

Responses to Ecosystem Change and to Their Impacts on Human Well-Being

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Main Messages	207
9.1 Assessing Sub-global Responses: Focus and “Lenses” Used	208
9.1.1 Response Features, Complexity, and Choices	
9.1.2 Institutions and Responses	
9.1.3 Resilience of Social-ecological Systems	
9.1.4 Selection of Responses and Methods for Assessing Effectiveness	
9.2 The Sub-global Findings on Responses	211
9.2.1 The Complexity of Sub-global Responses	
9.2.2 The Spatial Reach and Effectiveness of Sub-global Responses	
9.2.3 The Dynamic Nature of Responses	
9.2.4 The Effectiveness of Multilevel Responses	
9.3 Impacts and Effectiveness: Lessons Learned	215
9.3.1 Collaboration: The Interplay of Informal and Formal Institutions	
9.3.2 “Bridging Organizations” Facilitate Multiscale Collaboration	
9.3.3 Economic and Social Incentives	
9.3.4 The Reach of Sub-global Responses	
9.3.5 Synergy and Coherence	
9.3.6 Technology and the MA Conceptual Framework	
9.4 Lessons Learned for Future Assessments	220
APPENDIXES	
9.1 Thirty-seven Important Responses Reported by Different Sub-global Assessments	222
9.2 Features of the 37 Most Important Responses Reported by the Sub-global Assessments	225
REFERENCES	227

BOXES

- 9.1 Responses and Social-ecological System Resilience
- 9.2 Taking Advantage of Policy Windows: Sweden KW and South Africa
- 9.3 Bottom-up and Top-down Collaboration: Sweden KW, Laguna Lake Basin, and India Local
- 9.4 Wildlife Management Areas in Papua New Guinea: A Colonial Response with Unexpected Results
- 9.5 Public and Private Sector Actions: San Pedro de Atacama
- 9.6 Government–Community Co-management of a Sea Urchin Fishery: St. Lucia, Caribbean Sea
- 9.7 Aggregated Responses: São Paulo and Sweden SU

FIGURES

- 9.1 Four Features Used for Assessing Sub-global Responses: Multiplicity of Actors, Organizational Levels, Knowledge Systems, and Instruments of Action
- 9.2 Responses Using National Legislation as an Instrument May Be Different in Features and Complexity
- 9.3 Four Features of Responses for Three Sub-global Responses Where Bridging Organizations Played a Major Role

Main Messages

Declining ecosystem trends have been halted, and in some cases reversed, by innovative local responses. The “threats” observed at an aggregated, global level may be overestimated or underestimated from a sub-global perspective. Assessments at an aggregated level often fail to take into account the adaptive capacity of sub-global actors. Through collaboration in social networks, actors can develop new institutions and reorganize to mitigate declining conditions. On the other hand, sub-global actors tend to neglect drivers that are beyond the reach of their immediate influence when they craft responses. Hence, it is crucial for decision-makers to develop institutions at the global, regional, and national levels that strengthen the adaptive capacity of actors at the sub-national and local levels, so that context-specific responses that address the full range of relevant drivers may be developed. This means neither centralization nor decentralization, but instead institutions at multiple levels that enhance the adaptive capacity and effectiveness of sub-national and local responses.

All policy tools (instruments for executing responses) are by definition implemented in a specific institutional context. A focus on strengthening adaptive capacity and institutional interaction is more important than assessing individual policy tools in isolation. The sub-global assessments provided clear examples of various instruments for executing responses. The potential effectiveness of each instrument is increased if general legislation and economic incentives provide an enabling institutional framework, if a blend of scientific and more context-specific knowledge systems is used in crafting the response, if the dominant value system acknowledges the complexity of ecosystem dynamics, and if institutional interaction is benign. Natural resource management always involves conflicting interests, and the main lesson learned from this assessment of responses is that innovative ways of collaboration and conflict resolution, together with a reasonable legal and economic framework, are often crucial for effective responses.

The effectiveness of a response seems correlated to the degree of coherence among different types of policies and the degree of collaboration among stakeholders. Horizontal (multisector) collaboration ensures that multiple objectives (ecological, social, cultural, economic) are addressed in an integrative fashion. Vertical (multilevel) collaboration facilitates generation of resources and increases the probability that responses have a positive impact on the direct and indirect drivers of ecosystem change. Since these drivers typically occur at a continuum of social and ecological scales, responses would need to involve decision-makers (and action takers) at multiple organizational levels. For instance, local responses such as coping and adapting to environmental change among the Bedouins in Egypt and local communities in southern Africa have been largely ineffective due to the lack of institutional and financial support at the national level. In contrast, local people in the Eastern Himalayas took the initiative to form Eco-Development Committees, and this became an effective response. Collaboration, therefore, is not only a local phenomenon; it has been initiated by all categories of actors operating at all identified organizational levels.

Research institutions and the business sector initiated very few of the responses reported by the sub-global assessments. More often, they became involved in the responses at a later stage. Response initiatives by research institutions were found to be focused on initiating collaboration with other stakeholders. Examples of response initiatives by the business sector are found in Northern Range, Trinidad, where two banks initiated environmental projects with long-term commitment, and in Portugal, where the pulp and paper industry has taken voluntary initiatives to improve its forestry management.

Multiple drivers of ecosystem change have been addressed by integrated policies as well as targeted responses. To be effective, responses often need to address a range of drivers and interactions of human and ecological systems. Sometimes responses need to occur as a chain of actions to match the reach and interactions of the drivers of change. For instance, the new government policy for Western China is an integrated response including a series of interventions to combat poverty while at the same time halting current declining trends in several ecosystems. On the other hand, in some cases, a targeted action appears more effective, as illustrated by the South African Water Act of 1998, which was an effective response to several conflicts and drivers.

A set of responses may be mutually strengthening and reinforcing, but could undermine each other if they lack coherence among themselves. Institutional coordination is crucial to create enabling conditions. For instance, actors with different authorities or mandates may have potentially high organizational and institutional capacities for effective responses, but this potential may not be realized due to the inability to coordinate actions among actors at the same or different organizational levels. One example of this is various citizen actions to halt urban sprawl in Stockholm, Sweden. These actions have been supported by decision-makers at municipal and higher organizational levels. However, due to compartmentalization, decision-making is divided between different sectors, resulting in inconsistent policy proposals (conservation versus development). In this case, the administrative structure inhibited effective conflict resolution.

Collaboration among actors is often facilitated by “bridging organizations.” These provide arenas for multisector and/or multilevel collaboration for conceiving visions, trust-building, collaboration, learning, value formation, conflict resolution, and other institutional innovations. Bridging organizations lower the transaction costs of collaboration and crafting effective responses. They provide social incentives to identify unique win-win responses. The facilitation, leadership, and social incentives provided by bridging organizations or key persons in the community appear to be essential for capacity-building. The following three examples illustrate the formation of bridging organizations resulting from bottom-up, top-down, and external initiatives, respectively: (1) in Kristianstad Wetlands, Sweden, a new organization called Ecomuseum has initiated a process based on collaboration, trust-building, and conflict resolution; voluntary participation within the existing legal framework is transforming a declining area into a UNESCO Biosphere Reserve; (2) in the Laguna Lake Basin, Philippines, public agencies and nongovernmental organizations formed River Rehabilitation Councils that have been able to address social and ecological drivers in a collaborative and effective way; (3) in San Pedro de Atacama, Chile, the assessment team provided an arena for collaborative learning, trust-building, visioning, and conflict resolution.

Insights from sub-global assessments are extremely useful if one wants to understand the social dynamics underlying effective responses. Social, behavioral, and cognitive changes were involved in half of the reported sub-global responses. Conflicting world-views (assumptions about the relationships between humans, nature, and society) often underlie and explain conflicts over natural resource management. Hence it seems reasonable to address these issues in responses as well as in assessments of responses. The dynamics of “bridging organizations” and the fine-grained interplay between formal and informal institutions are only discovered in sub-global assessments. These dynamics underlie the adaptive capacity of sub-global actors to mitigate declining conditions and trends of ecosystem services observed at an aggregated level. In several cases, research institutions and assessment teams have enhanced this capacity (for example, in the Tropical Forest Margins assessment, where land and tree tenure reform in Indonesia was facilitated by the Alternatives to Slash-and-Burn program of the CGIAR).

When people with different interests, experiences, and knowledge cooperate across organizational levels, the diversity of response options increases and this enhances the potential effectiveness of responses.

