The Roles and Importance of Sustainability Indicators

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Abstract

We like to believe that the better information we feed decision makers, the better decisions they will make. Policy makers will argue about what actions will and will not promote sustainability. We need to be able to measure the impacts of these decisions within a feedback loop. In order for these measures to be used, there needs to be wide support that the measures are appropriate to assess sustainability. If we can agree on indicators of sustainability, then we build common understanding. In 1993, we embarked on developing the Sustainable Development Indicators, a national report that would organize existing governmental data into a body that could be used to assess national sustainability. This effort drew upon the work done on the Montreal Criteria. For future generations to be at least as well off as the present, the key is sustaining resources. Underlying capacities of systems must be maintained and increased if we are to grow. There is a common desire to boil down sustainability into one measure, one indicator. It is impossible to capture the complexity of sustainability into just one indicator. Through indicator sets, we can organize information in such a way that promotes ongoing conversations in relevant policy arenas.

Introduction

Substantial efforts are being made to develop sustainability indicators for natural resource systems such as rangelands and for the nation as a whole. These efforts reflect the beliefs that sustainability is an important long-range goal and that a system of regularly published indicators that can be used to monitor conditions and to assess trends relevant to sustainability will provide an effective means for making progress toward sustainability. This paper summarizes the history and concepts of sustainability and sustainable development. It then discusses the ways in which a system of sustainability indicators can be particularly useful in promoting sustainable development in America's multi-centric political and economic systems. Next it discusses the variety of roles and contexts in which sustainability indicators can be used including on-the-ground management, policy development, and social learning.

History and Concepts

Over the last 20 years, sustainability, achieved through sustainable development, has emerged as an important goal. In 1987, the Brundtland Commission Report, "Our Common Future," put forward the general concept of sustainable development that has become most widely accepted. It described 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).

The commitment to maintaining opportunities for future generations is a central theme of sustainable development. The integration of the economic, environmental, and social realms is also an important theme. If we want future generations to have the same or better opportunities as present generations, then it is important that current efforts to progress in one realm not cause long run declines or unexpected collapses in other realms.

Sustainable development was the organizing theme for the U.N. Conference on Environment and Development in Rio de Janeiro in 1992 at which many countries adopted Agenda 21 as the basis for efforts to implement the concept (UNCD 1992). Sustainable development will, of course, be the theme for the World Summit on Sustainable Development in Johannesburg in September 2002.

The Matter of Definitions.

No paper on sustainability would be complete without an attempt to say what it means. Most generally, sustainability of large complex systems is a dynamic condition that enables them to endure for an extended period of time. The biosphere provides the best example of a system that has achieved this type of sustainability. In the context of human economic and social systems and their interactions within the biosphere, sustainability is the condition under which the patterns of interaction and the resulting satisfaction of human needs and wants can endure from generation to generation. In other words, sustainability is the condition achieved when our economic, environmental and social systems are operating in a manner that yields constant or

increasing human well being over the long run. This anthropocentric version of sustainability encompasses the sustainability of the biosphere on which the human population depends.

Indicators, for the purposes of this paper, are taken to be statistical measures of observed phenomena, or classes of phenomena, regularly published, and organized in ways that make them more understandable and more accessible than the data from which they are derived. Indicators are not one-time events or measurements and they are not forecasts or projections. They show past trends leading up to the present.

Roles of Sustainability Indicators in the American Context

Many are concerned that the burdens being placed on the biosphere by a large and growing human population threaten sustainability and portend declines in human well-being in the 21st century. Yet, it also seems possible that, through sustainable development incorporating new technologies, new management techniques, and new ways of living, we may achieve a transition to sustainability with high levels of well-being for astonishingly large numbers of people. The premise of this paper is that the ways in which we create, organize and use information on the consequences of human activity will play an important role in the processes of sustainable development through which we may be able to achieve this possibility.

A frequently heard justification for developing indicators is that they will be used by "decision makers," yielding better decisions, decisions that are more effective at promoting sustainability. It is often assumed that such decision makers are politicians, high level public officials or corporate executives who, because of their positions, make decisions affecting the behavior of large numbers of people and the uses of significant amounts of resources. Clearly, advocates of sustainable development hope that high level decision making becomes more "sustainable." And most people who work to produce information and develop indicators certainly hope that their efforts will improve decision making. In the American economic and political context, however, sustainability indicators can play a much broader role and achieve much greater importance.

