical assumptions, worldviews, epistemologies, ontologies, paradigms, beliefs, as well as direction on procedures. The field of architectural science however, barely engages with such questions. The main lesson learnt is that it is important that we are able to contest the meaning of sustainable design and to develop evaluation tools that include radical educational objectives. Tools that promote community agency so that communities are engaged with the environmental problem, and allow communities themselves to explore how our futures demand both social and technical change especially for their own immediate contexts. The second lesson learnt is that POE approaches can be developed to address the superficial agenda persistent in the design of "green" buildings and to confront the architects' limited expectations. The objectives of the original project, as proposed, changed over the course of the research (based on the feedback from the academic and scholarly community in this field) and to improve potential future work in this field an integrative definition of environmental sustainability is crucial to tools within the field and needs to consider social, economic, and cultural realms. Through constantly striving to make our built environments more interactive, it is necessary to interrogate the broader implications of design strategies. Schools are one of the first built environments that individuals encounter. These environments can have a strong impact on children as well as families and communities in their awareness of environmental sustainability. Feedback mechanisms in the form of post-occupancy evaluation tools provide some of these opportunities, but their real potential to engage communities, including school communities, in their environments is undervalued. Future research in POE has the opportunity direct some attention to the potential POE has to transform attitudes and behaviors.

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The Role of Private–Public Partnerships in the Implementation of Sustainable Development Goals: Experience from the SDG Fund

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Abstract

The 2030 Agenda for Sustainable Development recognizes that the achievement of sustainable development is a shared responsibility among all countries and among all actors from the public and the private sectors. How the world would look like in 2030 will greatly depend on how different development actors come together, and how they find new ways of partnering. The SDG Fund supports the 2030 Agenda for sustainable development by implementing the innovative joint programmes and focuses on public–private partnerships to accelerate the achievement of SDGs in more than 20 countries. The SDG Fund promotes the universality of action where all actors need to play a role by engaging two new actors that are gaining new ground with the SDGs: private sector and universities. The goal of this paper is to analyze the experience of the SDG Fund to accelerate progress towards the SDGs through the partnerships with new development actors. The paper will analyze the innovative approach to work with new partners (private sector and universities) and their contribution to the SDGs. The methodology of this paper is based on case study analysis of innovative on-going joint programmes of the SDG Fund in three countries: Peru, Sierra Leone and Sri Lanka. Private sector has a critical role to play in accelerating the achievement of the SDGs by promoting public–private partnerships, social investments and corporate social responsibility. Promotion of greater participation of universities for the achievement of the SDGs through

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their involvement in development projects is another initiative of the SDG Fund. Under the universality approach, the main objective of the SDG Fund is to bring together UN agencies, national governments, civil society, and academia as well as business to address the challenges of sustainable development. Results from monitoring reports of the SDG Fund in Peru, Sri Lanka and Sierra Leone demonstrated how integrated efforts of new development actors can contribute towards a common goal. Through public–private partnerships, the private sector and universities are directly involved in carrying out important programme activities to increase the ownership and sustainability of development results. Practical examples and success stories of the SDG Fund working with the private sector and universities clearly demonstrate that participation of these actors has tremendous potential to contribute to the SDGs. Moreover, the contributions of these development actors, according to their area of competence, expertise and capacity, increase national ownership and sustainability of results. The findings of qualitative analysis suggest that there is a need to continue engaging new partners and pilot innovative initiatives of the SDG Fund have high potential to be replicated and scaled up. Therefore, the SDG Fund has a unique role in the transformation of the international partnerships landscape by bringing new actors to support sustainable development activities. This paper will be useful to academics, researchers and development practitioners around the world to raise awareness about the universality of the 2030 agenda and the role of the private sector and universities to play in accelerating the achievement of the SDGs.

Keywords
2030 Agenda · SGDs · Public–private partnership · Universality

1 Introduction

The 2030 Agenda for Sustainable Development and its accompanying Sustainable Development Goals (SDGs) were born following the previous Millennium Development Goals (MDGs), which were set to expire in 2015. The 2030 Agenda for Sustainable Development is a set of 17 Sustainable Global Goals aiming to guide global development efforts over the next fifteen years.[1] The need to implement the SDGs is more urgent than ever but the SDGs can only be realized with a strong commitment to global partnership and cooperation (UN General Assembly Resolution 70/1, 2015). The new 2030 Agenda is characterized by shared responsibility, mutual accountability, and inclusive partnerships for development

[1]UN General Assembly Resolution 70/1. UN Doc. A/RES/70/1 (2015). Transforming our world: the 2030 Agenda for Sustainable Development. Art. 21. 2015.

co-operation. Moreover, the key element of this Agenda is its universality, recognizing that the achievement of sustainable development is a shared responsibility among all countries and all among public and private actors (SDG Fund 2016a).

