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Author: Odermatt, Simon

Source: Mountain Research and Development, 24(4) : 336-341

Published By: International Mountain Society

URL: https://doi.org/10.1659/0276-4741(2004)024[0336:EOMCSB]2.0.CO;2

Mountain Research and Development Vol 24 No 4 Nov 2004: 336–341

Simon Odermatt

Evaluation of Mountain Case Studies by Means of Sustainability Variables

A DPSIR Model as an Evaluation Tool in the Context of the North–South Discussion

The International Year of Mountains (IYM) 2002 drew attention to mountain regions and their fragile ecosystems. The present article makes a comparative analysis of mountain case studies from developing countries (DCs) and industrialized countries (ICs) using sustainability variables in the framework of a Driving force–Pressure–State–Impact–Response Model (DPSIR Model). Response variables, ie efforts made by society to move towards sustainable mountain development (SMD), are believed to improve the situation with regard to sustainability, and are a focus of this study. In the course of the IYM, a total of 40 appropriate case studies were analyzed, to demonstrate the wide variety of approaches to SMD. Case studies that deal with themes considered to be particularly important in mountain regions were chosen for analysis. Such key themes include freshwater, forestry, agriculture, poverty, indigenous knowledge, migration, tourism, and legislation. Variables of great importance in any mountain area include "involvement of stakeholders in planning and development process (public participation)" and "gathering of baseline information." Additional challenges to SMD in DCs include lack of options to facilitate out-migration, declining forest cover, insufficient access to resources, and poverty. The main conclusion of this study is that the DPSIR Model that was applied is an adequate tool with which to analyze SMD case studies, especially studies relating to DCs.

Keywords: *Sustainable mountain development; mountain case studies; DPSIR Model; developing countries; industrialized countries; sustainability variables.*

Peer reviewed: *June 2004* ***Accepted:*** *August 2004*

Introduction

Since the publication of the *Brundtland Report* (WCED 1987) and the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992, numerous variables and indicators for sustainable mountain development (SMD) have been proposed (FAO 1996; Berkes and Gardner 1997; Rieder and Wyder 1997; Price and Kim 1999; Bayfield et al 2000; Kreutzmann 2001). However, there is need for a methodology that can be applied globally to all mountain regions (Royal Swedish Academy of Sciences 2002).

Why focus on mountain case studies?

In 1998, the UN General Assembly declared 2002 as the International Year of Mountains (IYM). The Food and Agriculture Organization of the United Nations (FAO) was invited to serve as the lead agency for the year. In the course of the IYM, FAO received an increasing number of inquiries from countries seeking technical and methodological assistance in establishing national strategies for the sustainable development of their mountain areas. In fact, an important focus of FAO's IYM-related activities is to assist countries in the development and refinement of policies and strategies related to sustainable development, and the management of mountain regions and their fragile resources. For this purpose, the IYM Coordination Unit planned to carry out an in-depth analysis of SMD approaches established and implemented since 1980 in different mountain regions of the world, and to document and analyze case studies of such experiences.

According to FAO (2000), mountains—as water towers of the earth, repositories of rich biological diversity, target areas for recreation, and hubs of cultural integrity and heritage—are globally important ecosystems (UNCED 1992). Approximately 12% of the world's population depends directly on mountain resources (Huddleston et al 2003), and it has been estimated that the goods and services provided by mountains are important to at least half of humanity (Ives 1992). Therefore, as stated in Chapter 13 of Agenda 21, mountain environments are essential to the survival of the global ecosystem. However, they are rapidly changing and are susceptible to accelerated soil erosion, landslides, and rapid loss of habitat and genetic diversity. In addition, there is widespread poverty among mountain inhabitants and loss of indigenous knowledge. As a result, most global mountain areas are experiencing environmental degradation (UNCED 1992). The important mountain characteristics or conditions that distinguish mountain regions from other areas can be termed "mountain specificities" (Jodha 1992). These specificities consist of a set of conditions of which one subset (inaccessibility, fragility, and marginality) represents constraints, and another subset (diversity, niche/comparative advantage, and adaptation experiences) represents opportunities for development and poverty alleviation (Papola 2002).

