Clean Techn Environ Policy (2005) 7: 71–72
DOI 10.1007/s10098-005-0273-3

EDITORIAL

Ravi Jain

Sustainability: metrics, specific indicators and preference index

Published online: 2 April 2005

In a recent editorial, Dr. Sikdar stated that discussing sustainability has been a cause for confusion and generates many questions. In an earlier editorial, I had suggested that it seems that everyone is for sustainability and sustainable development; therefore, it is difficult to be against it. The less one knows about it, the better it sounds.

One of the major components of sustainability is our concern for or an obligation to future generations. If we profess to be concerned about the welfare of future generations and not terribly concerned about the welfare and needs of the poor today, then there is a terrible inconsistency in our thinking stated Solow (1993).

Often there are discussions of the disparity of resources consumed by the rich nations as compared to those consumed by the poor nations. For example, about one-fifth of the world's population in highly industrialized countries continue to consume 80% of all goods and services. Within the industrialized countries, the situation of intergenerational and intragenerational acquity is not very good either.

Some may argue in favor of social responsibility of industries and corporations. Others, on the other hand, may see this differently. For example, Friedman (1962) stated that: "Few trends could so thoroughly undermine the very foundations of our free society as the acceptance by corporate officials of a social responsibility other than to make as much money for their stockholders as possible. This [Corporate Social Responsibility] is a fundamentally subversive doctrine."

It is clear that thoughtful people have and will continue to have differing views about sustainability. The role of scientists and engineers is to provide information so that the policymakers can make decisions that are based on science and focus on those general goals that, in spite of varying political persuasions, provide a common ground for a great majority of humankind. For example, these goals could be:

- Achieving a reasonable standard of living for this generation without compromising the ability of future generations to meet their essential needs.
- Reducing resource exportation to a sustainable level.
- Minimizing health and environmental impacts.
- Providing a balance between competing economic, social, and environmental needs.

If we were to generally agree on these goals, then the question arises as to how does one evaluate activities designed to further this agenda and how does one measure progress towards these goals. The ability to analyze different alternatives or to assess progress towards sustainability will then depend on establishing measurable entities or metrics used for sustainability. We live in an era where numbers are used to analyze different alternatives; and decision making has become increasingly data-driven.

To respond to these issues, three different possibilities can be explored:

- Metrics for sustainability
- Specific indicators for sustainability
- A framework for preference index

Metrics for sustainability

The book *Technological Choices for Sustainability* (Sikdar et al. 2004) provides extensive information about metrics for sustainability. The book includes numerous chapters that describe: technology sensitive indicators for sustainability, metrics for supply chain sustainability, quantifying technological aspects of process sustainability, and defining and measuring macro economic sustainability, etc.

R. Jain
School of Engineering and Computer Science,
University of the Pacific, 3601 Pacific Avenue,
Baun Hall, Stockton, CA 95211-0197, USA
E-mail: rjain@pacific.edu
Tel.: +1-209-9463066
Fax: +1-209-9463086
URL: http://wwwl.uop.edu/eng/index.html

The Yale Center for Environmental Law and Policy report (Environmental Sustainability Index 2005) suggests that sustainability is a characteristic of many dynamic systems. These systems maintain themselves over time and should not be viewed as a fixed endpoint. Thus, environmental sustainability refers to the long-term maintenance of natural resources and the environment in a dynamic human context. We then have to recognize that metrics used for sustainability have to respond to the interconnectivity and temporal variations.

Specific indicators for sustainability

For developing these indicators, the Sustainability Index Report (2005) presents a comprehensive set of variables that can be helpful. This report has identified seventy six indicators (or variables) grouped under five major components: environmental systems, reducing environmental stresses, reducing human vulnerability, social and institutional capacity, and global stewardship. Some examples of the indicators are: air quality, water quality, reducing ecosystem stress, natural resource management, basic human sustenance, environmental governance, private sector responsiveness and participation in international collaborative efforts. For each of these indicators, for example air quality, there is a set of elements (e.g. nitrogen oxides, sulphur oxides, particulates and indoor air quality) and their concentration levels provide the environmental status for that variable. These specific indicators, along with underlying set of elements, provide a comprehensive approach to analyze sustainability issues. It is important to note that in the absence of effective sustainability indicators, it is not possible for decision makers to evaluate different alternatives, policy choices, and progress towards goals.

Industrialized and developing countries have different and distinct challenges in relation to sustainability. In addition, sustainability indicators have to address issues related to economic development, economic growth, and international competitiveness. Thus, these indicators have to provide a general framework where, while providing means to measure progress and evaluating alternatives, they would allow industry or a nation to make choices and develop policy options. Since not all indicators and underlying elements are in common units and some elements are incommensurate, this tradeoff then naturally becomes a problem. For some cases, the target might be to reduce a damaging activity or a pollutant to a minimum levels; for others, sustainability may mean striking a balance between competing priorities, and scaling variables accordingly (Environmental Sustainability Index 2005). This is where the concept of preference index superimposed on specific indicators might be helpful.

A framework for preference index

A model derived from the work of Keeney and Raiffa (1976), which takes into account multiple objectives, preferences, and value tradeoffs can be used to develop a framework for preference index. One of the main problems in using such an approach is the tendency on the part of some technical users to quantify items that do not lend themselves to quantification.

In developing a policy or in making specific project choices among competing demands, the decision-maker can assign utility values to consequences associated with each path instead of using explicit quantification. The payoffs are captured conceptually by associating to each path of the tree a consequence that completely describes the implications of the path. It must be emphasized that not all payoffs are in common units and many are incommensurate. This can be mathematically described as follows (Keeney and Raiffa 1976, p. 6):

$$a' \text{ is preferred to } a'' \;\Leftrightarrow\; \sum_{i=1} P_i' U_j' > \sum_{j=1} P_j'' U_j''$$

where a' and a'' represent choices, P probabilities, and U utilities; the symbol $\Leftrightarrow$ reads "such that".

Utility numbers are assigned to consequences, even though some aspects of a choice are not in common units or are subjective in nature. This, then, becomes a multiattribute value problem. This can be done informally or explicitly by mathematically formalizing the preference structure. This conceptual approach provides a generalized framework for the preference index concept and it can assist in providing a meaningful tool for including complex variable in making value tradeoffs and policy choices, and for measuring progress towards sustainability in the context of specific industry, region or a nation.

Sustainability metrics and specific indicators are useful tools; their utility in making project choices and policy decisions remain limited. Consequently, an exploration of superimposing concepts related to preference index is suggested. This way, making project choices and making policy decisions can provide a more comprehensive framework and help address multiple objectives and competing priorities related to sustainability.

References

Friedman M (1962) Capitalism and freedom. University of Chicago Press, Chicago

Keeney RL, Raiffa H (1976) Decisions with multiple objectives: preferences and value tradeoffs. Wiley, New York

Sikdar S, Glavic P, Jain R (2004) Technological choices for sustainability, Springer, Berlin Heidelberg New York

Solow RM (1993) Sustainability: an economist's perspective. In: Dorfman RM, Dorfman NS (eds) Economics of the environment—selected readings. Norton

Environmental Sustainability Index (2005) Yale Center for Environmental Law and Policy Yale University, New Haven