Universality is one of the most highlighted and often mentioned differences of the SDGs from the previous development agenda. In light of the basic principle of the post-2015 SDGs "that no one will be left behind", the SDGs contain a "new universal Agenda" (Brolan 2016). As stated in its preamble,[2] the 2030 Agenda for Sustainable Development is a universal agenda that applies to everyone everywhere. According to Coonrod (2014), the MDGs were created through a top-down process, while the SDGs are created in one of the most inclusive participatory processes the world has ever seen with face-to-face consultations in more than 100 countries, and millions of citizen inputs on websites. Therefore, this can be viewed as a radically new understanding of development because it poses questions in terms of responsibilities, ethical understanding of development and how development should be financed (Pogge 2004). Universality also implies that responsibility is shared among countries and among public and private actors. The SDGs call for collaborative partnerships between all countries and stakeholders, ensuring that no one is left out. It is an inclusive and universal agenda, built on the co-ownership of all actors and on the understanding that these shared common goals will only be achieved through collaboration and collective action in a transparent, interlinked, universal space. Therefore, the SDGs are the universal goals, requiring international cooperation and joint responsibility.

To best contribute to the transition process from the MDGs to the SDGs, the Sustainable Development Goals Fund (SDG Fund)[3] was conceived to support innovative initiatives for UN countries offices to collaborate on joint efforts and innovative pilot programmes towards the achievement of the 2030 Agenda. Concrete example lies in the experiences of the SDG Fund in bringing together the UN Agencies, national governments, the private sector, academia and civil society to implement on-the-ground joint programmes, which accelerate the achievement of the SDGs in 22 countries. All joint programmes are linked to key social, environmental and economic priorities in the country. The SDG Fund in this regard promotes the universality of action where all actors play a role and where all actors will benefit if the SDGs are to be achieved. The joint programmes of the SDG Fund

[2]UN General Assembly Resolution 70/1. UN Doc. A/RES/70/1 (2015). Transforming our world: the 2030 Agenda for Sustainable Development. Preamble 2015.

[3]The Sustainable Development Goals Fund (SDG Fund) was created in 2014 for the implementation of the new agenda 2030. Multi donor and multi-agency mechanism is currently working in 22 countries, with 14 agencies of the UN and directly improving the lives of more than 1.4 million people (2016). More information about the Fund can be found in its webpage: http://www.sdgfund.org/about-us.

help to overcome the limitations of the traditional approach to development initiatives.[4] Moreover, these joint programmes with multidimensional and integrated approaches offer innovative solutions that are more effective in tackling complex problems such as inclusive growth for poverty eradication, food security and nutrition, and water and sanitation.

According to the SDG Fund's experience, there are two new development actors that are gaining ground with the SDGs: the private sector and universities. This paper will focus on the partnership with these two actors based on the SDG Fund's experience and monitoring reports of the joint programmes. The purpose of this study is to analyze the role of the private sector and universities in the implementation of innovative joint programmes and the impact of these partnerships on sustainable development. The following section will give an in-depth examination of these new two actors that are gaining new ground with the SDGs.

2 Role of the Private Sector Under the 2030 Agenda

Under the 2030, the private sector is one stakeholder from which much is expected. Being the supplier of capital and tax revenue, a creator of jobs and driver of technological innovation, numerous governments view the private sector as a crucial player (Eggler 2016). The SDGs require joint action and no SDG that can be achieved without the participation of the private sector. Under the 2030 Agenda, the private sector has a critical role to play in advancing the SDGs by promoting public–private partnerships, social investments and corporate social responsibility. The Article 67 from the UN General Assembly Resolution 70/1 (2015)[5] affirms that private business activity, investment and innovation are major drivers of productivity, inclusive economic growth and job creation. Moreover, it acknowledges the diversity of the private sector, ranging from micro-enterprises to cooperatives to multinationals, calling on all businesses to apply their creativity and innovation to solving sustainable development challenges. The Secretary-General Ban Ki-moon during the United Nations Private Sector Forum[6] (2015) confirmed that the SDGs are unprecedented in their ambition, but the fundamental ways that business can contribute remain unchanged. However, on a global scale, private sector participation across all sectors associated with the SDGs is relatively low. According to the World Investment Report of UNCTAD (2014) on investing in the SDGs, only a fraction of invested assets of banks, pension funds, insurers, foundations and

[4]The SDG Fund' innovative approach to advance the SDGs is to bring both traditional partners such as the UN agencies, national governments, civil society and non-traditional partners such as the private sector and the universities.

[5]UN General Assembly Resolution 70/1. UN Doc. A/RES/70/1 (2015). Transforming our world: the 2030 Agenda for Sustainable Development. Article 67.

[6]Secretary-General's remarks at the United Nations Private Sector Forum United Nations Private Sector Forum. September 26th, 2015.

endowments, as well as multinational corporations, are currently actively engaging with the SDGs. This is even less in developing countries, particularly the poorest ones.

To contribute to developing strong public–private partnerships, the SDG Fund established a Private Sector Advisory Group[7] (PSAG) formed by business leaders of 13 major companies from various industries worldwide. These leaders committed to work diligently towards identifying areas of common interest with the primary objective of deciphering the best methods of UN-private sector engagement. These leaders are helping the SDG Fund to provide large-scale solutions for achieving the proposed SDGs. The aim of PSAG is to collaborate, discuss practical solutions pertaining to the common challenges of contemporary sustainability, and build a roadmap for public–private alliances. According to the Terms of Reference, the PSAG is committed to identifying areas of common interest and deciphering the best methods of UN-private sector engagement, as well as offering suggestions for how to work more effectively at the country level. Moreover, the SDG Fund promotes the concept to move beyond a philanthropic or «resource mobilization model» to a «core business model», where the private sector is an actor rather than financial resources provider. For example, by developing new technologies, services, products or business models that address poverty, hunger, environmental protection or health, private sector can have a multiplying effect in improving lives around the world, and in doing so improving their prospects (SDG Fund, Harvard Kennedy School CSR Initiative and Inspiris Limited 2015).