To much of the world, sustainable development is a paradigm that relies heavily on central decision making, whether in the developing countries or in the social democracies of Europe. In the United States, however, our economic and political systems are multi-centric. We rely upon a mix of decentralized decision making, in households and small businesses, in communities and state governments, and centralized functions in the Federal government and large corporations. Even our "central" institutions exhibit many characteristics of decentralized decision making.

Thus, for sustainable development to occur most effectively in the United States, it will need to occur through decisions at many levels throughout our economic and political system. It will need to occur through on-the-ground management, through middle management, and through high-level government policy and corporate investment decisions. It will need to occur through management that affects production of commodities, goods, and services, and through the decisions we all make in our daily lives that affect the what and how of consumption and post consumption recycling or disposal of "waste."

Consequently, the importance of sustainability indicators is greater than is suggested by the mere hope that they will better inform high-level decision making. In a multi-centric economic and political system, information instead of plans and commands allows effective and coordinated choices to be made at many different levels. In our democracy, informed citizens use information in many contexts to exercise their freedoms and meet their responsibilities. In our markets, firms and consumers use information to make decisions that affect how resources are used in producing the goods and services we use.

Moreover, because sustainability is a new and overarching paradigm, successful sustainable development in the United States requires the emergence of a widespread understanding of the concept, its practical implications, and the consequences of a failure to make the transition to sustainability. Broad public acceptance of sustainability as a basis for decisions at all levels can legitimize and support the new kinds of actions that are needed to achieve sustainability. High-level decisions that are unacceptable to large numbers of people in the United States tend to be few and ineffective because of the many countervailing forces and processes within our multi-centric system. Actions that are understood and accepted by the public, however, tend to be repeated and strengthened.

Sustainability indicators are an important way to promote sustainability through the actions of well-informed citizens as they participate in our democracy and the economy. Thus, an important role of sustainability indicators is that they can be regularly broadcast to the public along with concise explanations, stories that tell people what has caused the conditions and trends the indicators portray. Consistent, regular reporting of sustainability indicators can contribute to a better, more widely shared understanding of the concept of sustainability and of the general causal relationships that affect its achievement.

The Roles of the Indicator Selection and Development Process

People who have been involved in the indicator development process, such as those participating in the Sustainable Rangelands Roundtable (SRR), sometimes feel some frustration at the seemingly endless discussion of what sustainability means and how to measure it. The participants include managers, scientists, and interested citizens. Because of the diversity of views and values among participants, the discourse often digresses into debates about what constitutes the good life, now and for our grandchildren. While it often seems that this delays progress in selecting indicators, in fact, it is an important benefit of the process.

The discussions inherent in the indicator development process contribute to a more broadly shared understanding of sustainability and of the human needs and wants our resources help satisfy. Maureen Hart, a consultant to many community sustainable development efforts, has as her motto, "We are what we measure. We need to measure what we want to be." I have suggested a somewhat more complex version: "We are more likely to become what we can agree to measure. We need to agree on what we want to become." Developing a broader consensus that we want to become a sustainable society and a broader, more specific agreement about what that means is an important part of the indicator development process.

Uses of Sustainability Indicators

Sustainability indicators can be used in a variety of ways in the decision contexts described above. One way is by analogy to the ways information is used in the delivery of medical care. A second can be drawn from the literature on policy and management processes. A third view of the uses of indicators can be developed from work on social values and objectives.

A Medical Analogy

A medical analogy is useful for understanding the different roles of information in our society. Information is used in four stages in the delivery of medical care:

1. Assessment
2. Diagnosis
3. Prescription
4. Treatment

Different types of information have different costs and contribute differently to what is useful to know at each stage. Thus, the type of information used in each stage tends to be different. We can illustrate how this applies to sustainable resource management by exploring the roles of information in the health care process.

A health assessment is designed to determine whether a patient has any health problems that need to be treated. Doctors use a relatively small set of indicators in a health assessment: vital signs and a few standard laboratory tests such as blood counts and cholesterol levels. Most of the information from a health assessment is used to determine whether the patient's various systems are functioning normally, whether they have the capacity to maintain life. If key indicators are outside of normal range, the result of the assessment is the conclusion that a problem may exist. Assessment is often a problem identification process. A health assessment also helps the doctor develop a shared understanding with the patient that legitimises further investigation leading to a diagnosis.

