

Achieving a Sustainable Biosphere: An International Endeavour

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THE EARTH'S ENVIRONMENT is deteriorating at an extremely rapid rate. Humans are at a crucial point in history. We are the first generation that can globally destroy life and may be the last one with the chance to reverse some of the deterioration: species are vanishing at a faster rate than ever, concentration of some atmospheric gases is increasing exponentially, and climate changes similar in magnitude to those that have occurred over millennia are predicted to occur over the next century.

Human activities aimed at improving our quality of life have unintended results. Agriculture, forestry, mineral extraction, industrialization, urbanization and so on produce food, fiber, shelter and consumer goods. Simultaneously, however, they result in a number of environmental problems such as loss of biotic diversity, desertification, pollution and climatic change. These problems are so serious that the ability of the biosphere to continue to perform its natural functions and support humans is questionable.

Aware of these problems, the Ecological Society of America initiated, in 1988, a process that culminated with *The Sustainable Biosphere Initiative: An Ecological Research Agenda* (SBI)^{1,2}. This document outlined priorities for research, education and environmental decision making. It recognized both the global nature of the environmental problems and the value of basic research to solve them. Finding solutions to these problems depends on our understanding of basic ecological principles. Thus, basic research is the foundation of sound environmental decisions, and the greater and more urgent the applied need, the more important the basic research becomes.

In addition to this effort by the Ecological Society of America, the then President and President-elect of the British Ecological Society

agreed on identifying priorities and suggested another set of them³. They emphasized the study of human population and carrying capacity, as well as research explicitly linking ecology with social sciences.

However, environmental problems in developed countries, such as USA and UK, are different from those in less-developed countries as a result of differences in land use. In the former, land is used relatively homogeneously, whereas in the latter we find both the largest expanses of pristine territory and the most striking examples of overutilization, misuse and the resulting desertification, erosion and pollution. Therefore, less-developed countries have the need to develop not only the technological tools to achieve sustainability of present systems but also the tools for using underexploited regions and satisfying increasing demands from both developed and less-developed countries.

One of the actions recommended by the SBI document was 'to organize a meeting of leading ecologists from many nations of the world to evaluate the Sustainable Biosphere Initiative' (my italics). Moreover, since no single country has the human and financial resources to undertake a project of this magnitude, the document also called for the 'construction of an operational framework for international cooperation'. Scientists from 14 countries met in Cuernavaca, Mexico, in June 1991; they concluded that although environmental problems are different in developed and less-developed countries, the path for solving them is essentially similar. They adopted the SBI and took it further. They recommended the establishment of a cooperative program, the *International Sustainable Biosphere Initiative* (ISBI)⁴. The goal of the ISBI is to facilitate the acquisition, dissemination and utilization of ecological knowledge to ensure the sustainability of the biosphere.

Given that what is in jeopardy is the biosphere, and the ability of the Earth to support humans, there is no research program with higher priority for society. In order to ensure the continuation of a supportive bio-

sphere, major decisions need to be made. The importance of the consequences of these decisions demands that society should give top priority to rapidly acquiring and disseminating the knowledge upon which they are based.

The concept of sustainability is key to this initiative. It refers to the use of natural resources in a way that satisfies current needs without compromising the needs or options of future generations. It implies the use of natural resources within the capacity of the environment to renew those resources and assimilate wastes.

The major problems of the world are ecological. However, to solve the environmental crisis that jeopardizes human society, a broader approach is required. It is not enough to generate the understanding needed to manage the biosphere in a sustainable manner; this knowledge should also be transferred and made accessible to decision makers in a convenient and practical way. Therefore, the ISBI is based on three components: research, education and environmental decision making.

Our present understanding of ecological systems is insufficient to devise a sustainable biosphere. Progress in research has been the result of unbound intellectual curiosity. Our understanding of Nature is mainly the result of the work of scientists trying to answer questions without an application in mind. Certainly, these endeavors should be maintained and enhanced. However, the shortage of financial and human resources makes it impossible to attack all problems simultaneously. The limited availability of resources and the urgency to solve some problems suggests the need to set priorities.

There is a trade-off between creativity and coordination. Investigator-initiated research, usually performed at universities or research laboratories, maximizes creativity and ingenuity. On the other extreme of the continuum, mission agency research responds to predefined objectives. Society at large cannot afford to lose scientific creativity to solve this complicated problem nor has the resources to answer all questions simultaneously. The ISBI attempts to address this problem by promoting investigator-initiated peer-reviewed basic research within the context of a coordinated program. It attempts to

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blur the differences between basic and applied research and to take advantage of the synergistic relationship between both approaches.

