Five Key Elements for Environmental Sustainable Progress

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Abstract

Sustainability has been defined and quantified in a number of different ways without a single direction for years. While many agree, this concept should lead to providing solutions, which are more environmentally favorable for the globe; few agree on how to accomplish this task. The framework of including the three pillars of sustainability: economic, environmental, and social has been widely promoted, but current application of these three pillars does not recognize the major and inherent differences in the necessary treatment of these three pillars. The author explores these problems and posits five key elements for a sustainable progress.

Introduction

Prior to any discussion, it is important to discuss what is meant by sustainability. Although the Brundtland Commission states that sustainable development "meets the needs of the present without compromising the ability of future generations to meet their own needs [1]," there has been no consensus on how to conduct an analysis which ensures this condition is met or even that progress is made in the right direction.

Authors have published views of incorporating the three pillars of sustainability into various diagrams to explain their relationship. Perhaps the most common is the overlapping circles of the Venn diagram, which shows that all three should receive the same focus and the goal is to operate in the intersection of all three circles. This author proposes that a different paradigm is necessary to ensure progress.

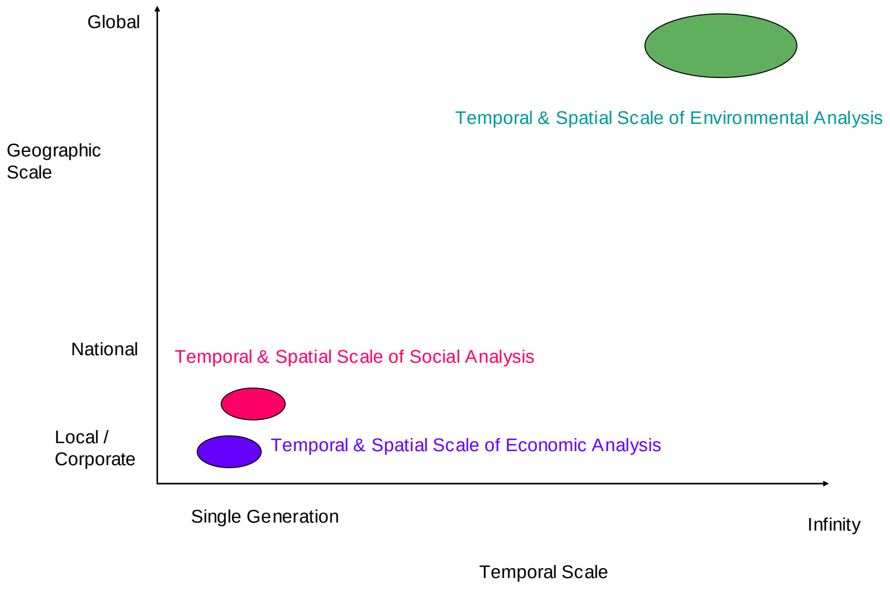
It was clear the early guidance for sustainable development was focused on environmental issues [2], but more recently, pursuit of environmental progress has sometimes been overshadowed with the more controversial social issues and subsequently, the prediction and measurement of sustainability has become more complex. Some are currently concerned the direction that sustainability has taken for the last few years is confusing and perhaps even counterproductive to the environmental movement. The author proposes below five key elements which relate to sustainability analysis.

Key Elements

Key Element 1: Economic sustainability is necessary for companies, cultures, and nations to operate. Social sustainability relates to the degree of unrest and therefore, continuance for companies, cultures and nations. Environmental sustainability should be at the core of sustainable progress since it is required for the health and welfare of people and other living things on the planet.

As pointed out earlier, sustainability was originally an environmental movement, because it recognized that significant degradation of the planet would lead to the decline of human health and welfare. Environmentally sustainable issues should be those issues, which have possible long-term and far-reaching consequences, such as, ozone depletion, global climate change, depletion of water, land, and other biotic and abiotic resources. Without the functions that are provided by nature (as in, ecosystem services) in regulating, supporting, and providing for human life, neither an economic or social analysis would be necessary, so environmental analysis should remain the focus of sustainability analysis.

Figure 1 shows the various temporal and spatial perspectives of economic, social, and environmental indicators in a typical sustainability analysis. Notice that economic and social analyses are typically focused on very localized and relatively short term issues while environmental analysis are typically focused on long-term global issues. (See later Key Element 3).