Besides the democratic appeal of public participation, the knowledge base is broadened when local, traditional, and indigenous knowledge systems are acknowledged. By close monitoring of a diverse set of ecological variables, local stewards are often able to observe and understand early signals of ecosystem change and to distinguish this from natural variability. In Kristianstad Wetlands, Sweden, for example, local steward organizations observed declining bird populations and other signals that sparked the formation of a bridging organization. Successful integration of different knowledge systems underlies several of the effective sub-global responses; for example, the Mangrove Marine Reserve in the Caribbean Sea resulted from collaboration between an NGO and local users that was aimed at meeting the needs of local users for fuelwood.

9.1 Assessing Sub-global Responses: Focus and “Lenses” Used

The MA conceptual framework suggests that responses occur when ecosystem changes and their effects on human well-being are perceived to pose either opportunities or threats to the well-being of societies and communities (MA 2003). The responses observed in the MA sub-global assessments offer insights on the variety of ways in which people respond to these changes. As used in this chapter, “sub-global responses” pertain to responses observed in the particular places and times of each sub-global assessment. In this sense, a sub-global assessment is itself a “response.”

This chapter assesses four features of responses to ecosystem change that are also used elsewhere in the MA process to characterize responses. (See Chapters 5 and 11 in this volume, and also Chapters 2 and 15 in *MA Policy Responses*.) It then examines the findings from the assessment of sub-global policy responses, as well as the lessons that can be learned from the process.

9.1.1 Response Features, Complexity, and Choices

The sub-global assessments reported a diversity of responses that may be assessed according to four features:

- The *actors* initiating and executing/implementing the responses vary among the sub-global assessments. At least six categories of actors were observed: (1) governments at national and/or sub-national levels; (2) international and national organizations other than governments; (3) research institutions; (4) the business sector; (5) communities (which include local civil society organizations, leaders, and sometimes local governments); and (6) individuals and households. This categorization of actors resulted from an iterative process adapted to the contexts described by the sub-global assessments. This is consistent with observations from elsewhere; examples include Imperial and Hennessey (2000) on “portfolio of actors”; Ayudhaya and Ross (2000) on “shared vision” of different actors as being critical to the success of watershed management in Thailand; Dangbegnon (1996) on resource management in Lake Aheme, Benin; and Clarke (1998) on how NGOs affect policy in Asia.

- The *organizational levels* at which actors initiate or execute responses may either be (1) local, (2) sub-national, (3) national, (4) regional, or (5) global, or a combination of these levels.
- The *knowledge systems* of the actors are referred to in one of three ways: (1) scientific knowledge (the use of formal methods of science); (2) local knowledge (based on site-specific experiences of the actors); and (3) traditional/indigenous knowledge (based on how a particular community of actors has, over generations, uniquely accumulated a combination of knowledge and practices that is now embedded in their culture). (See Chapter 5 for a more detailed discussion of these knowledge systems; the categories and definitions given here are for the limited purpose of referencing the degree to which knowledge systems are used and combined in a response.)
- The *instruments* for executing/implementing responses may come in any of five categories that may be combined in a single response: (1) interventions directly affecting the resource base and state of ecosystems (direct human actions on ecosystems such as reforestation); (2) technological innovations/dissemination (using techniques yet unused to address a problem); (3) statutory (legal) devices and economic incentives; (4) organizational devices (the formation of new entities for collaboration among actors); and (5) social, behavioral, and cognitive change (for example, reorientation of values). (See similar discussions in *MA Policy Responses* and in the MA conceptual framework.)

A response involving *multiple* actors, levels of organization, knowledge systems, and instruments of action can be recognized as being more complex than one that involves less. Increasing the complexity of a response (for example, through stakeholder collaboration) may be adequate to address the complexity in governing common-pool resources (Dietz et al. 2003), but this entails a variety of costs (social, political, financial, economic, and technological; for example, see Allen and Schlager 2000; Saxena 1997); these costs imply that a response’s degree of complexity will demand a corresponding level of resources from actors to initiate and implement that response. The choice made in relation to the degree of complexity could determine the extent to which a response can be sustained (for example, see Baland and Platteau 1996; Bebbington 1997; Contreras 2003; Magno 2001; Ostrom 1999).

An alternative interpretation of complexity would be to focus on the *content* of a response. But this would entail a very elaborate and detailed study of individual responses, which would be difficult since many MA sub-global assessments were not yet complete at the time of writing this report. This chapter therefore focuses on the *complexity* of a response with reference to its four features. (See Figure 9.1.) However, sometimes so many actors and instruments are involved in a response that it may be more reasonable to view its complexity as one body of several interrelated responses (see discussion below).

From the outset, there was no *a priori* assumption made about the merits of complex responses. It is only acknowledged that the responses observed and reported in the sub-

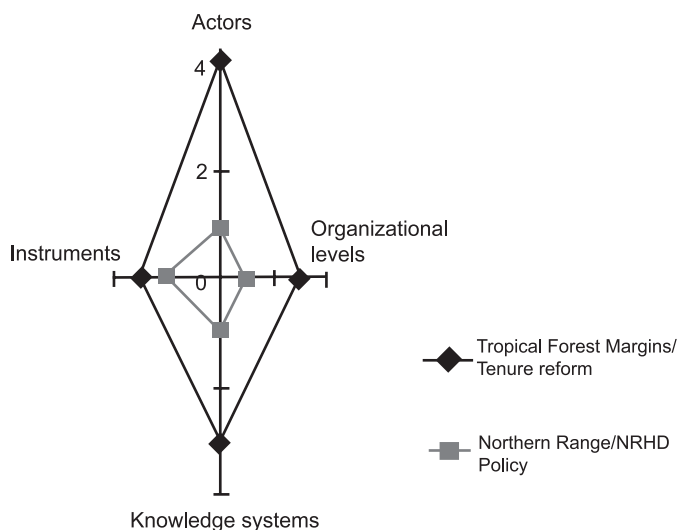


Figure 9.1. Four Features Used for Assessing Sub-global Responses: Multiplicity of Actors, Organizational Levels, Knowledge Systems, and Instruments of Action. In this chapter a complex response is defined as one involving several actors, organizational levels, knowledge systems, and instruments of action. The tenure reform of the Tropical Forest Margins Assessment was an effective response, thanks to good collaboration among several actors at several organizational levels acknowledging several knowledge systems and using many instruments of action. The NRHD Policy of Trinidad (Northern Range) was good but suffered from lack of collaboration, which impeded implementation and was therefore ineffective (see Appendixes 9.1 and 9.2). However, low complexity need not impede effectiveness (see Figure 9.2).

global assessments can be appreciated—and assessed—for patterns, trends, and lessons presented by their complexity.

9.1.2 Institutions and Responses

Responses always take place in the context of legal arrangements (formal institutions) as well as social norms and conventions (informal institutions). The collective infrastructure of regulations, organizations, markets, technology, culture, and traditions shape the reach and limits of what people can, may and must do in a given place and time, under certain conditions of their environment (see, for example, Edmunds and Wollenberg 2003 on devolution and forest resource management; Fischer et al. 2002 on mitigating agricultural vulnerability from climate change; Allen and Schlager 2000 on covenant institutions; and Bruns and Meinzen-Dick 1998 on legal pluralism). Rules and norms form economic and social incentives by rewarding or punishing environmental degradation (ENRAP 1996). Institutions play a role in the initiation and execution of responses, including by determining the distribution of transaction and other costs (North 1990). In turn, responses alter the institutional arrangements that define the choice sets of individuals and groups (Bromley 1990). Institutions provide the enabling conditions for (or present bottlenecks to) the successful initiation and execution of responses.

When actions are combined, the norms, standards, and rules that govern each one come into critical play. They

may either facilitate or hinder the ability of the actions to complement one another (for example, see Liu 2001; Utting 2000; Johnson et al. 2001; Imperial and Hennessey 2000; Ostrom 1999; Bruns and Meinzen-Dick 1998; Oram 1991). Institutions can operate at local levels (for example, among artisanal fishers in Lake Benin; see Dangbegnon 1996) or at global levels through treaties and international agreements (for example, UNCED 1992 and WSSD 2002).

In the MA context, “freedom” is related to the options and choices for action offered by institutions (rules and social norms) and by the condition of ecosystem services. Freedom and the condition of ecosystem services can be positively or negatively related. Institutions that protect ecosystem integrity in order to sustain ecosystem services (for example, carbon taxes) contribute positively to long-term human well-being. However, such institutions are popularly described as decreasing the freedom of the present generation to maintain its material standard of living. The freedom of the present generation may need to be compromised if the aim is to maintain freedom, opportunity, and human well-being for future generations. If this is the case, institutions should be evaluated according to how well they increase the social capacity to sustain the ecosystem services necessary for long-term human well-being. The challenge, it appears, is to develop a fine interplay between formal and informal institutions in order to minimize the perceived trade-offs between short-term and long-term freedom (discussed further below).