This study compares and analyzes case studies from developing countries (DCs) and industrialized countries (ICs) using sustainability variables, and draws lessons learned and conclusions. This is done in the framework of a so-called Driving force–Pressure–State–Impact–Response Model (DPSIR Model).

Methodology

Case studies on SMD

In the course of the IYM 2002, more than 100 appropriate case studies (ie project reports, programs, and initiatives)

were collected to demonstrate the wide variety of approaches to SMD. A total of 40 of these were selected and analyzed in depth, in order to conduct this study. In a first step, the focus was on 22 case studies from Africa, Central and South America, and Asia. In a second step, in order to compare DCs with ICs, 18 case studies from Europe and North America were included. The majority of these cover Switzerland and the European Alps. In order to reduce the scope, case studies were chosen that deal with themes believed to be—by comparison with lowland areas—specifically important in mountain regions all over the world. These key themes include freshwater (upstream–downstream cooperation), mountain forests and forestry, mountain agriculture and land management, poverty, local and indigenous knowledge, migration, mountain tourism (eg Messerli and Ives 1997), and legislation on mountains (eg Villeneuve et al 2002).

This study does not address the foundation of the concept of sustainable development (SD) as such. However, its normative dimension is reflected in the views of those who authored the case studies, and thus in the selection of core issues and problems.

Driving force–Pressure–State–Impact–Response Model

The development of an information system for SD must occur within a framework (Schwabe 2002). One of the most commonly used frameworks for organizing the development and selection of variables and indicators is the Driving force–Pressure–State–Impact–Response (DPSIR) Framework, as proposed by the European Environment Agency (EEA, Copenhagen). In its original form, the DPSIR Model is a general framework for organizing information about the state of the environment. In this study, however, the DPSIR Model is adapted for use in relation to variable development and for classification of variables/indicators of SMD. This adapted model assumes that basic sectoral trends influencing SMD (Driving forces) generate stress related to environmental, social, and economic issues (Pressures), which influence the current condition of sustainability variables (States). The effects of changes of state (Impacts) finally require efforts by society to move towards SMD (Responses) (Figure 1, adapted and elaborated from OECD 1993; OECD 1998; Jesinghaus 1999). These Responses (eg, policy and management options to solve problems) are the actual sustainability variables and constitute the main output of this study. Nevertheless, it must be recognized that any framework by itself is an imperfect tool for organizing and expressing the complexities and interrelationships encompassed by SD (UN 1996).

Results

In case studies from DCs and ICs, application of the DPSIR Framework led to a total of 22 Responses. In most cases it was possible to draw a DPSIR control loop from the documents at hand. An example of a control loop for a "Mount Kenya" case study (Kiteme and Gikonyo 2002) is given in Figure 2.

FIGURE 1 The DPSIR Model for analyzing sustainability in mountain areas. (Adapted and elaborated from OECD 1993; OECD 1998; Jesinghaus 1999)