The information typically used in a health assessment has been selected on the basis of well-known relationships between a wide variety of diseases and a few easily measurable parameters. The information used in assessments usually does not reflect the specific cause and effect relationships of all diseases. Assessment indicators generally do not show the precise nature of the problem and its cause. They merely indicate whether or not a problem exists.

In the diagnostic phase, specific tests are used to determine the nature of the problem and its cause. The selection of diagnostic information is based on specific knowledge of the cause and effect relationships among symptoms, diseases and their causes. Diagnosis is a puzzle solving process, but as is the case with health assessment indicators, diagnostic information is also used to convince the patient to undergo treatment. An important role of diagnostic information is to legitimize treatment.

Once a diagnosis has been made, a treatment is prescribed. This involves the design of actions to be taken and a decision to take them based on the expected consequences. The prescription of treatment is based on information about future outcomes whereas assessment and diagnosis are based on information about the patient's current and past conditions. Information is also used in the treatment phase. Some information is needed to implement the treatment. Other information is needed to monitor its effects. Monitoring of the patient's progress sometimes shows that the prescribed treatment has failed, leading to a new cycle of diagnosis and prescription.

Sustainable resource management is analogous to health care in a number of ways. Sustainability indicators can be structured for use in assessment, diagnosis or monitoring treatment. At each stage, they can be used to legitimize the next step.

The Policy and Management Cycle

The use of performance indicators within a management organization is often described as a part of an adaptive cycle as shown in Figure 1. Monitoring is a key source of information used in measuring performance in management organizations. Performance indicators provide accountability, but they also promote the evolution of management practices that are more effective at achieving the goals and objectives of the organization. They provide the feedback that allows reviews by on-the-ground managers, by mid-level managers, and by policy-level decision makers. At each stage, indicators can be used to determine from the observed consequences, what works and what doesn't. Information feedbacks help shape the evolution of policies and management practices to better achieve goals and objectives. Adaptive management processes help our organizations to repeat what works and drop what doesn't.

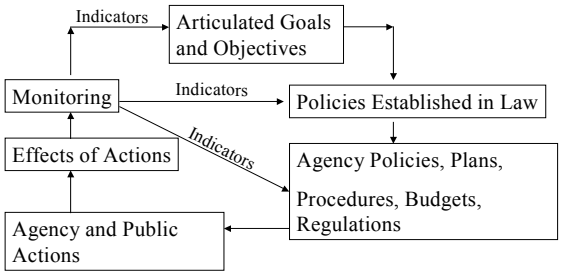

Figure 1. Use of Indicators in the Policy Cycle

Social Learning and Changing Societal Objectives

A similar evolutionary process occurs through the use of indicators by broader segments of the public. At this level, indicators are used by a variety of interested parties (often called stakeholders) in the public discourse that articulates the values, goals and objectives to be pursued in American society. Although basic values and fundamental goals are very slow to change, objectives, particularly those related to the means of achieving fundamental goals, change more rapidly. For example, the objectives of natural resource management change as people come to share a better understanding of resource conditions and the factors that cause them. In this process, indicators can be viewed as important contributors to social learning. As the public's understanding changes, people espouse new objectives for management organizations at all levels.

Figure 2 illustrates how information feedbacks affect society's objectives. It takes Underlying Human Nature as its starting place. This includes values inherent in, and common to, all humans. Next is the shared values in a society that flow from human nature, but are affected by the society's culture. These values differ among the individuals in a society, but are held by many. People have values about both the ends to be achieved in life and about the means through which they are to be achieved.

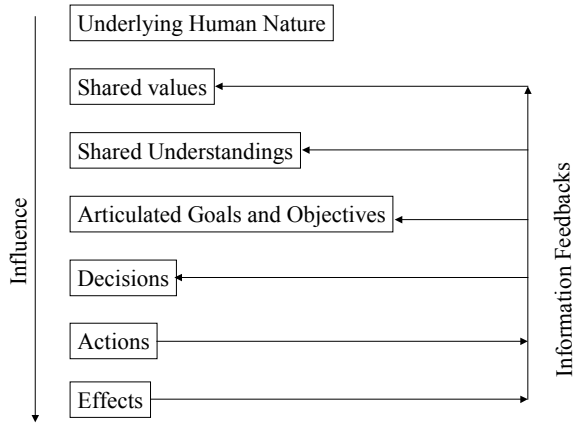

Figure 2. Information Feedback in Social Learning

The people in a society also have shared understandings about conditions and causal relationships. They have views about "how the world works" that include social and economic systems and the environment. People interact through a variety of social, political and economic processes in ways that articulate the goals and objectives in a society. Articulated goals and objectives tend to affect decisions and actions at many levels.