9.1.3 Resilience of Social-ecological Systems

This assessment recognizes that sub-global responses are best understood when viewed in the context of the particular social-ecological system in which they take place. The ability of a system to absorb shocks (as might come from changes in its social and ecological components) could determine the choice of responses made. Hence, in this assessment, it is assumed that effective responses (responses that affect existing conditions and trends of ecosystem services and human well-being) involve addressing ecological and social dynamics together. The system of analysis is neither natural nor social but a linked social-ecological system. (See Box 9.1.)

9.1.4 Selection of Responses and Methods for Assessing Effectiveness

The MA sub-global assessments reported over 50 responses observed at their assessment sites. Thirty-seven (37) responses from 18 sub-global assessments were deemed sufficiently described for the purposes of this chapter. The sub-global assessment teams were asked to justify the selection of responses: why were the identified responses important? The most common answer was that the response addressed pressing ecosystem issues, often in a comprehensive or holistic way (as stated by the assessment teams). The justifications for each of the selected responses are stated in Appendix 9.1, which also summarizes the key issues addressed in each sub-global assessment and briefly describes the 37 responses selected for analysis in this chapter.

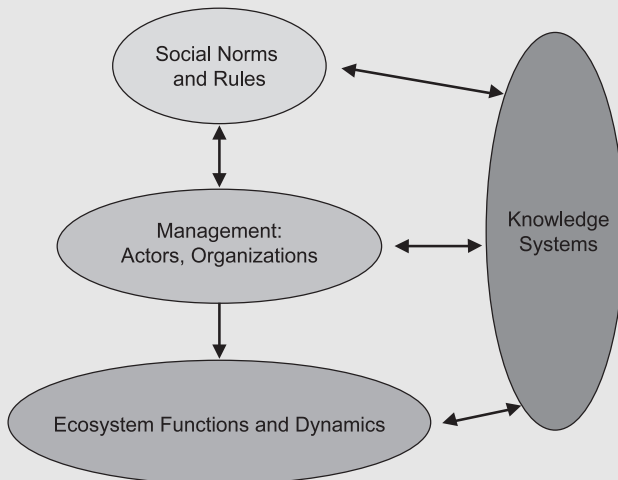
BOX 9.1

Responses and Social-ecological System Resilience

The concept of resilience is tightly connected to the diversity and the sustainability of social-ecological systems (Gunderson and Holling 2002; Berkes et al. 2003; Lele 2000). Responses that increase losses of diversity may pave the way for sudden drastic switches and stochastic events like shocks and surprises (Scheffer et al. 2001). Resilience has three defining components (Gunderson and Holling 2002):

- the capacity to absorb shocks or disturbances (while retaining the same controls on function and structure);
- the capacity to self-organize (to reorganize endogenously, in the absence of external drivers); and
- the ability of a system to invent creative solutions in response to change.

As the figure below suggests (modified from Hahn et al. in press), a social-ecological system consists of three parts: the first concerns the capacity of ecosystems to generate ecosystem services, the second concerns how different management practices influence ecosystem capacity, and the third concerns the underlying institutional capacity of ecosystem management. Signals and feedback from the ecosystems are interpreted by knowledge systems that in turn are fed into, and influenced by, management organizations and institutions.



Resilience in a social-ecological system depends on the capacity of ecosystems as well as social capacity to respond to ecosystem change in a way that sustains and enhances the capacity of ecosystems to generate essential ecosystem services (Folke et al. 2003). "Social capacity" in this context includes organizational capacity (organizations capable of executing responses) and institutional capacity (the rules and social norms underlying these organizations). Social capacity can also be understood as capital defined to include social capital (trust, skills in collaboration and conflict resolution, etc.; see, for example, Pretty 2003); human capital (advancement in different knowledge systems); and cultural capital (beliefs about how people, nature, and society are related, sometimes called a worldview; see Adams et al. 2003; Berkes and Folke 1994; Castro 1984; Contreras 2003; and Gatmaytan 1992).

Resilience is particularly crucial to how people understand vulnerability (both their own and that of their environments). Thus resilience bears directly on how actors shape and design their responses, including the trade-offs that they may decide to incur between complexity and reach of their responses.

The sub-global assessment teams were asked whether the responses observed in their assessments appeared to be effective or not. This was not an easy task: it is widely known that for effective decision-making, political, institutional, economic, social and ecological implications across various domains should be identified and analyzed. Where this is not done adequately, many strengths and weaknesses of responses might not be fully considered by decision-makers. The implementation of the idea of integrated assessment requires extensive resources, because it needs to recognize the multidimensional nature of impacts; it also requires methods that are sensitive to a plurality of perspectives from diverse scientific and other disciplines. Decision-makers are often subjective when judging the success or failure of a response. Along any one dimension, using any particular criterion for assessment, the evaluation process can distinguish between constraints that render a policy option unfeasible, and those considerations that, while important, may be treated as costs associated with the implementation of an option that stakeholders might be willing to bear. (See *MA Policy Responses*, Chapter 3.)

An assessment of responses may be an enormous task; it is worth doing, however, as it becomes a guiding element for decision-makers. Evaluations of the human dimensions of ecological responses are bound to be subjective. Decision-makers must be geared to face the situation where consensus is rare and conflict is in abundance. Important steps that should be taken to limit potential conflict include emphasizing inclusive evaluation processes, so that assessments are not only done by elite decision-makers; maintaining transparency and accountability throughout the assessment process; and ultimately, developing responses that are flexible enough to maintain their effectiveness despite dynamic social and ecological conditions. (See *MA Policy Responses*, Chapter 3.)

In the sub-global assessments, an *effective* response improves the condition of ecosystems services and human well-being (or at least improves one without reducing the other). Acknowledging the difficulty in assessing the effects of responses, the sub-global assessment teams were also asked whether the social capacity to organize effective responses had increased in their assessment areas as a result of a given response. If so, that response was viewed as *promising*. (See Appendix 9.2.) This is consistent with the resilience framework which assumes that social capacity-building is crucial for enhancing ecological capacity to generate ecosystem services.

The fact that responses have been an interest of the sub-global assessment teams may have resulted in some bias toward successful or effective responses. Hence, the selection of responses analyzed should not be viewed as a random sample of "what is going on at the sub-global level." Ideally, each sub-global assessment would have identified responses and *non-responses* to the most pressing conditions and the most important trends and drivers in ecosystems, and assessed the institutional capacity to undertake appropriate responses. Such a rigorous approach was applied to varying extents in the sub-global assessments. Nevertheless, the reported 37 responses offer good insights into the dy-

namics of social-ecological systems in different parts of the world, along with several emerging lessons learned.

As was mentioned earlier, many sub-global assessments are still on-going and it is too early to evaluate the long-term success or failure of the reported responses. Some responses can be interpreted as ineffective in terms of not appearing to reverse or halt current trends in declining ecosystem services. However, these are not necessarily “bad” responses; ineffective responses may have more to do with the actors’ lack of economic and political power (see discussion below).

9.2 The Sub-global Findings on Responses

9.2.1 The Complexity of Sub-global Responses

Most of the 37 responses were complex. They involved multiple actors initiating and executing actions at many levels of organization, and using a variety of knowledge systems and instruments of action. The complexity of responses seems to cut across all sub-global assessments.

9.2.1.1 Actors

The most common responding actors were governments at national and/or sub-national levels, followed by communities (which include local civil society organizations, leaders, and sometimes local governments). Research institutions and the business sector initiated very few of the responses reported, although they more often became involved in the responses at a later stage. For almost all reported sub-global responses, several actors were involved in the execution/implementation. (See Appendix 9.2.)

Actors have varying roles and capacities to shape and reshape responses. For example, an actor may have developed a good proposal to respond to declining ecosystem services. However, good ideas are not sufficient. The problem that the proposal responds to must be perceived as pressing to the political community, and there must be political momentum and a politician who is able to push and negotiate the proposal through the political process. When these occur, policy windows are opened (Kingdon 1995). (See Box 9.2.)

9.2.1.2 Organizational Levels

A coordinated response that embraces more than one organizational level entails vertical or multilevel collaboration.

Coordination occurs generally when institutional interactions are benign (Young 2002), which may be hard to assess. For instance, in India, forest ecosystem services for decades were managed formally at the sub-national (state) level, except for national parks, which were managed at the national level. When new biodiversity management committees were created after the Biological Diversity Act was passed in 2002, village councils (which are elected bodies at the local community level) suddenly had legal power to co-manage forests. This multilevel institution for forest management may result in eroded legal power at the sub-national (state) level unless the state Forest Departments find new ways to collaborate with the village councils. (See

BOX 9.2

Taking Advantage of Policy Windows: Sweden KW and South Africa

According to Kingdon (1995), the simultaneous existence of a perceived pressing issue (problem stream), a proposal suggesting a solution (policy stream), and political momentum (political stream) explain political decisions. The policy entrepreneurs perform the function for the system of coupling the previously separate streams. Two forces may open a window: either decision-makers become convinced that a problem is pressing and seek a policy (problem-driven window) or they adopt a theme for their administration and look for problems that may justify change and proposals that support their theme (politically driven window). The window opens because of some factor beyond the realm of the policy entrepreneur but this person/group takes advantage of the opportunity. Different interest groups usually develop certain policies and proposals and then wait for problems to come along to which they can attach their solutions, or they wait for a development in the political stream that favors their proposals.