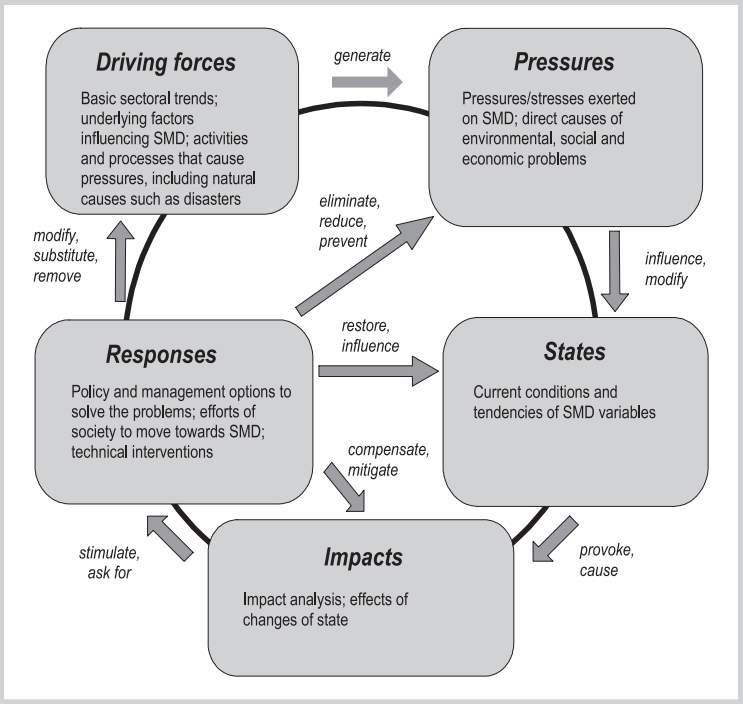
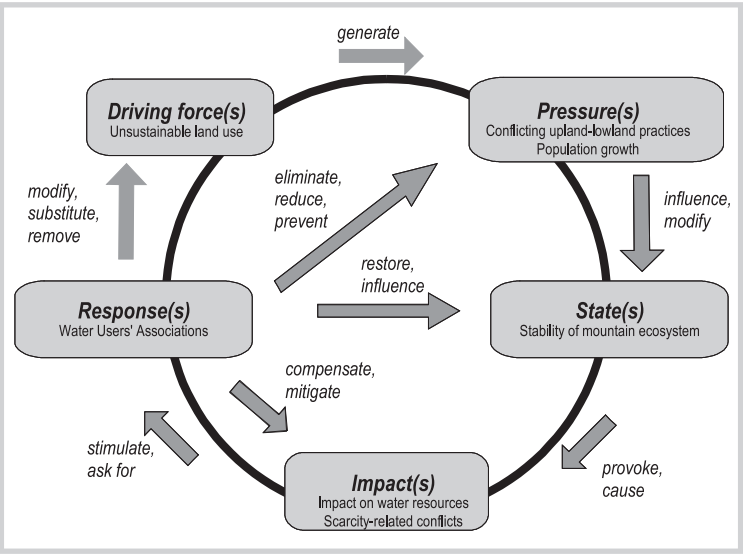


FIGURE 2 DPSIR control loop drawn from a selected case study. (Source: Kiteme and Gikonyo 2002)



Vision of a sustainable mountain area

The descriptive Table 1 integrates the Responses from case studies in DCs, and discusses best practices for a

TABLE 1 Vision of a sustainable mountain area. Responses that were found in the case studies from DCs that were analyzed are listed separately.

Vision of a sustainable mountain area	Mountain theme Responses from DCs
Governments need to be encouraged to produce and publish mountain-specific statistics, which are currently lacking, to improve policies for SMD. The development of new information and exchange networks dedicated to mountain issues will contribute to strengthened capacity to implement SMD. Furthermore, any SMD program or project should involve the stakeholders for whom the site under consideration has cultural significance. The needs and priorities of local communities need to be considered from the beginning. Mountain peoples and communities, including women, need to be involved in decision-making processes at the national level.	**Generic** • Gathering of baseline information • Building mountain networks (Mountain Forum) • Involvement of stakeholders in planning and development process (public participation) • Empowerment of mountain communities in decision-making processes
New livelihood opportunities to guarantee employment must be explored. An improvement in rural access roads leads to new opportunities for social and economic development and the development of the secondary and tertiary sectors. There are opportunities to generate income through trading activities (accessibility). Micro-enterprise banks could be set up to lend money to mountain women for income generation and educational advancement. External donors must support these internal development processes.	**Poverty** • Creation of new livelihood opportunities • Improvement of transport networks • Income generation through trading activities • Development of micro-enterprise banks • International cooperation through donor activities
Emphasis should be placed on the water sector: practices such as watershed management and hydropower generation may also lead to poverty reduction. Hydropower generation will increase as its extensive potential is developed in the future. Awareness of the importance of upstream–downstream linkages is increasing considerably, as most of the resource demand is in the lowlands, while many of the resources are in the headwaters. Promising types of upstream–downstream cooperation include Payment for Environmental Services, Water Users' Associations and Watershed Councils.	**Freshwater** • Watershed management • Hydropower generation • Payment for Environmental Services • Water Users' Associations • Watershed Councils
Sustainable mountain forest management is considered a key to the development of upland resources. Village-level forestry activities must be strengthened to establish, manage and harvest crops with the participation of the local population. The three main functions of mountain forests—the productive, the protective, and the cultural & amenity functions—can be approached through reforestation or the establishment of forest plantations.	**Mountain forests & forestry** • Sustainable mountain forest management • Community forestry management • Reforestation in mountain areas • Establishment of forest plantations
The principles and practices of sustainable mountain agriculture such as the use of internal resources and knowledge and the use of natural processes (eg nutrient cycling), are applied to improve smallholders' livelihoods. Pilot farms can be used as examples to train a large number of farmers who live under the same conditions and have the same natural resource potential. However, basic education is the cornerstone for environmental and development education.	**Mountain agriculture & land management** • Sustainable mountain agriculture • Practical education and training for mountain people in conservation and development
SD requires an immediate commitment of individuals and communities. To be committed, mountain people must have confidence in their own capacity and knowledge to deal with the many environmental challenges they face. Mechanisms to share the benefits of using traditional knowledge, innovations, and practices need to be established.	**Local & indigenous knowledge** • Promotion of mountain people's self-confidence • Documentation and communication of local knowledge

