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Sustainability in a Time of Global Change: The Challenge for Research

Mitigating global environmental problems requires most societies to focus on sustainability. To support the corresponding reorientation of priorities, researchers need to complement their rather isolated investigations of individual phenomena with studies that involve humans more deeply. The scientific community must continue to contribute to both the accumulation and the implementation of knowledge. To effectively translate knowledge into action, all actors and all parties affected must be involved. Because international agreements on measures to mitigate key problems of global change are very difficult to reach, they must be complemented by regional views, which have a much greater chance of enactment. The syndrome approach evoked in this article—which is based on an earlier collaborative study—is a research framework that can provide the necessary scientific basis for regional decisions within a global context. It seems particularly appropriate for identifying and tackling problems of global change in mountain regions.

FIGURE 1 Monoliths on Easter Island: witnesses of a time long gone when natural resources were abundant. (Photo by Cliff Wassmann)

Easter Island—Earth Island?

When Jakob Roggeveen "discovered" Easter Island in the middle of the Pacific in 1722, resources on the—by then barren—island were scarcely sufficient to sustain the roughly 2000 natives (the Rapa Nui) who still lived there. But the more than 200 monoliths on the island, some of them weighing over 80 tonnes, could only have been made and transported by a highly organized society (Figure 1). We know today that Polynesians began to settle what was then a lush island with rich flora and fauna between 400 and 700 AD. A cultural zenith was reached between 1200 and 1500 AD. However, decay set in as the result of a population increase followed by overuse and the extinction of most animal and plant species, among them the local trees that must have been used to transport the statues. The Rapa Nui were unable to curb the foreseeable collapse of their ecosystem and culture by limiting their use of resources.

By now, the Earth is threatened as a whole. Its natural resources are being extensively used by a rapidly growing population. For the first time in the history of our planet, human activity is having an impact on the Earth as a whole. There is no escape from global environmental problems. Whether or not we have personally caused specific damage, we are all implicated. To take up the provocative question asked by Paul Bahn and John Flenley in their book entitled *Easter Island, Earth Island,* will we be able to make more sustainable use of the "island Earth" in the solar system than the Rapa Nui did of Easter Island?

Changes on a global scale

We are aware of a large number of environmental changes that have global impacts. Among the key problems of global change identified at the Rio Earth Summit in 1992 are the following:

- Climate change.
- Increasing land use and soil degradation.
- Destruction of ecosystems and loss of biodiversity.
- Increasing scarcity and pollution of water, soil, and air.
- Human-induced natural disasters.
- Uncontrolled population dynamics and disparities in development.
- Health risks and insufficient food security.
- Limited energy and other resources.

Our understanding of processes and interrelations in these key problem areas is of vital importance since long-term impacts must be anticipated and measures taken many decades before impacts become apparent to individuals.

Scientific findings in several of these key problem areas have been summarized in international synthesis reports, eg, by the Intergovernmental Panel on Climate Change (IPCC), the Biodiversity Assessment of the United Nations Environment Program (UNEP), and the Ozone Assessment of the World Meteorological Organization (WMO). Today these reports are the basis of international conventions. Unfortunately, as the Climate Convention shows, it is very difficult to reach even very modestly formulated international agreements such as the Kyoto Protocol.

Thus, the challenge confronting researchers is even more difficult in many respects than the one the Rapa Nui failed to meet on Easter Island. Indeed, the dissociation between agents of change and parties affected in space and/or time makes it more difficult to ascertain causalities and the impact of individual actions. As a consequence, interactions between individual activities and their impacts are often not experienced immediately. Hence, accountability appears to be limited while nonsustainable actions dissociated from local and/or regional conditions are encouraged. When thinly populated, mountain regions are typically affected by such dissociations, and populations are primarily victims rather than agents of globalization, with little power for counteraction. Interactions between highland and lowland areas are complicated by dissociations, and problem-solving is extremely complex. Generally speaking, attempts to mitigate key global problems such as climate change on a worldwide basis are thus poised to fail.

Soil degradation has claimed about a third of the Earth's arable land, or a sixth of its total land surface.