While business is not being asked to deliver the SDGs alone, the 2030 Agenda cannot be realized without meaningful engagement by business,[8] where the private sector has a critical role as a driver of innovation and technological development and as a key engine of economic growth and employment. In fact, the World Bank Report (2013) confirms that the private sector is the key engine of job creation, accounting for 90% of all jobs in the developing world. Moreover, the World Business Council for Sustainable Development Report (2017) states that as much as the SDGs need business, long-term business success also hinges on the realization of the SDG. Integrating sustainability into the core business and governance, and embedding sustainable development targets across all functions within the company, is key to achieving set goals. By integrating sustainability considerations across the value chain, companies can protect and create value for themselves by, for example, increasing sales, developing new market segments, strengthening the brand, improving operational efficiency, stimulating product innovation and reducing employee turnover (UN Global Compact 2015). It is a fact that many businesses are already integrating the SDGs in their sustainability reports and other reporting mechanisms. One year after the adoption of the 2030 Agenda, many companies have begun to align or map the content of their sustainability reports with the SDGs. Best practices for reporting on the SDGs, however, have yet to be

[7]Please consult the following website for more information: http://www.sdgfund.org/sdg-fund-private-sector-advisory-group.

[8]UN General Assembly Resolution 70/1. UN Doc. A/RES/70/1 (2015). Transforming our world: the 2030 Agenda for Sustainable Development.

established and the full spectrum of the SDGs still needs to be effectively integrated into any major reporting standards and frameworks (UN Global Compact 2016). As a set with goals and targets, many businesses find easier to track their contribution, particularly taking into account that the 17 goals and 169 targets cover most of the key business areas of companies around the world. This allows companies to «cherry picking» the SDGs they believe are in better position to achieve. A survey conducted by Price Waterhouse Coopers (2015) among business and citizens revealed a high SDG awareness amongst the business community (92%) compared to the general population (33% among citizens). Moreover, at that moment 71% of the companies participating in the poll already started to take action and started planning how to respond to the SDGs. Therefore, the SDG Fund has a unique role in the transformation of the international partnerships landscape by bringing the private sector to support the 2030 Agenda and strengthen public–private partnerships.

2.1 Role of Universities Under the 2030 Agenda

Higher education was never explicitly involved in the MDGs as either a development goal in its own right, or as a potential agent to address the development goals (Roberts and Ajai-Ajagbe 2013). Promotion of greater participation of scientific and academic community in the achievement of SDGs is another important initiative of the SDG Fund, following the UN General Assembly Resolution 70/1 (2015). Universities can contribute to the 2030 Agenda not only by producing research and data analysis, but also by being important part of development projects. Under the universality approach, universities are not isolated and as much as possible are integrated through collaborative efforts between government, civil societies and private sector. Universities are centers of innovation and knowledge, and therefore, they can have important role under the 2030 Agenda. The SDG Fund brought universities at the core and center of the 2030 Agenda, where they can play at least three key roles for sustainable development:

– *Expanding human capital with the SDGs perspective*. The 17 goals of the 2030 Agenda are interconnected, and universities will need to educate their students to understand the social, economic and environmental implications for their future careers and professional work. Higher education institutions also have a crucial role to play in national development, especially in developing countries. For instance, the beginning of the 21st century witnessed a massive increase in enrolment of higher education in developing countries, especially in Africa (Mohamedbhai 2015; O'Keeffe 2016). Universities are responsible for education on the importance of the SDGs and equip a new generation with the expertise for the international development agenda. Moreover, massive open online courses for non-university students are a clear example of what can be done to raise awareness on the 2030 Agenda and contribute to international development programmes curriculums.

- *Research*. Research is a crucial for the implementation of the SDGs, including innovative ways of implementation, and the risk of not investing enough for achieving the SDGs. Under the universal agenda, researchers can help to understand the SDGs at both global and local levels, including underlying similarities and differences among countries and territories and analyze the interlinkages and correlations among different goals. Moreover, the creation of new knowledge by universities does not just benefit education systems. Research can help meet the SDGs on other areas such as climate change, food security, nutrition or renewable energy (Warden 2015).
- *Implementing the 2030 Agenda*. From observer perspective, universities are becoming active actors of multi-stakeholder partnerships for the SDGs. Universities participate in joint development projects by contributing with their expertise and knowledge. Moreover, they can contribute to transfer knowledge and build the tools that the SDGs will require. Thus, it is important that university are not isolated and as much as possible are integrated in partnerships with government, civil societies and private sector to coordinate efforts for development projects.