project aiming to promote SMD. Table 2 lists Responses found in case studies from ICs.

Discussion and conclusions

The main conclusion of this study is that the DPSIR Model was an adequate tool for deriving sustainability variables (Responses) in the SMD case studies analyzed. Although the sample of case studies analyzed is rather small, the documents analyzed support the conclusions made in this section. It is also understood that the vision presented in Table 1 does not cover all important aspects related to mountain areas. Most of the Responses found in case studies from ICs (see Table 2) also constitute appropriate policies in DCs (Price and Kim 1999). However, Responses from DCs and ICs are deliberately kept apart, in order to have a suitable basis for comparison. In order to fully discuss key themes that affect mountain regions, one would also need to deal with themes such as biodiversity, climate change, mining, energy production, education, gender issues, and conflicts or war-like activities.

Case studies in the context of DCs and ICs

Case studies in DCs often address generic issues, such as sustainable agriculture, whereas those in ICs address more specific issues, such as the concept of multifunctionality in agriculture. This explains the more specific Responses found in case studies from ICs. The reason for the difference is that case studies in ICs are usually conducted by academic institutions, while those in DCs are usually conducted by development organizations or state-based ministries. The underlying rationale is that in DCs, problems related to sustainability issues are much more apparent and urgent, while in ICs—where societies, from a technical point of view, are more complex—the approach is often to *steer* the future development of sustainability. Examples of the more technical context of projects in ICs include the use of scenario analysis techniques, GIS and the appliance of mathematical models, the use of input–output analysis as a tool, inter alia, to make predictions about future developments of the regional economy or the introduction of new telecommunication technologies.

It can be concluded that a DPSIR Framework as applied in this study is generally better suited to analysis of case studies from DCs than from ICs. The more specific a Response, the harder it was to create a control loop. Furthermore, it was interesting to see that—depending on the area in which it appears—a variable might be seen as a Pressure, an Impact, or a Response. One example is "out-migration:" this variable is usually an Impact, as Pressures such as poverty and environmental degradation force mountain people to migrate to the lowlands. In Bhutan, the situation is somewhat different: the percentage of labor in the agricultural sector is too high. If there were more urban development, out-migration from the rural mountains would be facilitated (Response) to meet the growing demand for new workers in the industrial and service sectors.

Interrelations between key mountain themes

The two Responses "involvement of stakeholders in planning and development process (public participation)" and "gathering of baseline information" are believed to be of utmost importance, as the framework

TABLE 2 Response variables found in case studies from ICs.