In the policy realm, the societal goals and objectives that emerge from the social learning process are often manifested in laws. For example, a number of the Federal laws affecting rangeland management have emerged from the social learning process in the past: The Federal Land Policy and Management Act, The National Forest Management Act, and The Resources Planning Act.

The downward arrow on the left of Figure 2 represents processes that influence objectives and the upward arrow on the right represents information feedbacks. In our social and political processes, information includes formal information such as indicators along with many forms of informal information.

Sustainable development can usefully be seen as a major transformation in human behavior patterns to be achieved through social learning. Shared understandings of conditions and causal

relationships are an important manifestation of the social learning process. Information, particularly well organized, relevant, well communicated formal information such as regularly reported indicators, can make an important contribution to social learning by promoting more widespread understanding.

Through social learning, people come to share changed and more effective understandings of conditions and causal relationships as realistic information feedbacks reinforce those understandings. This leads to actions that are more effective at achieving goals and objectives. Science formalizes much of the process of social learning, but does not, in itself, promote changes in understandings among non-scientists. The social learning process is assisted by science, but it occurs largely outside of the community of scientists through education and a variety of formal and informal communications processes.

A transition to long-run sustainability is not likely to be achieved merely by changing the formal information used by decision makers in federal agencies. It will also require the use of information to promote social learning, the gradual change in the values and understandings shared widely within our society and the objectives that become articulated to guide federal agencies.

This suggests that an important aspect of indicator development is the design of the means by which relevant information can be effectively communicated to millions of people, means by which they come to understand more realistically the current conditions and situations as well as the cause and effect relationships that are key to improving them.

Toward a National System of Sustainability Indicators

Several efforts are making it possible to develop a national system that will assemble information relevant to sustainability and provide access to the portions of that information that are suitable for use at different scales and in different contexts. In the long run, it may be possible to develop and report on a set of indicators at the national to local scales for governments, businesses, and individuals that are based on consistent measures. The sort of consistency that has been achieved in economic measurement, reporting, and indicators may eventually emerge in the environmental and social realms as well. The work of the Interagency Working Group on Sustainable Development Indicators (the SDI Group) can serve as an integrating framework, an umbrella under which the work of the SRR and the other Sustainable Resources Roundtables can be brought together along with indicators for other aspects of the economic, environmental and social realms.

The SDI Group began its efforts in 1994 to develop sustainability indicators that could be applied at the national level. In 1998, it published a report setting forth a framework for organizing indicators and a set of 40 experimental indicators covering the economic, environmental and social realms (IWGSDI 1998, also see www.sdi.gov).

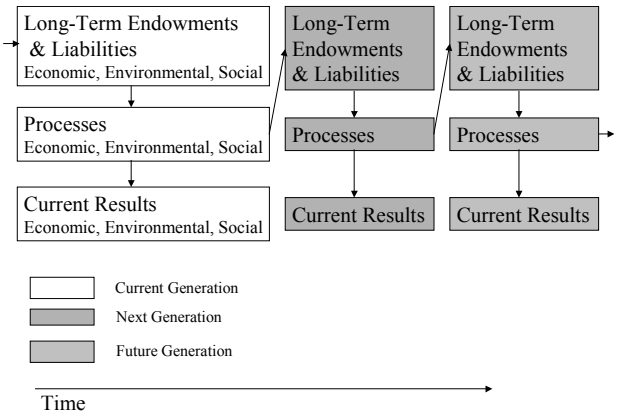

Figure 3. Sustainable development indicator framework.

The SDI Group's framework is shown in Figure 3. It was based on the Brundtland Commission concept of sustainable development, the Pressure-State-Response Framework being used for environmental indicator development in Canada, the Netherlands, OECD and the U.S. EPA, and the capital maintenance approach being developed by the World Bank and others. The SDI Group framework distinguishes three categories of indicators:

- Endowments, including productive capacities, stocks, capital assets.
- Processes, including particularly Driving Forces that cause changes in Endowments.
- Current Outputs and Results, including the goods and services humans use and the resulting satisfaction of human needs and wants.