For Kristianstad Wetlands, Sweden, a policy window was open at the municipal level after the national election in 1988 that highlighted environmental issues. A policy entrepreneur (who became the director of Ecomuseum Kristianstad Wetlands in 1989) had already formulated a proposal based on the vision of an ecosystem approach and managed to generate broad support for this among local stakeholders. A key politician was willing to push the proposal through the decision-making process. Three factors were necessary to enable this response: the existence of a proposal, an open policy window, and a top politician who pushed the proposal through the political process (Olsson et al. 2004b).

The democratic transition in South Africa in 1994 opened a policy window for water management. The new government established a national panel representing all interest groups to craft the National Water Act of 1998. The Act gave priority in the allocation of water to basic human needs and the needs of aquatic ecosystems, and established a framework for the rational allocation of the remainder. This new legislation was based on the principles of equitable benefit-sharing, ecological resilience, and efficiency, and marked a dramatic shift from the previous water legislation that favored the agricultural sector and gave riparian rights to landowners (Bohensky et al. 2004).

Box 9.3 for this and other examples of sub-global responses with successful multilevel collaboration.)

Multilevel collaboration sometimes involves conflicting priorities. In the Caribbean, the U.N. Resolution on Integrated Management of the Caribbean Sea emphasized co-management of marine resources at the regional level. While this provided a collective framework for management, to date there has been no organized progress on implementing the commitments to, or exploiting the opportunities of, this Resolution. Moreover, the different historical legacies, languages, cultures and traditions, and norms and legislation of the 33 participating countries pose (often serious) constraints on their cooperation (Caribbean Sea).

Western China has succeeded in some responses through integrated government policy. This includes a series of local interventions, in collaboration with local governments, to combat poverty while at the same time halting current de-

BOX 9.3

Bottom-up and Top-down Collaboration: Sweden KW, Laguna Lake Basin, and India Local

A response executed by the public sector may be based on ideas and initiatives from any stakeholder. For instance, in Kristianstad Wetlands, Sweden, the municipal response was sparked by the vision of one key individual and developed into a proposal in collaboration with a few stakeholders across sectors (environment, agriculture, tourism, and university). This proposal was adopted by the municipal executive board and turned into a policy for ecosystem management. The number of stakeholders involved increased during the trust-building and learning process of implementation, resulting in horizontal (multisector) and vertical (multilevel) networks. The latter have been important to attract project funds from the national and EU levels. Thus a bottom-up initiative has resulted in a flexible, cost-effective project organization that has succeeded in applying the ecosystem approach and adaptive co-management to water resources without changing the legal framework (Sweden KW; Hahn et al. in press).

Laguna Lake Basin illustrates successful collaboration through top-down initiatives. The Laguna Lake Development Authority responded to declining water quality by forming River Rehabilitation Councils to address the pollution coming from the lake's 22 tributaries. The councils are composed of people's organizations, environmental groups, industry representatives, and local government units, with the Laguna Lake Development Authority as the facilitating institution. The involvement of civil society has proven to be crucial to resolving major conflicts (for example, industry versus community; fishery versus industry; agriculture versus conversion of land to other uses). The multisectoral nature of the councils has resulted in a sustained clean-up of some tributaries, thereby reducing pollution loading in the lake (Laguna Lake Basin).

India's Biological Diversity Act of 2002 aims to achieve cooperation from the range of resource users through a multiscale management approach. This involves the establishment of biodiversity management committees at the *Panchayat* (village council), municipality, and city corporation levels, to complement the State Biodiversity Board and National Biodiversity Authority. The recognition that critical biodiversity knowledge is also held at the grassroots level is reflected in this decentralized management approach. Effective implementation of the Act will rely on global, national, and local information. For example, the selection and preservation of threatened species requires information on global and national socioeconomic factors, local tenurial arrangements, and site-specific biodiversity. Thus the layered documentation will provide a valuable knowledge base to underpin decision-making at each management level as well as across the multilayered management structure (India Local).

clining trends in several ecosystems. One effective intervention is the Grain for Green Project, in which degraded farmland or slopes are converted back to forests or grasslands. Farmers receive monetary compensation and also benefit from the trees, shrubs, and grass (Western China).

Integrated responses involving stakeholders at several organizational levels are not a goal in themselves; in some cases, a targeted action by a single actor using a single instrument was effective. This is best illustrated by the South African Water Act of 1998, which was an effective response to several conflicts and drivers.

In the Southern Africa local assessment, responses by households and communities were successful in maintaining a diversity of livelihood strategies. However, these households and communities are often unable to deal with the drivers of social and ecological change (such as macro-economic policies, government inefficiencies, diseases and epidemics, and climate fluctuations). Households and communities often do not have sufficient capacity to involve agencies and other actors at higher organizational levels to address local concerns. Hence responses generally appear insufficient or ineffective in terms of their ability to reverse or halt current trends in declining ecosystem services. These are not necessarily "bad" responses but reflect the actors' lack of power or organizational and institutional capacity. One important reason behind the failure of some responses is the lack of collaboration between local and national levels of decision-making. In situations without collaboration, governments may respond to water scarcity, for example, by building a dam, but the benefits may not accrue to local people, who often do not have access to municipal water services and instead must resort to alternative responses such as storing water in individual small, mobile containers. Local people are frequently averse to large dams and other large infrastructure because they take up valuable grazing land, reduce the diversity of options, and often do not benefit people in the immediate vicinity.

The only ineffective response highlighted by a sub-global assessment involving more than one organizational level was the creation of wildlife management areas in Papua New Guinea. In this case, local and national actors had different objectives (not just different priorities) resulting in an *uncoordinated* response. (See Box 9.4.) Hence, a multiplicity of organizational levels does not automatically enhance response effectiveness (discussed at greater length later in this chapter).

9.2.1.3 Knowledge Systems

There tended to be spontaneous and extensive mixing of knowledge systems in the sub-global assessment responses, reflecting ubiquitous multi-actor collaboration. Scientific knowledge was used to craft 34 of the 37 selected responses; where scientific knowledge was not used, responses appear to have been ineffective. (See Appendix 9.2.) The ineffectiveness of these responses may, however, be attributable to other factors, such as power imbalance and conflicting interests between local people and central authorities, rather than lack of adequate knowledge. Local ecological knowledge was used in 25 responses but never as the sole source of knowledge. Traditional/indigenous knowledge was used in 13 responses but never together with scientific knowledge unless local knowledge was also involved. This suggests that local ecological knowledge might actually serve as a bridge between scientific and indigenous knowledge. Ten of the selected responses used a combination of all three types of knowledge.

As was the case with multiple organizational levels, the multiplicity of knowledge systems did not automatically enhance the effectiveness of a response. For instance, in San Pedro de Atacama, an area of indigenous development had been established, in which government departments and

BOX 9.4

Wildlife Management Areas in Papua New Guinea: A Colonial Response with Unexpected Results

Wildlife management areas were established in Papua New Guinea under legislation passed at the end of the colonial period to mitigate the threat to biodiversity that was thought to have arisen as a result of the acquisition of shotguns by local villagers. The legislation allows a local community to have a portion of its territory designated as a wildlife management area and then to establish a management committee that would make and enforce its own rules to regulate hunting activities within the protected area. This is still the only effective legal instrument in Papua New Guinea for the protection of biological diversity in areas held under customary ownership.

In practice, local communities have commonly used the WMA designation as a device to register claims to their traditional territorial domains against the claims of neighboring groups of customary landowners. Only in a minority of cases have they been persuaded by nongovernmental organizations to adopt this measure as a response to the anticipated loss of biological diversity. Even where WMAs are providing biodiversity protection, there is nothing in policy or legislation to prevent government agencies from negotiating with local landowners to include the WMA within an area allocated for resource development that might threaten biodiversity. Local landowners will commonly take this development option because it enables them to establish another kind of legal claim to customary ownership of their resources, as well as to secure a share of the resource rent generated by the development process.

In the meantime, the original rationale for the legislation creating wildlife management has largely disappeared, because the cost of buying shotguns and cartridges now exceeds the monetary or subsistence benefit that can be derived from their use.

representatives from local indigenous communities might work together toward developing the area. Multiple initiatives have been undertaken to recover the local communities' traditions and indigenous knowledge on such matters as health, education, and community development. However, these have yet to be incorporated into the ADI's formal decision-making processes, where discourse is still in the language of science and bureaucracy. Still, the institutional capacity for responses has increased with the ADI and the new advisory committee for that sub-global assessment. (See Box 9.5.)