Aware of the tremendous potential of universities to contribute to the sustainable development, the SDG Fund has also established the University Chair in collaboration with researchers, students and universities across the world, which will advocate for universities' central role for the 2030 Agenda. The SDG Fund has established a partnership with the King Juan Carlos University as the main partner of the University Chair with the aim to involve the universities around the world in the promotion of the SDGs. The main objective of this partnership is to focus on academic trainings (face-to-face and online), research and technical assistance in the implementation of development cooperation programs. Other important initiatives to engage the universities in a greater manner to contribute the SDGs include the Education 2030 Framework for Action[9] and the Higher Education Sustainability Initiative.[10]

3 Methodology

The research method used in this study is based on case study analysis of three joint programmes of the SDG Fund: Peru (Latin America), Sri-Lanka (Asia) and Sierra Leone (Africa). Using the last available monitoring reports from these joint programmes, the case study technique is applied to analyze the main features of new development actors that are gaining new ground with the SDGs Fund: the private

[9]Please consult the following website for more information: http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/education-for-all/education-2030-framework-for-action/.

[10]Please consult the following website for more information: https://sustainabledevelopment.un.org/sdinaction/hesi.

Table 1 Case-study analysis of the SDG fund joint programmes

Title of joint programme	Country	Involved UN agencies under the SDG Fund mechanism	New development partners
Engagement of private sector in the quinoa value chain development 2014–2017	Peru	ILO, FAO and UNESCO	Private sector
Scaling up nutrition through a multi-sector approach 2015–2017	Sri Lanka	FAO and WFP	Universities
Enabling sustainable livelihoods through improved natural resource governance and economic diversification in the Kono District 2015–2017	Sierra Leone	UNDP and FAO	Private sector and universities

sector and universities. This methodology is particularly recommended when a holistic, in-investigation is needed (Feagin et al. 1991). Qualitative analysis of ongoing partnerships with private sector and universities provides examples of new development opportunities that can accelerate the achievement of the SDGs. The table below presents the list of on-going joint programmes that are analyzed in this paper (Table 1).

The next section presents the analysis of the SDG Fund innovative joint programmes that engage new development actors: private sector and universities.

4 Results

This section presents the preliminary results from the on-going SDG Fund joint programmes based on the last available monitoring reports (November, 2016). This section seeks to demonstrate how the engagement of new partners can contribute to achievement of the development goals by generating new opportunities and models of inclusive partnership.

4.1 Engagement of Private Sector in the Quinoa Value Chain Development in Peru[11]

The SDG Fund's joint programme "Economic Inclusion and Sustainable Development of Andean Grain Producers in Ayacucho and Puno 2014–2017" together with three UN agencies (ILO, FAO and UNESCO) seeks to create a value chain of quinoa production that will boost the production of grains, increase the income of

[11]Please consult the following website for more information: http://www.sdgfund.org/economic-inclusion-and-sustainable-development-andean-grain-producers-ayacucho-and-puno.

small farmers, and improve the overall quality of food and nutrition in the community. In recent years, exports of quinoa and other Andean grains from Peru are found to be increased exponentially. However, this has not translated into a better quality of life for farmers. The situation is especially difficult for women in the rural communities, who accounts for 69% of all agricultural producers, and faces significant hardships compared to male agricultural producers.

The engagement of private sector organizations has a crucial role to promote public–private cooperation, support local producers and contribute to the adoption of productive practices for the sustainable development of the quinoa value chain. In this context, the innovative joint programme of the SDG Fund, together with the Ministry of Agriculture and Irrigation and the Association of Exporters (ADEX) took initiative to form national public–private partnership with the purpose of improving the value chain of the Andean grains, including organic production and marketing. The SDG Fund has facilitated dialogue and consultations with the private sector through the ADEX and Andean Grain exporters and processors. For instance, for the implementation of a system of standardized quality and traceability (one of the main quinoa value chain bottlenecks), an alliance was created with the Swisscontact Foundation, the ITC, PROMPERU, INACAL and the Center for the Promotion of Imports of Holland. Moreover, to strengthen the collective brand of quinoa AYNOK'A, the partnership between producers and processors was created to provide technical assistance in commercial matters and traceability issues.

Preliminary results from the SDG Fund's monitoring report in Peru (SDG Fund 2016b) demonstrate that the effectiveness of development and promotion of the quinoa value chain is directly correlated with effective collaboration between public and private sector actors. In this sense, the creation of public–private partnerships under the joint programme contributes to the promotion, innovation and sustainable development of the quinoa value chain. Moreover, the private sector has a leading role in the promotion of quinoa competitiveness through provisioning business development services and technical-productive assistance to their suppliers (small producers linked to the value chain). Private companies are also invited to participate in the design of policies, strategies, programmes and projects for the quinoa value chain and provide information for the design and management of technical standards in agronomic management, processing and marketing. As result, the public–private partnerships contribute to the achievement of the programme objective by generating new opportunities for local farmers, supporting women producers and promoting better quality of food and nutrition in the community.

4.2 Engagement of Universities in Sri-Lanka[12]

The most recent comprehensive assessment in Sri Lanka (WFP 2012) found that 1.3 million persons in the Northern and Eastern Provinces were still food insecure

[12]Please consult the following website for more information: http://www.sdgfund.org/current-programmes/sri-lanka/scaling-nutrition-through-multi-sector-approach.