Key Element 2: Social indicators must be selected carefully and maintained independently from economic and environmental indicators.

One of the most confusing aspects of sustainability has been the use of social indicators. While there are obvious goals for economic indicators (i.e., maximizing profits) and environmental indicators (i.e., minimizing impacts), social indicators need to be treated in an entirely different manner because of the inherent nature of the indicators.

Social sustainability recognizes that current practices might lead to corporate, cultural, or cross-national dissatisfaction, strife, human unrest, and war. Following these actions may be the collapse of any of the impacted groups. Since sustainability analysis is often applied at the corporate level and many times involves the reputation of a corporate entity on the global stage, it follows that lack of attention to social responsibility can bring economic impacts which may lead to the decline of the corporate entity.

One of the most difficult aspects of social indicators is there is no agreement on what indicators need to be included in the social field. While it is popular to include social indicators in sustainability [3-8], it is difficult to form consensus on what indicators should be included. National bodies like the President's Council for Sustainable Develop (PCSD) [9] and international bodies like UNEP / SETAC Life Cycle Initiative have attempted to come up with guidance on social indicators [10], but each effort is the result of a normative process which is limited by the experiences and biases of the people who develop the guidance. The development of social indicators should be inclusive, which would encourage the participation of many and various people, but as evidenced in current literature, this process can lead to a long list of indicators which is difficult to analyze.

To continue the discussion of why social indicators should not and cannot be optimized, it is recognized within the UNEP / SETAC document for Social LCAs that social indicators can be quantitative, semi-quantitative, and qualitative indicators "depending on the goal of the study and the nature of the issue at stake… Qualitative indicators describe an issue using words. They are nominative, for instance, text describing the measures taken by an enterprise to manage stress [10]." The management of an amorphous list of social indicators at various levels of quantification can make these issues more difficult, and this complexity can consume the time and attention of the entire sustainability analysis, thus leading to an unbalanced focus on social sustainability.

This is not to say that social indicators should be dismissed in a sustainability analysis. On the contrary, social indicators should cover those issues that are perceived as poor business management by shareholders, consumers, or the public (e.g., human rights violations). Similar to Life Cycle Thinking, social indicators should take into account the various steps in the life cycle chain including those suppliers or end-of-life processors outside the normal analysis. This is the time to ask: Do I know my entire life cycle chain well enough to know if there are any issues, which would be perceived as unpopular, and/or embarrassing if revealed to the public? If so, these issues should be eliminated and/or modified prior to moving forward with any economic or environmental sustainability analysis.

Key Element 3: Environmental analysis should be considerate of various life cycle stages and focused on long-term temporal and large-scale geographic impacts.

Previous efforts to quantify the absolute boundaries of sustainability by conducting predictions of how many earths are required to maintain a certain population and lifestyle choice are largely dependent upon highly uncertain models with inherent value choices to aggregate the various impacts. While it is impossible to predict the absolute limits for most environmental degradation, it is possible to predict the direction of environmental progress for individual impact categories.

Research has been on-going for years to make comprehensive impact assessment available in the most practical framework for Life Cycle Impact Assessment (LCIA) [11], process design, pollution prevention, green chemistry, and green engineering. Although many of these applications include a comprehensive list of impact categories, for sustainability analysis, the focus should be on long-term temporal and large-scale geographic impacts. With this focus, methodologies are available for various impact categories (e.g., ozone depletion [12-14], global climate change [15-21] midpoint models), but much controversy remains for other impact categories (e.g., land use, water use, abiotic and biotic resources). Perhaps even more important than in a typical environmental analysis, sustainability may need to consider the "tipping point" of many of these impacts (e.g., the loss of Threatened and Endangered Species) beyond which there may be little or no hope for reversibility.

Key Element 4: While decision makers may prefer fewer indicators to consider, the aggregation of sustainability indicators obfuscates the more comprehensive view of individual indicators. These indicators need to be evaluated independently, since the decline or collapse of any one of these indicators may be significant.

Discussions concerning the appropriateness of aggregating environmental indicators have been held in relation to the ISO 14040 series development [22-25], and discussions relating to midpoint, endpoint, and damage modeling [11, 26-29]. Concerns include: the lack of comprehensiveness and scientific integrity when models are extended with forecasting and value-laden assumptions to conduct damage level aggregation, increased uncertainty, the lack of transparency, and the incorporation of normative factors into a scientific analysis [26, 29]. Consider Figure 2, which shows that aggregation based on damage indicators may lose significant endpoints, which are not calculated.