9.2.1.4 Instruments of Action

The most common instruments of action employed in the 37 selected responses were organizational devices, that is, the formation of new entities for collaboration among actors (27). This is followed by statutory/legal and economic devices (21), and social, behavioral, and cognitive change (20). Direct interventions and technological innovation or dissemination were not frequently an important part of the reported sub-global responses; apparently the assessment teams regarded collaboration and other institutional innovations, initiated by new organizations, as more important.

Organizational devices are formal and informal measures to organize multi-actor collaboration. For most responses, this involved the formation of new organizations with spe-

BOX 9.5

Public and Private Sector Actions: San Pedro de Atacama

The Antofagasta region in northern Chile has low social capital, with a poor associative capability and a weak sense of belonging among its people. However, the municipality of San Pedro de Atacama, presents a different situation, with strong associative and organizational capability and an unprecedented opportunity to respond to challenges raised by ecosystem change.

The ADI (*"área de desarrollo indígena"* or area of indigenous development) is the mechanism used to coordinate *public sector* decisions and priorities. It seeks to bring national scale institutions in touch with specific local situations. Here, public sector bodies set out their priorities and decisions with the Atacameño community, and agree on priorities or coordinated efforts in order to achieve certain objectives. Although this initiative has only been in effect since 2002, it has contributed to reducing communities' distrust of the public sector. Unfortunately, ecosystem changes have not yet become a focus for the ADI's work issues and objectives.

All the *private sector* institutions and stakeholders with influence in the area, such as mining and tourism companies, are excluded from the ADI. In the community this has generated the perception of two separate and opposing blocs. To overcome this division, the sub-global assessment team set up an advisory committee (*Grupo Asesor*) that includes the private sector. The advisory committee provided an arena for dialogue and decision-making. Area leaders and key sector representatives for the Salar de Atacama's ecosystem were invited to participate.

The advisory committee was made up of 16 representatives from different sectors and interest groups, and held regular meetings. Following its first meeting in October 2003, participants stated that this was the first time public and private sector bodies and community representatives had sat down together to discuss the ecosystem and local development. Capacity-building was reinforced through scenario workshops undertaken in late 2004.

cific management responsibilities (for example, the River Rehabilitation Councils in the Philippines) or devolution of management authority (for example, biodiversity management committees in India Local and the co-management arrangements in St. Lucia, Caribbean Sea; see Box 9.6). Some responses rely on informal measures (for example, Sweden KW), which illustrates how collaborative learning in social networks without any formal power to set or enforce rules can solve conflicts and pave the way for effective responses. The joint forest management organizations in India Local started as an informal collaboration but later acquired statutory status. These collaborations between the local and sub-national/national levels provide conflict resolution arenas for different stakeholders, even if they do not always have formal power.

The *legal and economic devices* were in most cases national policies or laws. Economic incentives were rarely reported by the sub-global assessments. Possible reasons for this are discussed later in this chapter.

9.2.2 The Spatial Reach and Effectiveness of Sub-global Responses

Most sub-global responses did not address all drivers of ecosystem change or all impacts on human well-being. They

BOX 9.6

Government–Community Co-management of a Sea Urchin Fishery: St. Lucia, Caribbean Sea

Since the 1950s, the white-spined sea urchin *Tripneustes ventricosus* has been part of locally important open access fisheries in the Caribbean island of St. Lucia. The sea urchins are harvested for their edible roe which is eaten roasted, but during the 1970s and 1980s, the prepared shells were also sold as ornaments. In the early 1980s, severe declines in sea urchin stocks led to the voluntary closure of the fishery by the community and government. In 1984, new legislation prohibited the “disturbance of sea urchins” without written permission from the Chief Fisheries Officer. The fishery was formally closed by the Department of Fisheries in 1987, with the ban remaining in place until 1990.

In order to determine the conditions for the recovery of the stocks and the management of the harvest, a monitoring program was carried out from 1987 to 1989 to assess the abundance, growth, and recruitment of sea urchin eggs. In 1989, discussions began between the Department of Fisheries and the sea urchin harvesters on the feasibility of implementing a co-management arrangement and resuming the harvest under controlled conditions. The fishery was then re-opened with provisions for the harvesters to assume co-management responsibilities.

These responsibilities included observing a minimum size limit for harvesting and reporting when the large size classes were depleted so that the harvest could be closed. Other management measures introduced over time were identification cards for harvesters, harvesting licenses, export licenses, and a maximum permitted selling price. In 1993, the Department of Fisheries also issued notices, requiring harvesters to form groups and select individuals to represent them in licensing negotiations. These groups were required to participate in monitoring the status of stocks before licenses would be issued, with no licenses being issued if stocks were lower than previous years. A further requirement imposed was for sea urchin egg cleaners to obtain licenses. According to Smith and Koester (2001), discussions with local residents in May 2000 indicated that the co-management system was having its intended effect.

addressed only direct drivers that could be modified by the responding actors within their immediate landscapes. Hence, the responses tended to be direct, deliberate, and practical in purpose and design.

The responses gravitated around issues that can be attended to immediately and locally (such as land use, cropping, pollution, social and ecological conflicts, planning, and regulations). None focused on exogenous drivers of ecosystem change such as climate change, population growth, urbanization, external trade pressures, or technological and political changes. These drivers are recognized as concerns in a number of sub-global assessments (see Chapter 7 for a full treatment of drivers), and some responses could be seen to address some aspects of the local manifestations of these drivers. For instance, the São Paulo Green Belt can be seen as both a response to local climate change (lowering temperature) and a local response to global climate change (carbon sequestration). But no response, by itself, was focused on addressing these drivers directly or exclusively. It seems that most of sub-global actors were reluctant to invest efforts in trying to control

what appeared to them to be beyond their control. While some responses attempted to reach beyond their immediate locales (for example, involving the United Nations in the case of the Caribbean Sea, and the establishment of a regional organization in the Tropical Forest Margins assessment), most were limited to only what was do-able or modifiable by the responding actors within their immediate areas.

Indeed, drivers are recognizably multiscale, and they are often interpreted according to the scale from which they are perceived by actors. (See Chapter 4.) For instance, urbanization can appear to be an indirect driver at the village level in the India Local assessment, but a direct driver at the national or regional levels in other sites (for example, Sweden SU). For actors at these different scales, urbanization can be addressed by either better village planning or by changes in economic policy (discussed later in this chapter).

The effectiveness of the responses, too, was apparently viewed by local actors (and the assessment teams) in terms of their impact on ecosystem changes and human well-being at specific scales. That is, their judgments on how much a response was affecting ecological conditions and social capacities were based on what they saw within the boundaries of their sphere and scale of interest. For instance, actors involved in biodiversity conservation in Portugal and in Kristianstad Wetlands, Sweden, shaped actions that acknowledge the European Union agricultural subsidy system, but did not work with the subsidy system itself.

9.2.3 The Dynamic Nature of Responses

Most responses in the sub-global assessments involved actors from several sectors and organizational levels, using multiple knowledge systems and instruments to implement responses. Collaboration among stakeholders had the effect of bringing together an array of actions, and it is sometimes hard to know whether these actions should be regarded as a single, composite, or several interrelated responses. Each of these actions has the potential to complement or limit other actions, and thus either strengthens the response, inhibits it, or evolves into an entirely new response. (See Box 9.7.)

9.2.4 The Effectiveness of Multilevel Responses

Of the 37 selected responses analyzed in this chapter, seven can be interpreted as ineffective, in that they do appear to reverse or halt current trends in declining ecosystem services. (See Appendix 9.2.) As noted, these are not necessarily “bad” responses, but rather reflect the actors’ lack of power or organizational and institutional capacity. These seven ineffective responses occur in PNG, SAfMA Livelihoods, Bajo Chirripó, Sinai, Northern Range, and Sweden SU. Six of these ineffective responses involved only one organizational level, often the local level, where actors at the local level were in conflict with (or at least enjoyed no financial, institutional, or political support from) actors at the national level. Hence, ineffective responses may be attributed to the lack of multilevel collaboration; this finding is supported in a review by Pretty (2003).

BOX 9.7

Aggregated Responses: São Paulo and Sweden SU

The São Paulo and Stockholm sub-global assessments provide good examples of aggregated responses. Urbanization and declining green spaces prompted certain actors to initiate actions to mitigate these trends. In both cases, the initial actors expanded their collaboration with other actors at different levels of organization (international, municipal, and other organizations in the case of São Paulo; the national government, three municipalities, and several NGOs in the case of Stockholm), which prompted multiple actions by actors other than those who initiated the response. On the one hand, many of these actions can be seen as a composite response to the same situation. On the other hand, the actions can be regarded as a sequence of different responses where one response feeds into another.