(2 out of 5 households). While Sri Lanka made impressive progress between the 1970s and 2000s, there have been high levels of under-nutrition in the past decade. The most affected vulnerable groups are the female-headed households, the disabled, and populations located in disadvantaged areas. The SDG Fund's joint programme on "Scaling Up Nutrition through a Multi-Sector Approach 2015–2017" seeks to provide technical and programmatic to support the Government of Sri Lanka in implementing its multi-sectoral action plan on nutrition together with two UN agencies (FAO and WFP). The action plan includes nutrition baseline surveys, promotion food fortification including a rice pilot, and policy formulation. The programme is expected to improve the efficiency and effectiveness of government investments in food security and nutrition and achieve behavioral changes through enhanced nutrition education and nutrition promotion.

The academia is directly involved in the implementation of this innovative joint programme. For instance, the University of Peradeniya was selected as the research partner to conduct the rice fortification pilot study. The results of this report will be used to inform and identify the obstacles and issues that may occur in the future for scaling up rice. Moreover, the WFP collaborates with the Medical Research Institute (MRI) of Ministry of Health to conduct national baseline surveys on the food and nutrition security of pregnant and lactating women and on school children, which will inform policy decisions on necessary interventions regarding the SDG 2 (Zero Hunger) and, in turn, address the SDG 5 (Gender Equality) and influence the SDG 1 (No Poverty). The reports of these two baseline surveys will serve as concrete advocacy tools for government, public and private sector interventions to improve the nutritional status of the country. Academics also participated in FAO-supported consultative meetings on developing nutrition guidelines, circulars, Trainer of Trainers manuals, and curricular material for joint programme activities.

Preliminary results from the SDG Fund's monitoring report in Sri Lanka (SDG Fund 2016c) demonstrate that universities can become the full partners in advancing the SDGs not only by research support but also by direct engagement in programme implementation and policy development. In fact, seven academics were involved in presenting research on under-nutrition, and in providing inputs regarding preparation of nutrition supplementary documents and design of the pilot food fortification programme.

4.3 Engagement of the Private Sector and Universities in Sierra Leone[13]

Another example of collective efforts to bring new development actors is the SDG Fund's joint programme in Sierra Leone on "Enabling Sustainable Livelihoods Through Improved Natural Resource Governance and Economic Diversification in

[13]Please consult the following website for more information: http://www.sdgfund.org/current-programmes/sierra-leone/enabling-sustainable-livelihoods-through-improved-natural-resource-governance-and-economic.

Kono District 2015–2017". This programme brings together UNDP and FAO, as well as new development actors, including the private sector and universities. The programme focuses on governance of natural resources and the diversification of livelihoods in Kono district. Kono district is the richest in mineral (diamonds and gold) in the country, but it was significantly affected by the 10 years conflict in Sierra Leone and in 2013 Ebola's outbreak. Revenue generated through the extractive sector is not sufficiently invested in local development, where safe drinking water is limited and deep pits dug in the search for diamonds pose serious environmental and health risks. This programme in Kono district supports diversification in sectors that offer potential for job creation and business opportunities.

Results from monitoring reports confirm the importance of the SDG Fund's innovative approach in supporting the formation of strategic public–private partnerships with regional and local businesses and universities. Partnerships are being formed around agriculture, aquaculture, value-added trade, and mini-processing and production activities. Communities are gaining knowledge and skills to establish and manage mini aquaculture enterprises and poultry farms. Moreover, the programme provides vocational training and helps enterprises to boost self-employment in urban and rural areas. Moreover, universities act as new development actors in providing trainings and support for programme implementation. For instance, the Njala University in Sierra Leone provides training of youth farmers on poultry and fish farming. Meanwhile, with support from the Center for International Earth Science Information Network (CIESIN) of Columbia University, the joint programme works with the Environment Protection Agency to monitor environmental change through a centralized GIS-database and to train staff to produce, interpret and disseminate information based on satellite images. Findings from monitoring report in Sierra Leone (SDG Fund 2016d) confirm that collaboration with the universities as new development partners is the way in advancing the SDGs under the universality approach. Moreover, direct engagement from academia during project implementation presents opportunities for the consolidation of efforts in pursuing the development goals.

In addition, the example of public–private collaborations in Kono district confirms how partnership can build transparency and engage community to rebuild social trust and confidence. More than one year into the project, in March 2017, a pastor Emmanuel Momoh discovered in Kono district one of the world's largest uncut diamonds (BBC News 2017). This is largest diamond found in Sierra Leone since 1972, weighing 709 carats. Emmanuel Momoh is one of thousands who work in the informal mining sector dominating the diamond-rich Kono region. He brought the diamond to the local authorities, and it is now in the hands of the Sierra Leone government. In the words of President of Sierra Leone Ernest Bai Koroma Korama the owners should get "what is due to them" and it should "benefit the country as a whole". According to The Guardian (2017), the government plans to hold a transparent auction for the gem to the benefit of the community and country once tainted by so-called blood diamonds.