The Endowment category contains indicators that facilitate sustainability assessment by focusing on measures of the productive capacities. The SDI Group chose the term "endowment" because it conveys the concepts of stewardship and trusteeship. Table 1 shows the Endowment indicators that were included in the experimental set of 40. Indicators in the Endowment category will facilitate assessments based on the capital maintenance approach. Declines in our Endowments would suggest that we are not passing sufficient opportunities along to future generations.

Driving Forces are processes that cause increases or decreases in Endowments. They build up or draw down stocks, capacities and capital. Driving Forces include many activities that are the focus of economic or resource management such as investment and environmental restoration. They also include pressures on environmental endowments such as pollution discharges and landscape alteration. Table 2 shows the Driving Force indicators included in the experimental set of 40. Indicators of Driving Forces can be used to assess sustainability by focusing on changes in endowments rather than the total capacities of endowments. For many aspects of our natural endowments, it is easier to get data on changes than on total capacity. If increases in Endowments are greater than decreases, it suggests that we are passing more capacity along to future generations than was passed to us by previous generations.

Current Outputs and Results indicators measure the goods and services produced in the current period and the extent to which their use satisfies human needs and wants. Table 3 shows the indicators included in the SDI Group's experimental set. Current Outputs and Results indicators are the most widely available and widely used, but are less useful in assessments of sustainability because it is possible to achieve high levels of output over a limited period at the expense of long run sustainability. Nevertheless, this category of indicators is useful for assessing how well we are meeting the needs and wants of the current generation. Long-run declines in Current Outputs and Results indicators would suggest the possibility of underlying sustainability problems.

The focus on Endowments in the SDI Group's framework is generally consistent with the approach evident in the Criteria and Indicators for Conservation and Sustainable Management of Temperate and Boreal Forests, often called the Montreal Criteria and Indicators for short (see Journal of Forestry, Vol. 93, No. 4 April 1995). Most of the seven criteria call for maintenance of capacities or other valued attributes of forest ecosystems. As a result, many of the 67 indicators could be included in either the Endowment or Driving Force categories of the SDI Group's framework.

The SRR is not using the SDI Group's framework nor is it following exactly the approach of the Sustainable Forest Criteria and Indicators. It appears, however, that there will be a substantial focus on the productive capacities and other valued attributes of rangelands and on the factors that cause them to change. This will make it possible for indicators selected by the SRR to be incorporated into the national framework. Thus, the work of the SRR will not only make indicators available for assessments focused on rangelands at various scales and in various contexts. It will also contribute rangeland indicators that can be used, along with those emerging in the parallel efforts on Forestlands, Minerals and Energy, and Water Resources, in sustainability assessments at the national level.

Table 1. Long Term Endowments & Liabilities

Economic	Environmental	Social
Capital Assets	Surface Water Quality	U.S. Population
Labor Productivity	Acres of Major Terrestrial Ecosystems	Children Living in Families with Only One Parent Present
Federal Debt to GDP Ratio	Contaminants in Biota	Teacher Training Level and Application of Qualifications
	Quantity of Spent Nuclear Fuel	
	Status of Stratospheric Ozone	
	Greenhouse Climate Response Index	

Table 2. Processes – Driving Forces

Economic	Environmental	Social
Energy Consumption (per Capita and per $ of GDP)	Ratio of Renewable Water Supply to Withdrawals	Contributing Time & Money to Charities
Materials Consumption (per Capita and per $ of GDP)	Fisheries Utilization	Births to Single Mothers
Inflation	Invasive Alien Species	Educational Attainment by Level
Investment in R&D (% of GDP)	Conversion of Cropland to Other Uses	Participation in the Arts & Recreation
	Soil Erosion Rates	People in Census Tracts with 40% or Greater Poverty
	Timber Growth to Removals Balance	
	Greenhouse Gas Emissions	
	Identification & Management of Superfund Sites	

Table 3. Current Outputs and Results

Economic	Environmental	Social
Domestic Product	Metropolitan Air Quality Non-attainment	Crime Rate
Income distribution	Outdoor Recreational Activities	Life Expectancy at Birth
Consumption Expenditures Per Capita		Educational Achievement Rates
Unemployment		
Homeownership Rats		
% of Households in Problem Housing		

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