In the case of São Paulo, the creation of a UNESCO Biosphere Reserve, a process originated at the grassroots level, was used to initiate a multisector effort to develop integrated environmental management strategies focusing on the entire São Paulo Green Belt. Many different activities have been initiated, related to forestry, sustainable agriculture, ecotourism, public awareness, social and community projects, participatory management, and the sub-global assessment initiative itself. These are intended to complement each other in a single integrated approach to managing the area (São Paulo).

In the case of Stockholm, the initial actions by environmental organizations to control the loss of green spaces engendered other actions that then evolved into different responses, one by the national government (to establish the first National Urban Park in the world), others by the County Administrative Board, and yet others by citizen groups that have now organized to advocate controls on urbanization. The National Urban Park now requires three municipal governments within Stockholm County to perform a diverse range of tasks related to developing and maintaining the park (Sweden SU).

However, multiple organizational levels need not necessarily be involved for responses to be effective. Figure 9.2 compares two effective responses; although both use national legislation as a policy instrument, the complexity (number of actors, organizational levels, and knowledge systems) differs markedly. Nine of the 30 apparently effective or promising responses involved only one organizational level, usually the local level, but in these cases the actors were not in conflict with actors at other organizational levels, and they had sufficient institutional and organizational capacity to carry out the response by themselves (for example, the Stakeholders against Destruction for Toco, Trinidad). Hence, even if a response is done at only one organizational level, good cross-level relations would be valuable.

The remaining 21 apparently effective or promising responses involved coordination among several organizational levels. Such “vertical collaboration” was an important element in the success of all 21 responses, according to the sub-global assessment teams. The important factor here is coordination; mere involvement of actors at several organizational levels does not in itself increase the effectiveness of a response, as discussed below. The active involvement of several actors may not always be cost-effective, considering the trade-offs and opportunity costs; the resources used to

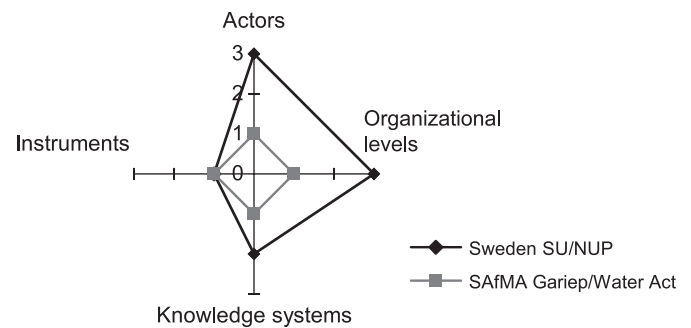


Figure 9.2. Responses Using National Legislation as an Instrument May Be Different in Features and Complexity. The National Urban Park (NUP) and other forms of protected areas in Stockholm Urban assessment (Sweden SU) resulted from initiatives by several actors at different organizational levels using different knowledge systems. The SAfMA Gariep Basin/South African Water Act of 1998 involved a panel representing different stakeholders (see Box 9.2), but the process was initiated and executed by the government; hence it can be regarded a single-actor response. Both responses were effective, which illustrates that there is no simple relationship between the complexity of a response, as defined in this chapter, and its effectiveness. Both responses appeared to have made appropriate trade-offs, for their specific contexts, between a more complex response entailing extra cost, and cost-effectiveness.

involve more actors may mean forgone opportunities to use the same resources for other purposes, such as undertaking other responses or increasing the reach of a given response.

9.3 Impacts and Effectiveness: Lessons Learned

Several patterns emerge concerning how the complexity and reach of responses are related to impacts and effectiveness.

9.3.1 Collaboration: The Interplay of Informal and Formal Institutions

From the 37 selected responses, the pattern that emerged suggests that the effectiveness of a response is correlated to the collaboration of a variety of actors involved in its execution. There appear to be at least three reasons for this pattern.

First, horizontal (multisector) collaboration ensures that multiple objectives (ecological, social, cultural, economic) are addressed in an integrative fashion (Wondolleck and Yaffee 2000). This involves public agencies as well as non-governmental organizations. Compartmentalized decision-making bodies typically impede multisector collaboration. In urban Stockholm, for example, the county administrative board and national authorities are divided across different sectors, resulting in inconsistent policy proposals (conservation versus development), while environmental NGOs do not collaborate with the business sector to resolve conflicting objectives (Sweden SU). Hence, responses to halt urban sprawl have not been effective. Similarly, the Northern Range Hillside Development Policy in Trinidad was a good plan, but it was impaired by lack of collaboration and an

inadequate administrative structure in which well-defined enforcement mechanisms were not fully integrated (Northern Range).

Second, vertical (multilevel) collaboration increases the probability that responses have a positive impact on the social and ecological drivers of ecosystem change. To the extent that these drivers occur at a continuum of social and ecological scales, responses may be more effective if they involve decision-makers (and action-takers) at multiple organizational levels. Responses, to be effective, often need to address a range of drivers and interactions of social and ecological systems, to match the reach and interactions of those drivers. The existence of several actors, at various organizational levels, managing the same natural resource, results in a redundancy in governance. This is generally criticized in policy analysis, although it has been defended in the management of complex adaptive systems like ecosystems (Low et al. 2003), which require institutional flexibility. An array of institutions at different organizational levels enhances the diversity of response options (Hahn et al. in press). This has been referred to as scale-matching (Lee 1993), institutional fit (Folke et al. 1998; Brown 2003), or multilayered or polycentric governance (Ostrom 1998; McGinnis 2000).

Third, public participation is important for effective decision-making and execution of responses. Pretty (1995) discusses two fundamental reasons for public participation in development projects: (1) as a means to increase efficiency (if people are involved in a project, they are more likely to support it), and (2) because it is a fundamental right that relates to empowerment. To this could be added another reason, namely that the knowledge base can be significantly broadened by acknowledging the local, traditional, and indigenous knowledge of different stakeholders. Each knowledge system contains specific ecological, social, cultural, economic and political knowledge that influences the design of a response. It has been suggested that responses to ecosystem change can be enhanced if a diversity of knowledge systems is acknowledged (Gadgil et al. 1993; Dahlberg 2000). In the case of scientific knowledge, it often needs to be interpreted and contextualized by actors who know the local conditions, and be synthesized with other kinds of knowledge systems (Folke et al. 2003). This is well-illustrated by the responses in Sweden KW (Olsson et al. 2004b).

People who depend on ecosystem services for their livelihoods often accumulate ecological knowledge that external researchers lack (Tengö and Hammer 2003). Through adaptive management, including close monitoring of a diverse set of ecological variables, they are able to observe and understand early signals of ecosystem change, and to distinguish this from natural variability. Hence, community-based natural resource management (for example, devolution of management authority to co-management arrangements as in the Caribbean Sea) has implications for democracy (empowerment) but also for resilience in social-ecological systems. (See Chapter 11.)

The existence of several actors, at various organizational levels, managing the same natural resource, does not result

in constructive collaboration and effective responses unless the institutional interaction is benign (Young 2002). Sometimes the overlaps in management responsibilities result in conflicts over management objectives and practices. This impedes collaboration and effective execution of responses, as illustrated by the São Paulo and Sweden SU assessments. Hence, even if the technical and institutional resources to respond appear to be high, the social *capacity* to coordinate various actors and policy instruments can be lacking.

Overlaps among sectors are unavoidable. For instance, projects driven by economic motives often have unintended ecological effects. Within the ecological sector, the legal competencies of institutions at different levels (national, district, community) generally overlap to some extent. Reducing overlaps in management responsibilities could be a solution to conflicts, but can also result in compartmentalization and reduction in the diversity of knowledge systems and of responses. A more fruitful approach, as suggested by the findings of the sub-global assessments, is to make an effort at improving collaboration: of the 22 sub-global responses where several actors at different organizational levels were involved in the execution of responses, 21 exhibited constructive collaboration resulting in effective, or at least promising, responses.

The interplay among various instruments of action is another theme in several sub-global responses. One conclusion is that the combination of “hard” formal institutions (legislation, economic incentives, and subordinate rules) and “soft” instruments (social, behavioral, and cognitive change, and also the formation of non-statutory organizations) is of particular interest. Learning and experimentation thrive in informal settings, but formal institutions define power relations when negotiation is needed to solve conflicts (Hahn 2000). The interaction between learning and collaboration in informal networks on the one hand, and formal decision-making and enforcement on the other, appears to be a crucial challenge facing several sub-global responses.