To fulfil the objective of attaining a sustainable biosphere, the ISBI defined three research priority areas: diversity and sustainability, sustainability in a changing biosphere, and human dimensions of sustainability.

Diversity and sustainability

It is very important to improve the understanding of the relationship between ecological diversity and functional properties of ecosystems and how natural and human disturbances affect them. This area of research priority has three foci.

(1) *Ecosystem response to disturbance.* Different ecosystems respond in different manners to similar disturbances. What are the ecosystem characteristics controlling these responses? Answering this question will allow us to develop a functional classification of ecosystems, which in turn will be the basis for a theory of ecosystem management. It will assist in predicting how sensitive an ecosystem may be to a new disturbance or to an array of interacting disturbances.

(2) *Consequences of simplification.* Human activities result in a loss of diversity at species, community and landscape levels. What is the relationship between biodiversity and ecosystem behavior? At which level of simplification is stability affected? How does the simplification-stability relationship interact with energy input and global change?

(3) *The nature and maintenance of diverse systems.* Species-rich communities should be maintained in near-natural conditions to preserve biodiversity. What are the mechanisms that result in complex systems? How does this diversity originate? How is it maintained?

Sustainability in a changing biosphere

Understanding how to achieve a sustainable biosphere for constant conditions is a challenging exercise. Furthermore, global change is occurring as a result of changes in land use, atmospheric composition and climate. Thus, sustainability must be achieved in the face of a changing biosphere. This research priority also has three foci.

(1) *The state of the biosphere.* The present state of the biosphere and the factors controlling the rate and direction of change are poorly documented. The sustainability problem is global in nature but most data can only be collected at a much smaller scale. What are the controls on the growth of organisms at the regional scale?

(2) *Responses and feedbacks of biotic systems to change.* It is necessary to build our understanding of how the units of the biosphere respond to global change and which are the biotic feedbacks to global change. What are the responses of ecosystems and organisms to changes in land use, atmospheric composition and climate? What are the interactions among the multiple sources of stress? These questions are related to the factors controlling the distribution, abundance and productivity of systems and organisms in a changing environment.

(3) *Synthesis and modelling.* Innovative approaches need to be developed to synthesize information collected at different scales. What are the approaches to link ecosystem level models with global circulation models? What methods can be used to interpret broad-scale patterns in terms of fine-scale processes?

Human dimensions of sustainability

Achieving sustainability requires the cooperative work of several disciplines – even those that have had little interaction in the past. Ecologists should work along with social scientists in a complementary manner. This priority area has three foci.

(1) *Human populations and perceived resources.* The objective is to understand the relationships between human populations and renewable resources. How is population growth related to perceived resource availability? Here the emphasis is on perceptions as being controlled by cultural constraints and in turn controlling human demography.

(2) *Human values and resource degradation.* Value systems have an important role in the use of resources. How do belief systems affect the depletion of natural resources? Which are the values that promote or constrain resource depletion?

(3) *Cultural styles and environmental change.* Socioeconomic systems and life styles affect resource use. What are the ecological impacts of different human life styles? What are the ecological consequences of different industrial technologies?

The ISBI was motivated by the Sustainable Biosphere Initiative of the Ecological Society of America and shares with it two research priority areas: biodiversity and global change. The ISBI added a strong interest in the human dimension of sustainability, which became a research priority area in itself. Sustainability changed from being one of the research areas of SBI to being the focal point of the ISBI.

The first action of ISBI was to publish the proceedings of the Cuernavaca workshop with the purpose of informing the scientific community at large and stimulating the curiosity of individual scientists to study sustainability issues⁴. The Cuernavaca meeting envisioned that the ISBI will develop into a major program, ideally under the auspices of the International Council of Scientific Union. The general assembly of the Scientific Committee on Problems of the Environment (SCOPE) met in Seville, in January 1992, and adopted a proposal to develop a sustainable biosphere project to synthesize the available information and understanding on this subject. The goal of this SCOPE project is 'to identify the scientific basis with which to achieve a sustainable biosphere and to describe the ways in which the necessary information can be acquired and appropriately applied in regions throughout the world'. The project is mandated to address the interactions between social and environmental processes relative to achieving a sustainable biosphere.

References

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