5 Conclusion

This paper analyzes the role of the private sector and universities in the implementation of the SDG Fund' innovative joint programmes and the impact of these partnerships on sustainable development. Based on case study analysis of three joint programmes of the SDG Fund in Peru, Sri-Lanka and Sierra Leone, the findings confirm that the integrated efforts of new partners can contribute to achieving a common goal. Through public–private partnerships, the private sector and universities can be directly involved in carrying out some of the programme activities, increasing ownership and sustainability of achieved results. Moreover, the contribution of new development actors, according to their area of competence, expertise and capacity, facilitates the achievement of the SDGs.

The results of qualitative analysis suggest that there is a need to continue engaging new partners to build integrated and sustainable responses to international development challenges. Moreover, the SDG Fund' experience confirms that development is changing and that all actors have a role to play, including universities and the private sector. The achievement of the 2030 Agenda for sustainable development is not possible without the participation of new development actors, particularly the private sector and universities. How the world would look like in 2030 will greatly depend on new ways of partnering, according to the collaborative partnership established by the UN General Assembly Resolution 70/1 (2015). It is not possible to consider the public sector and the UN agencies to be solely responsible for the achievement of the 2030 Agenda. Encouraging the private sector and academia to become involved in the implementation of the 2030 Agenda is essential to ensure sustainability of development results. Inclusive partnerships for development co-operation is aligned with the principal of universality, where the SDG Fund has the leading role to raise awareness within the private sector and academia on how the SDGs can be integrated in their core business and research activities.

Practical examples and success stories of the SDG Fund working with the private sector and academia demonstrate that participation of these actors has tremendous potential to contribute to the SDGs. Although this research paper has reached its goal, showing the innovative approach to work with new development partners and their contribution to the SDGs, there are some limitations and constraints. First, the case study analysis is based on only three joint programmes. Therefore, to generalize results the further research should include a larger sample of joint programmes. Second, the analysis of private–public partnership with new development partners is based on the experience of the SDG Fund. Additional research might be done to explore these partnerships with different development agencies around the world. Finally, while the findings of this paper confirm the positive effect of collaboration between public and private sector actors, further research is needed to analyze the incentives for private business and universities to participate in private–public partnerships. Additional study in this area can be very important for public policy development aimed to address the trust deficit between the public and private sector actors.

To conclude, the results of this research could be useful for development practitioners, the private sector and academia to analyze the innovative experience of the SDG Fund and design new pilot initiatives of international partnership. The work of the SDG Fund fully addresses the need to engage everyone equally, including the private sector and universities, to contribute in joining efforts to achieve the SDGs. Therefore, the experience of the SDG Fund has a high potential to be replicated and scaled up by bringing new actors to support sustainable development activities. Using the experience of the SDG Fund, it is possible to design new joint programmes, allowing specialized agencies of the UN to coordinate efforts, and promote inclusive partnerships towards the SDGs. Moreover, involvement of new development actors to collaborate with the UN agencies, government authorities and civil societies ensure that the approaches and priorities are best adapted to local needs.

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The World Sustainable Development Research and Transfer Centre (WSD-RTC)

Walter Leal Filho

Abstract

This paper introduces the World Sustainable Development Research and Transfer Centre, a new initiative to support the implementation of the Sustainable Development Goals (SDGs). The rationale behind the Centre is outlined, and its activities are described.

Keywords

SDGs · Sustainability · Research · Transfer · Cooperation

1 Introduction

As the process of industrialisation progresses and the associated problems related to it such as biodiversity depletion, climate change and a worsening of health and living conditions—especially but not only in developing countries—intensify, there is a perceived need to search for integrated solutions to make development more sustainable. The current model of economic growth used by many countries, heavily based on the exploitation of natural resources, is not viable. There are many evidences which show that a more careful, i.e. a more sustainable approach towards the use of our limited resources, is needed.

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The literature on sustainable development has shown a variety of efforts to understand it better (e.g. Leal Filho 2006, 2011), to document experiences related to it (Leal Filho et al. 2017b) and to identify ways to promote sustainability across disciplines (Leal Filho et al. 2017a) and sectors (Kates et al. 2011) as part of the wider debate on sustainability sciences. With the paper "The future we want", Leal Filho et al. (2015) drew the attention to some of the key issues which will guide sustainable development in the coming years.

The United Nations has acknowledged the need to intensify approaches towards fostering sustainable development, and to draw from previous lessons. Among other measures, it produced a set of document at the latest UN Conference on Sustainable Development (Rio+20), held in Rio de Janeiro, Brazil in June 2012. In September 2015, the UN General Assembly approved the "2030 Agenda for Sustainable Development (UN 2015)". On 1st January 2016, the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development officially came into force. The goals cover the three dimensions of sustainable development: economic growth, social inclusion and environmental protection. The 17 SDGs are:

- Goal 1: End poverty in all its forms everywhere
- Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- Goal 5: Achieve gender equality and empower all women and girls
- Goal 6: Ensure availability and sustainable management of water and sanitation for all
- Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all
- Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- Goal 10: Reduce inequality within and among countries
- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable
- Goal 12: Ensure sustainable consumption and production patterns
- Goal 13: Take urgent action to combat climate change and its impacts
- Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

- Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development

Over the next 13 years, with these new Goals and the **169 targets** that universally apply to all countries, nations are expected to mobilize efforts to end all forms of poverty, fight inequalities and tackle climate change (UN 2015). The SDGs recognise that global efforts towards ending poverty need to be supported by strategies that build economic growth and addresses a range of social needs in areas as varied as education, health, social protection, and job opportunities, while tackling climate change and environmental protection.