Navigating these social-ecological systems requires an atmosphere of high trust (Ostrom et al. 2002; Berkes et al. 2003; Pretty 2003). Examples of the importance of trust-building can be found in San Pedro de Atacama (where an advisory committee brought together public and private interests); Caribbean Sea (the Department of Fisheries and sea urchin harvesters in St. Lucia reached an agreement on new institutions); India Local (Joint Forest Management is important for achieving desired outcomes); Portugal (actors with diverging interests are developing a certification system); and Sweden KW (a range of effective trust-building responses).

9.3.2 “Bridging Organizations” Facilitate Multiscale Collaboration

In half of the selected 37 responses, governments at national and/or sub-national levels and local communities collaborated in the execution of the response. This is typically the kind of collaboration that is missing in ineffective responses and highlights the importance of national governments and

“bridging organizations.” A bridging organization provides an arena for trust-building, sense-making, identification of common interests, learning, vertical and/or horizontal collaboration, and conflict resolution (Folke et al. 2005). Bridging organizations create the space for innovative institutions. Bridging organizations differ from “boundary organizations,” which synthesize and translate scientific knowledge to make such knowledge relevant for policy-making. (See the Glossary for further clarification.)

In some sub-global assessments (SAfMA Livelihoods, Bajo Chirripó, Sinai), local people are politically and economically marginalized and thus lack the organizational and institutional capacity to initiate collaboration. For instance, in the Southern Africa local assessments, community members are noted to have a good deal of social capital, but because they lack technical skills or access to markets, they are unable to convert this social capital into action (although there are some exceptions). The same applies to national-level actors referred to in SAfMA Livelihoods: good policies are in place but the human resources to do the job are scarce, and corruption often impedes capacities.

Vertical collaboration requires that actors at different organizational levels are free to initiate collaboration. In the Joint Forest Management of India Local, bottom-up initiatives have worked better than top-down initiatives. (See Chapter 11.) The relationship between rights and freedom is determined by formal institutions (laws and rules), but also by informal institutions (social norms and conventions). Most sub-global responses involve local level actions and they suggest a clear pattern: democratic and representative participation of local communities correlates strongly with effective responses. In some cases, although participation was acknowledged as important, effective participation did not occur because the enabling formal institutions were not in place or not enforced (SAfMA Livelihoods and Bajo Chirripó). Some local communities considered the concept of participation in this case as lip service rather than a genuine effort. In Sweden SU, there is great potential for collaboration because the institutional resources are in place; however, no actor has managed to take sufficient leadership to form a bridging organization or to perform the functions of such an organization.

9.3.2.1 Under What Circumstances Does Collaboration Take Place?

Collaboration takes place when key stakeholders realize that they cannot reach their goals in isolation from other stakeholders (Wondolleck and Yaffee 2000). The sub-global assessments provide several examples of this pattern:

- The advisory committee in San Pedro de Atacama was a horizontal collaboration of actors across sectors, and the assessment team functioned as a bridging organization, leading the actors to collaborate on ecosystem issues for the first time.
- In Sweden KW, the organization Ecomuseum Kristianstad Wetlands is a textbook example of a bridging organization. EKW has transformed local conflicts between nature conservation and economic development into win-win situations, by offering an arena for trust-building, collabora-

tive learning, conflict resolution, and adaptive co-management (an adaptive management system involving several actors at more than one organizational level; see Olsson et al. 2004a).

- In the Caribbean Sea assessment, an NGO has functioned as a bridging organization for policy-makers in St. Lucia and local communities. Mangroves have become marine reserve areas, and reforestation projects are meeting local demand for fuelwood. In the Tropical Forest Margins assessment, land and tree tenure reform in Indonesia is facilitated by the Alternatives to Slash-and-Burn program, which functions more and more like a bridging organization (the first Tropical Forest Margin response was to establish ASB). This tenure reform was the result of several years of dialogue and consensus-building involving research institutes, NGOs, local government offices, and the Krui community.
- In the Philippines, the Laguna Lake Development Authority has been responding to ecosystem change for several years, but it was only with the formation of River Rehabilitation Councils that a comprehensive and effective response could be put in place. The scientific community played an important role in this case.

Indeed, the scientific community may function like an NGO in offering services intended to benefit communities and constituencies that are often left unserved by the formal institutions of the state. Similar examples are presented in the India Local, Portugal, and Tropical Forest Margins assessments.

9.3.2.2 Bridging Organizations and Adaptive Capacity

Eight responses that were initiated or coordinated by bridging organizations (that is, the advisory committee in San Pedro de Atacama, the NGO response in the Caribbean Sea, two Sweden KW responses, two Laguna Lake Basin responses, the Portugal ExtEnSity project, and Tropical Forest Margin tenure reform) exhibit a similar pattern in features: a multitude of actors, several organizational levels, a diversity of knowledge systems, and an emphasis on institutional innovation and social learning. (See Figure 9.3.) These responses illustrate the adaptive capacity of sub-global actors to mitigate the declining conditions and trends in ecosystem services observed at an aggregated level. Similar organizational dynamics probably underlie several other responses, but a local, fine-grain analysis would be needed to discover them. (See Chapter 11.) This finding supports neither centralization nor decentralization, but rather polycentric (multilayered) institutions that enhance the adaptive capacity and effectiveness of sub-global responses. In order to develop context-specific responses that do address the full range of most relevant drivers, sub-global actors need “enabling legislation” from higher organizational levels (Olsson et al. 2004a).

The previously mentioned examples of multisector and/or multilevel collaboration appear to have resulted in effective responses. Trust-building processes appear to have underpinned these instances of collaboration. Investment in

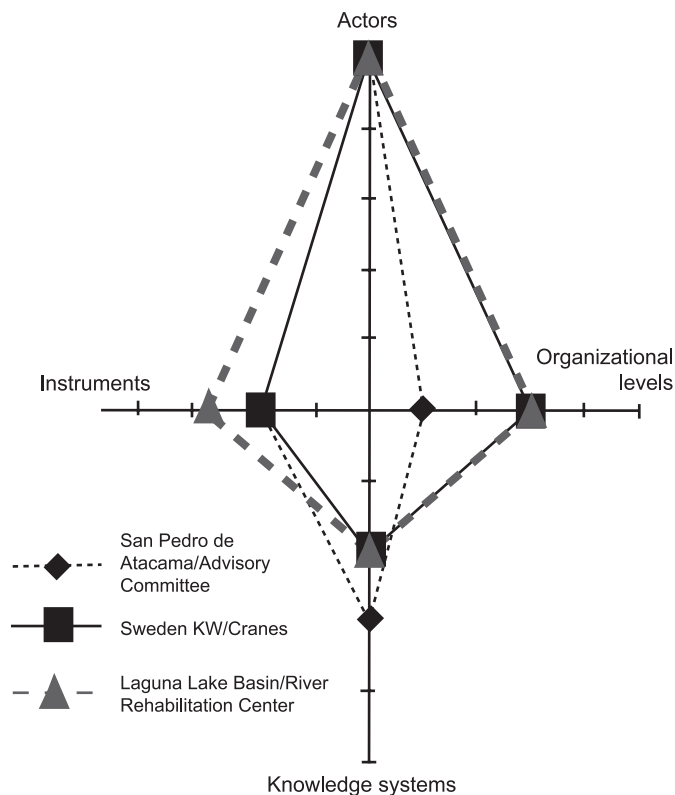


Figure 9.3. Four Features of Responses for Three Sub-global Responses Where Bridging Organizations Played a Major Role. The similarities in features are striking, although the contexts of the responses are very different. Bridging organizations bring different actors together. In the Advisory Committee of San Pedro de Atacama, Chile, only local actors were involved, while the other responses included actors at three organizational levels.

trust-building can be viewed as a transaction cost that ought to be minimized according to conventional economic theory (for example, North 1990). However, recent research on ecosystem management (for example, Olsson et al. 2004a; Scheffer et al. 2002) suggests that investment in trust-building is crucial for mobilizing institutional and organizational capacity to make responses. The leadership and facilitation offered by bridging organizations (or key persons where no such organizations exists) is instrumental, as is the synthesis and mobilization of different knowledge systems (Olsson et al. 2004b).

9.3.3 Economic and Social Incentives

Market-based instruments and other economic incentives are mostly absent in the responses reported by the sub-global assessments (the privatization of wildlife mentioned in the SAfMA Regional assessment and the response to forest fires in Portugal are two exceptions). To some extent this is because about half the sub-global responses were crafted at local or sub-national levels, while economic incentives are generally crafted at national, regional, or global levels because the greater breadth of legitimization and implementation requires higher level policy action. For instance, the integrated responses assessed in Western China included an array of policies but no economic incentives.

In general, the absence of reported economic incentives in the sub-global assessments can be interpreted in two, equally plausible, ways.