Sustainability—A worldwide challenge

It is an illusion to hope that global-scale threats to humankind can be thwarted by solving key problems individually since these problems are often intricately linked. Many substituents of ozone-depleting substances, eg, are powerful greenhouse gases. Short-term measures to improve public health and food security have an impact on land cover, often triggering soil degradation, especially in fragile mountain environments. Solving one key problem may thus aggravate another. As the Brundtland Report has made clear, our overall goal must therefore be to sustain a habitable environment that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Environmental research must complement research on key individual problems by supplying a holistic view that will allow responsible decisions and actions leading

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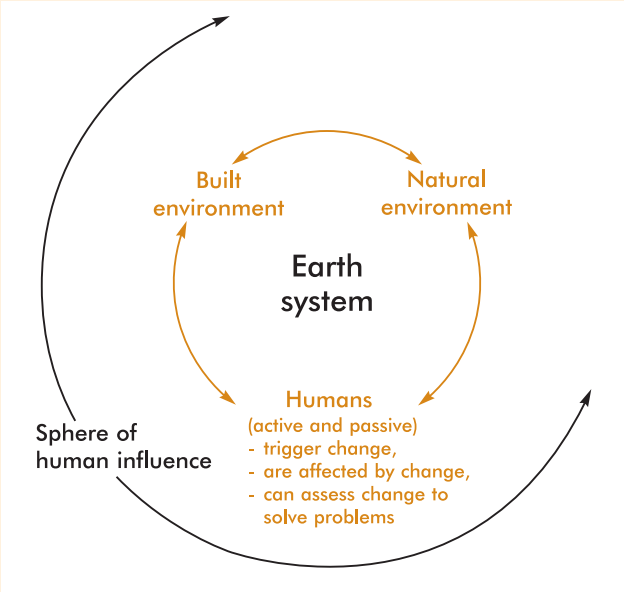

FIGURE 2 Research on sustainability requires the involvement of humans because they trigger change, are affected by change, and can trigger further change when solving problems.

to sustainable use of resources. This requires the integral involvement of human beings (Figure 2).

Research on syndromes to promote sustainability

The causes of global change differ from one region to the next since interactions between human beings and the environment vary greatly. While climate change caused predominantly by densely populated large cities may have severe consequences for farming, cities may in turn depend on the food and clean water from less populated regions. Decision makers thus need scientific advice to strike a balance between short-term political and economic benefits and long-term perspectives for survival in a region. Regional governmental agencies generally tend to promote research that is specifically tailored to their needs. Because every region is different, this tends to impose severe limitations on the relevance of research efforts. The challenge for researchers is to overcome this by searching for patterns or syndromes of global change—the so-called syndrome approach.

This approach seeks to facilitate an understanding of typical basic processes; these can be studied in international partnerships wherever similar patterns prevail. The syndrome approach aims to identify vicious cycles that are likely to exacerbate a syndrome and suggest measures to break out of them. Hence, causes are addressed and "end-of-pipe" solutions avoided. Moreover, the necessary fundamental changes can generate economic opportunities. Solutions derived from the syndrome approach can be compared in different regions of the world and are thus more credible.

Because it starts with local and regional situations, the syndrome approach also has a greater emotional impact on society, thus making it easier to involve the population in designing specific solutions than when problems are approached from a global perspective as key problems. The syndrome approach involves humans as agents and victims of change and as actors making assessments and devising solutions. It is cross-sectoral and is concerned with several key problem areas, establishing links between them. Syndromes therefore connect the anthroposphere and the biosphere (Figure 2). In their annual report for 1996, the German Advisory Council on Global Change (WBGU) proposed a set of 16 syndromes (see box).