But as previous experiences gathered during the implementation of the Millennium Development Goals (which have preceded the SDGs) have shown, policy making and the setting of objectives alone are unlikely to suffice in addressing the sustainability problems seen today, and those expected in the future. In order to increase the likelihood that it yields the expected benefits, the implementation of the SDGs needs to be supported by high caliber, high impact sustainability research on the one hand, but also by training and technology transfer on the other.

Indeed, the fact that technology transfer is so important raises the question as to whether one additional SDG may be informally added to the official list of SDGs namely "SDG 18-Technology Transfer on the SDGs". Figure 1 outlines this additional and informal SDG.

In order to address this need, **the World Sustainable Development Research and Transfer Centre (WSD-RTC)** has been created. WSD-RTC is a multi-stakeholder, academic based research and transfer centre, which congregates the best available knowledge and technologies on sustainable development, in support of the implementation of the SDGs.

Fig. 1 The informal 18th SDG

Fig. 2 Logo and motto of WSD-RTC

The slogan of WSD-RTC is "Towards a More Sustainable and Healthier World", meaning that it focuses on matters related to sustainable development as a whole, and a focus on climate and health issues in particular, since these are two vital components of the global sustainability efforts.

The philosophy of WSD-RTC is that the holistic implementation of sustainability measures requires not only political decision-making, but also concrete research, capacity-building and technology transfer, as well as improved collaboration and information and data exchanges among institutions (Fig. 2).

2 Mission and Objectives of the World Sustainable Development Research and Transfer Centre (WSD-RTC)

The **Mission** of WSD-RTC is "to support the implementation of the SDGs by undertaking high level, high impact transformative and interdisciplinary research, combined with the execution of projects, the provision of training and the facilitation of technology transfer on matters related to sustainable development, vis-à-vis the implementation of the SDGs".

This unique Mission and the scope of the works of the Centre, means that it fills in a gap in the existence of a duly qualified, world class research and transfer institution, which may act as a hub linking the theory and practice of sustainable development, and where sustainability sciences may offer a robust support towards achieving the SDGs.

The **objectives** of the WSD-RTC are:

(a) to undertake high level, high impact transformative and interdisciplinary research and projects, which may address the many barriers and challenges seen in the implementation of the SDGs and facilitate pursuing each of the 17 specific goals;
(b) to offer advice and expertise on matters related to sustainable development and technical support towards the implementation of the SDGs to government organisations, international agencies, education institutions, foundations, banks and other stakeholders at the national and international level, seeking expertise in order to implement the SDGs;

(c) to test, implement and promote tangible measures and activities to concretely implement the SDGs by means of pilot projects and initiatives in the field;
(d) to provide training (postgraduate and in-service) and facilitate the exchange of ideas and the transfer of technologies by means of Symposia, Conferences, Seminars and Courses, on matters related to sustainable development, vis-à-vis the implementation of the SDGs.

The **thematic focus** of the WSD-RTC is related to each of the 17 SDGs. In addition, since **climate change** is closed related to **sustainable development**, and many of the SDGs are addressing the core drivers of climate change, WSD-RTC will give a **special emphasis to climate change**, as part of its activities.

In order to meet the above objectives, WSD-RTC combines its own expertise with the know-how of a variety of organisations known to have proven experience with sustainability research and transfer, which are its associated members. By doing so, it ensures the best available knowledge and technologies are available, and may be put to use in both industrialised and—especially-in developing countries.

Since national governments are expected to take ownership and establish national frameworks for the achievement of the 17 SDGs, and have the primary responsibility for follow-up and review of the progress made in implementing the Goals, the work and activities of the WSD-RTC may be instrumental in supporting their work.

3 Structure of the World Sustainable Development Research and Transfer Centre

The Centre is **chaired** by Professor Walter Leal and a team of **Associate Directors** from across all geographical regions. These work from a set of **Associated Centres**, composed by universities, sustainability centres and non-governmental organisations representing the world sustainability community across the world. The main office of WSD-RTC in Hamburg is managed by two **scientific managers**, who oversee the day to day operations and coordinate the various projects run by and/or performed by the Centre in cooperation with its partners. The Associated Centres have their own staff, who is in constant contact with the office in Hamburg, and among themselves as they perform a number of cooperative activities.

Furthermore and in line with the integrative and inclusiveness philosophy of WSD-RTC, it has a wide range of **network members**, with which it informally cooperates and perform specific activities on an *ad hoc* basis.

Indeed, consistent with the philosophy of the "2030 Agenda for Sustainable Development", the work of the WSD-RTC is based on multi-stakeholder partnerships, i.e. it seeks to mobilize all stakeholders concerned with and interested in supporting the implementation of the SDGs.