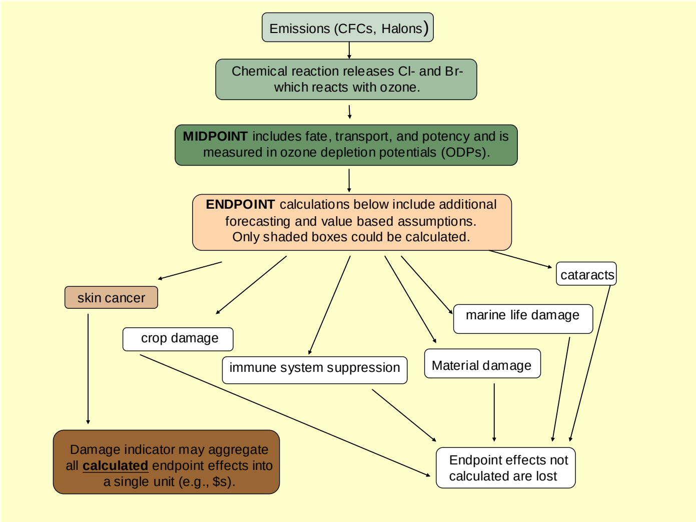


Figure 2. Illustration of endpoints lost when damage indicators are used and not fully comprehensive [11].

Also important when considering sustainability issues is the obfuscation of issues which may be critical by themselves, but whose results are lost when a single environmental score is considered. For example in a recent weighting exercise conducted for the National Institute of Standards and Technology [30] various impact categories were weighted for use within BEES (Building for Environmental and Economic Sustainability). Water use was considered to have an 8% priority when compared to all the other impact categories which were quantified. Whether this weighting is correct or not is not an issue here. The concern is that in a sustainability analysis of biobased products, the additional water use necessary for increased agricultural production could significantly deplete the water resources available within in given geographic region. This fact may be lost in an aggregated score which may even show overall environmental progress has been made when weighting factors are considered. If each category were analyzed on their own merits, it would be more apparent the water use of additional agriculture could compromise the agricultural sustainability of the land for generations.

Key Element 5: Resource use categories are important to environmental sustainability, but continued research is needed in this area.

While the more traditional pollutant related impact categories of ozone depletion and global climate change were developed with international consensus years ago, impact assessment modeling of resource use categories are still in the earliest stages. Some of the earliest recommendations characterized abiotic depletion in a simplistic manner using the following equation:

$$abiotic\,depletion = \sum_i \frac{material\_use_i(kg)}{reserves_i(kg)} \qquad \text{Eq. 1}$$

Early guidance did not specify impact assessment for land and/or water resources [31, 32], but was used for fossil fuel and mineral depletion. Several more recent attempts to propose land use impact assessment include biodiversity, scarcity, and ecosystem services, with most of the research focusing on biodiversity [33-52]. Water use impact assessment is even less well-developed [53-55].

One of the primary difficulties of conducting resource use impact assessment is the recognition that localized parameters matter. Whereas, for ozone depletion and global warming, it does not matter where on the globe the emissions occur, for impact categories such as land use, landscape heterogeneity significantly impacts the available ecosystems services which change with land transformation and occupation. Therefore, while the analysis may need to be global for an impact category such as land use, the methodology may require GIS-linked input parameters to more sophisticated ecosystem service tools.

Summary

Although the original focus of sustainable development was on environmental progress, more recent treatment of quantifying sustainable progress has been highly contentious, and the environmental focus of the early years has been recently been diminished. This paper proposes five key elements, which are listed below:

- Environmental sustainability should be at the core of sustainable progress since it is required for the health and welfare of people and other living systems on the planet.
- Social indicators must be selected carefully and maintained independently from economic and environmental indicators.
- Environmental analysis should be considerate of various life cycle stages and focused on long-term temporal and large-scale geographic impacts.
- Sustainability indicators need to be evaluated independently, since the decline or collapse of any one of these indicators may be significant.
- Resource use categories are very important to environmental sustainability, but continued research is needed in this area.

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