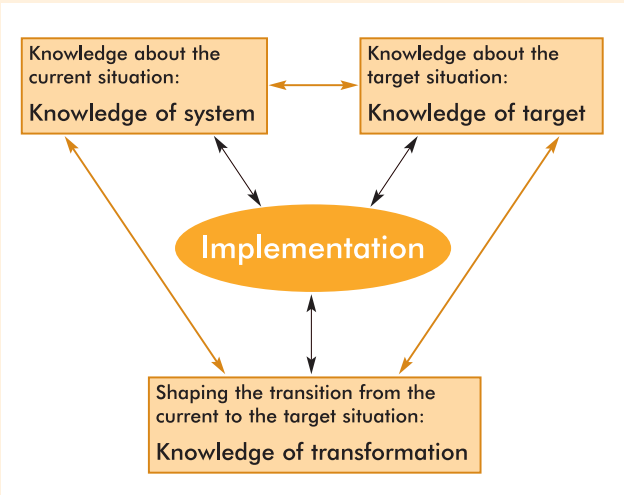

FIGURE 3 Three types of knowledge contribute to research aiming to support decision-making.

Syndromes in mountain regions

All utilization syndromes are relevant to mountain regions since mountain ecosystems are very vulnerable to anthropogenic pressures. Overcultivation, overexploitation, rural exodus (syndromes 1–3) and mass tourism (syndrome 6) affect most mountain regions worldwide. Nonsustainable use of soil and water, the depletion of nonrenewable resources, and destruction through war (syndromes 4, 5, and 7) have major impacts on specific mountain

regions. In mountain regions, the Aral Sea syndrome (the first development syndrome) is caused by economic growth induced by the lowlands, such as the construction of major traffic routes through narrow valleys or large dams that create risks and cause other problems further downstream. The generally greater abundance of water in mountain regions encourages inappropriate farming methods (syndrome 9), leading to overuse, erosion, or pollution. Thus, highland–lowland interactions are an important aspect of all mountain-relevant syndromes wherever surrounding lowlands are heavily affected by changes in the mountains and vice versa.

From knowledge to action

The scientific community can supply three types of knowledge (Figure 3) to help decision makers establish priorities:

- Knowledge about current processes and variabilities within the Earth system.
- Knowledge about target situations, involving definitions of tolerance levels, critical rates of change, ethical guidelines, visions of what our future should look like, etc.
- Knowledge about how to shape and implement the transition from the current to the target situation.

The syndrome approach cuts across academic disciplines and involves decision makers at the governmental and private sector levels. It supplements the approach focusing on key problems, which uses interdisciplinary studies of processes specific to a given problem, as is currently done in global research programs such as the World Climate Research Program (WCRP), the International Geosphere-Biosphere Program (IGBP), the International Human Dimensions of Global Change Program (IHDP), the biodiversity program DIVERSITAS, the Global Mountain Biodiversity Assessment (GMBA), and the Global Observation Research Initiative in Alpine Environments (GLORIA). The syndrome approach offers great advantages over strategies aiming to deal with individual key problems:

- Mitigating global key problems such as climate change on a worldwide basis is doomed to fail because the agents of change and the parties affected are often dissociated in space and time. Different countries thus set different priorities. Knowledge of the system will help identify common key problems and set up corresponding priorities.
- Actions to mitigate a syndrome of global change, on the other hand, are usu-

Overview of Syndromes of Global Change

From German Advisory Council on Global Change (WBGU). 1997. *World in Transition: The Research Challenge. Annual Report 1996*. Berlin: Springer Verlag, page 116, box 18.

Utilization syndromes

1. Overcultivation of marginal land: Sahel syndrome.
2. Overexploitation of natural ecosystems: Overexploitation syndrome.
3. Environmental degradation through abandonment of traditional agricultural practices: Rural exodus syndrome.
4. Nonsustainable agroindustrial use of soils and bodies of water: Dust Bowl syndrome.
5. Environmental degradation through depletion of nonrenewable resources: Katanga syndrome.
6. Development and destruction of nature for recreational ends: Mass tourism syndrome.
7. Environmental destruction through war and military action: Scorched earth syndrome.

Development syndromes

8. Environmental damage of natural landscapes as a result of large-scale projects: Aral Sea syndrome.
9. Environmental degradation through the introduction of inappropriate farming methods: Green revolution syndrome.
10. Disregard for environmental standards in the course of rapid economic growth: Asian tigers syndrome.
11. Environmental degradation through uncontrolled urban growth: Favela syndrome.
12. Destruction of landscapes through planned expansion of urban infrastructure: Urban sprawl syndrome.
13. Singular anthropogenic environmental disasters with long-term impacts: Major accident syndrome.