4 Financing of the World Sustainable Development Research and Transfer Centre

In order to achieve the SDGs, substantial investment is required, in both industrialised and developing countries. The Addis Ababa Action Agenda (AAAA) that came out of the Third International Conference on Financing for Development held in Ethiopia in July 2015, provides a strong foundation for countries to finance and adopt the SDGs. It also reiterates that the implementation and success of the SDGs will rely on countries' own sustainable development policies, plans and programmes, and will be led by countries themselves. Moreover, the AAAA clearly states that all stakeholders, i.e. governments, civil society, the private sector, and others, are expected to contribute to the realisation of the new agenda.

Financing for the operations of the WSD-RTC is therefore expected to come from:

(a) projects to be performed on behalf of—or in cooperation with—national and international organisations, which will finance staff time, travel and other project related costs
(b) fees charged for those who intend to participate at the events organized by WSD-RTC, if these are not already directly funded by any agency
(c) donations from the private sectors, Foundations and national and international organisations.

The provision of advice and facilitation of communication between stakeholders will be part of the remit of WSD-RTC and entails no costs to its partners or associates. But it is expected that users interested to take advantage of the expertise and services of WSD-RTC, need to make a contribution towards its operational costs.

5 Strategic Relevance of WSD-RTC and Operational Schedule

The work of WSD-RTC is performed in communication with a variety of international actors and agencies, including the UN Division of Sustainable Development and with the UN "High-level Political Forum on Sustainable Development". The Director of WSD-RTC is expected to attend its annual meetings, since the Forum will play a central role in reviewing progress towards the SDGs at the global level, and will work towards ensuring that financial resources are effectively mobilized to support the new sustainable development agenda. Whenever appropriate, WSD-RTC may also support in the elaboration of the annual SDG Progress Reports, to be prepared by the UN Secretary-General.

Operationally, from 2017 to 2030, WSD-RTC will perform the following activities:

(a) **Execution of sustainability projects submitted to national and international bodies**. The projects will be prepared by WSD-RTC staff and by its various partners. Being donor-driven, the themes of the projects will be related to the themes set by the funding bodies, bearing connections with one or more of the SDGs.
(b) **Provision of advice to government and non-governmental agencies interested in the implementation of the SDGs**. Support to national governments and international organisations will be provided, in implementing the SDGs.
(c) **Organisation of courses and training events on the SDGs**. In order to build capacity and place staff at government and non-government agencies, as well as those in the private sector in a better position to implement the SDGs, specific training courses and seminars will be organized. These will be held in the countries which will offer to host them. The main goal of the raining schemes is to equip participants with accurate, up-to-date and practical knowledge on the SDGs and raise awareness on the means to achieve them.
(d) **Organisation of the biennial World Symposium on Sustainability in Higher Education (WSSD-U-series)**, the world's prime event gathering researchers/practitioners on sustainability in higher education to be held in:

- 2018 (Malaysia, in September 2018)
- 2020 (to be held in Africa in September 2020)
- 2022 (to be held in Asia in September 2022)
- 2024 (to be held in the Pacific Region in September 2024)
- 2026 (to be held in Latin America in September 2026)
- 2028 (to be held in Europe in September 2028)
- 2030 (to be held in North America in September 2030).

(e) **Organisation of the biennial Symposium on Sustainability Science and Research**. Following the pioneering "World Symposium on Sustainability Science and Research: Implementing the UN Sustainable Development Goals", held in Manchester, United Kingdom on 5th–7th April 2017, subsequent events will be planned on a biennial basis, in:

- 2019 (to be held in North America in September 2019)
- 2021 (to be held in Asia in September 2021)
- 2023 (to be held in the Pacific Region in September 2023)
- 2025 (to be held in Africa in September 2025)
- 2027 (to be held in Latin America in September 2027)
- 2029 (to be held in Europe in September 2029)
- 2030 (to be held in North America in September 2030 closing "Agenda 2030").

The biennial Symposia will cater for a monitoring of progresses in the implementation of the SDGs, with a focus on research and technology transfer aspects.

(f) **Publication and dissemination of experiences**. In order to ensure that experiences on the implementation of the SDGs are documented and disseminated, the **World Sustainable Development Research and Transfer Website** will be set up. The site will be used to both, promote the activities of the WSD-RTF, and the work performed by other organisations interested to support the implementation of the SDGs. The WSD-RTC staff will also actively engage with publishers and identify suitable outlets for the promotion of experiences.

The staff at WSD-RTC will be present at key events and will interact as much as possible with the user community, always keen to gather ideas, suggestions or advice on how to continuously improve its activities.

6 Conclusions

The World Sustainable Development Research and Transfer Centre fills in a gap in respect of a high profile and specialised organisation, which may support United Nations agencies and other organisations across the world in pursuing the SDGs, by a combination of research and transfer activities and projects. WSD-RTC coordinates and supports the complex, transdisciplinary research efforts of various organisations, departments and institutions in pursuing the SDGs, via research and curriculum development, and field research activities, specialist events and projects carried out round the world.

In addition to its regular employees at the Headquarters in Hamburg, WSD-RTC acts as a hub congregating thousands of academics, representatives of NGOs and local governments round the world. They are all connected to WSD-RTC in respect of implementing strategies, performing background studies, organizing conferences and training programmes, establishing PhD scholarships and performing joint projects where cooperation between institutions and universities are envisaged.

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