Mountain tourism
• Sustainable mountain tourism • Monitoring system for sustainable mountain tourism • Development of tourism in a qualitative direction • Promotion of ecotourism • Community-based nature tourism • Creation of resort marketing program • Creation of systematic growth management strategy • Creation of sustainable landscape management strategies • Creation of cross-border cooperation program • Income generation through tourism and recreation • Strategies for maintaining the agricultural labor market and activities
Demography
• Development of the secondary and tertiary sectors • Creation of additional employment opportunities in trade and tourism • Reliable subsidy from government for production • Creation of multi-service centers • Introduction of new communication technologies
Legislation
• Regional mountain-specific conventions • National mountain-specific laws • Establishment of mountain protected areas • Labels of origin for mountain products
Forestry
• Sustainable mountain forest management to yield positive externalities
Forestry and agriculture/land use
• Development of tools and models for sustainable mountain agriculture and forestry

led to these Responses in many case studies dealing with various mountain themes. The Responses "watershed management" and "hydropower generation" emerge in both water- *and* poverty-related case studies, indicating that these themes are closely linked: watershed management and hydropower generation may both lead to poverty alleviation. Since much of the freshwater in the world originates in mountain areas, capturing the value of this strategic resource can provide important economic benefits for mountain people. Generally speaking, one can conclude that poverty is also linked to such diverse issues as mountain agriculture, mountain forestry, mountain tourism, and demographic issues. There is a link between mountain agriculture and tourism. Agricultural activities have been the driving force for settlement of the Alpine region and the basis of subsistence for a long time; a high-quality physical and cultural environment in an area increases its tourist potential.

The major Driving forces and Pressures found in DCs (unsustainable agriculture and land use, weak or independent national economy; erosion, deforestation, shifting cultivation, low salaries, and savings) and for ICs (mountain tourism and recreation, demographic dynamics, globalization, building of tourist infrastructures, depopulation) support the conclusions in the following section.

Priorities for SMD in DCs and ICs

The lack of baseline data is without a doubt a serious obstacle when considering mountains in the developing world. While mountain populations are generally increasing in DCs, rural populations in mountain areas in ICs are generally declining and aging, owing to outmigration of a young labor force to lowland urban areas. The problem in many mountain areas in DCs is that mountain dwellers do not get the chance to outmigrate to the lowlands. One reason is that the weak economies of DCs cannot absorb migrants. Case studies that focus mainly on demographic aspects such as migration or population growth would be of great relevance to the scientific community.

While forests are generally expanding in Switzerland and many other ICs, it is a priority in the developing world to take care of remaining mountain forest resources. In many DCs, forests are overexploited owing to the high demand for firewood and agricultural land, and unsustainable forest practices. This issue is also linked to a key problem in DCs, namely the lack of access to resources, in particular to water in lowland areas. High levels of poverty in mountain regions can be partly explained by the "specificities" of mountain environments (Jodha 1992). By comparison with DCs, ICs are often better off with regard to "mountain specificities" such as inaccessibility or marginal development.

Tourism has become a major issue for mountain areas in both ICs and DCs; it is a great potential source of employment that has been shown to stabilize mountain populations and encourage growth. However, its environmental impacts and management have been studied much more thoroughly in Europe and North America than in the Southern Hemisphere.

As quoted in Villeneuve et al (2002), mountain law is still in its infancy: there are few mountain-specific legal instruments currently in force at either the national or international level. Attention should be given to shaping legally binding, mountain-specific international instruments, either globally or regionally, thereby including DCs.

Indicators are the most useful tools for measuring a concept as complex as sustainability. In order to generate *indicators of SMD* from Response variables, these would need to be made measurable.

ACKNOWLEDGMENTS

This paper was prepared at the Institute of Agricultural Economics (IAW) of the Swiss Federal Institute of Technology, Zurich (ETH), in collaboration with the FAO Zurich. The constructive input of Thomas Hofer of the FAO is gratefully acknowledged. I would also like to thank Prof Peter Rieder of the IAW for his support.

AUTHOR

Simon Odermatt
Baarerstrasse 60, 6300 Zug, Switzerland.
simon_oder@yahoo.com

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