Sink syndromes

14. Environmental degradation through large-scale diffusion of long-lived substances: Smokestack syndrome.
15. Environmental degradation through controlled and uncontrolled disposal of waste: Waste dumping syndrome.
16. Local contamination of environmental assets at industrial locations: Contaminated land syndrome.

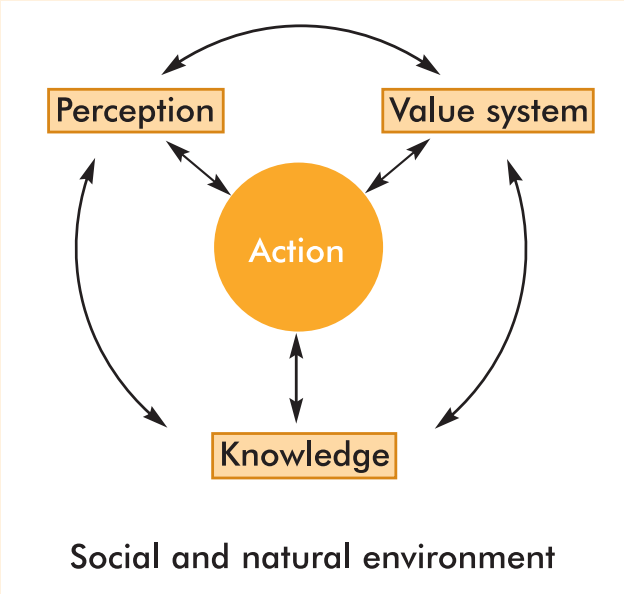

FIGURE 4 Knowledge alone does not lead to action and action is not directed by knowledge alone.

ally planned on a regional scale and may offer secondary benefits such as improved health or economic conditions strengthened by longer-term perspectives.

Knowledge of target situations and knowledge of transformation will be attained by integrating local or regional perceptions and value systems (Figure 4).

Indeed, in order to assess the extent to which knowledge is relevant to action, both knowledge and action need to be viewed from a wider perspective. Knowledge is not usually translated directly into action. Human actions are not directed by knowledge alone but are also influenced by perceptions and a value system within a specific social and natural environment (eg, basic needs, cultural diversity and tradition, state of technology, access to resources, distribution of power, institutional restrictions, ethics, social networks, dynamics of an ecosystem, etc.) (Figure 4). Only if scientists are prepared to reflect on and study these complex interrelations will they be able to conduct research relevant to practice and make a contribution toward solving and preventing environmental problems. Moreover, research is also necessary into why and how certain instruments of implementing scientific knowledge are successful and why others are not.

The future of research for development in mountains

One of the main issues discussed at a seminar on mountain research held in June 2000 in Autrans, France (see the report in *MRD* 20(4), pp. 374–375), was related to the wide gap between the scientific perception of problems in mountains and the social needs of the populations concerned. There is hope that an understanding of syndromes that prevail in many mountain areas worldwide will help bridge the gap between the production of scientific results and their application in local land use systems and societies as well as stimulate communication between scientific communities in the North and South. Indeed, the syndrome approach offers an opportunity to link scientific know-how and indigenous knowledge, thus offering a new perspective for global cooperation in mountain research. Using this approach is now one of the main goals of long-term mountain research projects in Switzerland involving international cooperation, such as those currently designed by the Swiss Interacademic Commission for Alpine Studies (ICAS), ProClim, the Swiss Commission for Research Partnerships with Developing Countries, and the Swiss Biodiversity Forum.

NOTE

This paper is based on a study entitled *Research on Sustainability and Global Change—Visions in Science Policy by Swiss Researchers*. It was published in 1997 by the Conference of the Swiss Scientific Academies (CASS) and the Forum for Climate and Global Change (ProClim). It summarizes the results of a series of exchanges among the members of the Swiss scientific community and is available on the Internet at www.proclim.ch/visions.html in English, German, and French.

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