The first interpretation is that economic incentives do play an important role in the reported and non-reported responses, but the sub-global assessment teams emphasized other types of responses that are more directly within the scope of local actors to initiate and implement. Changes in the institutional arrangements that indirectly provide new economic incentives may be regarded as drivers rather than responses. One example is the EU Common Agricultural Policy, which is extremely important for providing incentives and disincentives for nature conservation and landscape management. This would have a profound effect on agriculture-related responses in Sweden KW and Portugal, but the CAP has been regarded as a driver in these particular assessments. (See Chapter 7.)

Economic incentives provide an institutional framework in which individual actors craft their responses. “Bad” (perverse) incentives make it more difficult for local actors to collaborate and work out “good” responses that enhance the capacity of ecosystems to generate valuable services. For instance, irrigation subsidies have a profound effect on relative prices and hence water allocation. Surprisingly, none of the sub-global assessments reported on this kind of incentive.

The second interpretation is that economic incentives are not as important to ecosystem management as values and attitudes at local levels. The mere existence of a policy for conserving biodiversity, supported by some subsidies, may not in itself result in effective responses. Instead, *social, behavioral, and cognitive change* appear to be important to understanding the extent to which people respond to economic incentives. Changes in values and attitudes evolve through public awareness and education. Furthermore, values and attitudes can change depending on various internal and external forces including environmental change, natural disasters, education, technological advancement, religion, crime, or war. According to Sen (1995, p. 18), “many of the more exacting problems of the contemporary world—ranging from famine prevention to environmental preservation—actually call for value formation through public discussion.” Several sub-global responses emphasized similar issues; for example, the areas of indigenous development and the advisory committee in San Pedro de Atacama were reported to be based on collaborative learning and value formation. The Northern Range civic response at Toco (Trinidad) and India Urban assessments both provide examples of actors formulating visions for improved natural resource management.

Indeed, changes that affect social norms—including values, worldview, vision, and commitment—may be more important as drivers of social change than economic incentives, which only affect cost-minimizing behavior. Without changes in social norms, people often revert to old ways when economic incentives end or regulations are no longer enforced (Pretty 2003). Thus to the extent that conflicting worldviews (assumptions about the relationships between humans, nature, and society) do underlie and explain con-

flicts over natural resource management (Adams et al. 2003), it seems reasonable to address social norms and value formation in assessments of responses. Measures that reduce non-monetary transaction costs for individuals to adopt “good” responses can be regarded as “social incentives.” Bridging organizations are important to provide these social incentives by rewarding collaboration, learning, reevaluation of preferences, and conflict resolution.

Several sub-global responses involved leadership that provides social incentives to undertake deeper changes in values. Examples include the advisory committee in San Pedro de Atacama; the certification system in Portugal; the range of responses in Sweden KW; land tenure reform in Tropical Forest Margins; and the land use plan change in India Urban. These responses carry elements of *community visioning*, which is a community-wide process with the aim of “enhancing society’s ability to solve problems and resolve conflicts” (Dukes 1996). Discovering such social processes, which are going on all over the world, requires assessments that include the local level.

Economic incentives are an important part of an enabling institutional framework for responses but social norms and incentives are also important to assess to achieve a fuller understanding of responses. The facilitation, leadership, and social incentives provided by bridging organizations (or key persons in communities) appear to be essential for capacity-building, which in turn enhances opportunities for crafting effective responses today and in the future.

9.3.4 The Reach of Sub-global Responses

The reach of a response across places and time (that is, the spatial and temporal scales of a response) appears to play a critical role in shaping and reshaping the linkages between ecosystem services and human well-being. It affects the choice and success of the combination of responses that are deployed to address different ecosystem changes and their impacts on human well-being.

9.3.4.1 The Reach of a Response across Places

The multiplicity and diversity of actors, organizational levels, knowledge systems, and instruments of action involved in most sub-global responses seem linked to their frequently crossing community (or district, national or regional) boundaries. This also appears to be related to the tendency of many actors initiating a response to match their actions to the geographic reach of the drivers and interactions they seek to address. It seems likely that the tendency of responses to expand across actors and levels of organization may consequently entail movements across space, so the response will actually proceed to involve more actors located in many more places. One example is the impact of upland deforestation causing disruption in watershed functions for downstream stakeholders (see the Tropical Forest Margins assessment). The effectiveness of the responses to deal with this problem will depend on the extent that complementary efforts are undertaken across all places where the drivers have an effect, by all actors in various levels of organizations that may be located in many different places.

If the spatial reach of the drivers and responses vary, then there might be a need for legal and economic interventions which would need to be negotiated by different administrative parties overseeing the management of the ecosystem, to ensure that decisions formulated are efficient and equitable, across all places and scales of organization of the actors involved.

All SAFMA Regional responses and the Portuguese response to forest fires appear to be good examples of using economic incentives as part of a response to complex cross-scale problems. In the more local sub-global assessments, however, organizational devices focusing on collaboration were more common, because these were at the disposal of local decision-makers. This suggests a relationship between the spatial reach of a response and the choice of instrument: organizational devices are very common at local settings while economic incentives are more often used as responses at the national/regional level. Interestingly, the privatization of wildlife and the transboundary water co-management institution described in the SAFMA Regional assessment combine legal and economic devices with organizational devices.

9.3.4.2 The Temporal Reach of a Response

Changes in ecosystems and their corresponding services can occur over a range of time horizons. Losses in provisioning services occur in a relatively shorter time span (“fast variables”) than losses in the regulating and supporting services (“slow variables”).

Temporal properties can influence the type and success of a response. The main factor that underlies the temporal dimension is uncertainty. If the loss in ecosystem service and/or the intensity and breadth of its impact on human well-being is uncertain or unclear, but expected to occur within a short time span, then perhaps a hybrid of regulatory and legal interventions (for example, marine reserves and other prohibitions) might work relatively well, perhaps much more so than economic and market-based incentives that seek to alter long-term behavior.

However, if there is uncertainty but the impacts are expected to occur only in the distant future (for example, in the case of biodiversity decline and the establishment of biodiversity management committees described in the India Local assessment), then perhaps regulations may be best combined with economic and market-based incentives for a response to work well.

It seems that the longer the time scale of an ecosystem change, the higher will be the degree of the uncertainty of its impacts on human well-being; when this occurs, the actors can be less certain about what combination of responses to utilize. Investments in trust-building, learning, collaboration, and conflict resolution, referred to previously as “social incentives,” may be of particular importance for longer time scales. Unlike economic incentives, the effects of social incentives continue after the policy (for example, a subsidy scheme) has ceased. The different time spans of effects make the analysis of trade-offs between different instruments of action more difficult.

9.3.4.3 The Combined Effects of Time and Space

The responses described in the sub-global assessments are apparently linked to the unique conditions of ecosystem services across places and time.

This linkage is corroborated by lessons from elsewhere. For example, dryland ecosystems have been observed to be in constant transition (in climatic conditions, production systems, social institutions, and demography; see Mortimore et al. 1998) so that a fundamental problem for their management is that there are often direct trade-offs that need to be accepted between their provisioning services and their regulating, cultural, or supporting services. These trade-offs occur across time and space, and across actors and stakeholders and their levels of organization. In the case of the upstream dams and drainage schemes in the Tigris-Euphrates river system, provisioning services (such as fresh water and food production) have increased, but at the expense of the Mesopotamian marshlands, which have decreased in area by 90% during the past quarter century (UNEP 2002). The degradation of the marshlands over both space and time has led to loss of habitat for native plants and animal communities as well as many species of migratory birds, mammals, and fish, and the displacement of indigenous peoples, the Marsh Arabs. In cases such as this, the temporal, spatial, and social dimensions of the responses all interact to address the same aspects of the changed (and changing) services offered by ecosystems.

9.3.5 Synergy and Coherence

The synergy of responses must reflect the synergy of ecosystem changes. The sub-global assessments show a high degree of synergy among various ecosystem services. (See Chapter 3.) Unsustainable use of provisioning services (such as excessive biomass harvesting) may impair the productivity of regulating and supporting services (such as water and nutrient cycling; see the Tropical Forest Margins assessment). This, in turn, might negatively affect the ability of the ecosystem to continue to provide provisioning services in the long run. The loss in regulating services may also have greater effects on human well-being in the long-run when sensitive lands (like catchment headwaters, shallow soils, steeply sloping lands, and landscape sink areas such as wetlands and riverine buffer areas) are subjected to unsustainable cropping or grazing practices. The interdependent nature of ecosystem services, and the impacts that different ecosystem services have on human well-being, have often not been taken into account in management and policy decisions relating to sub-global responses.

This synergy implies that responses to changing conditions of ecosystem services must have the same interdependent and coherent dimensions as the drivers, services, and impacts that they address. The institutional context of an ecosystem service may differ across locales, and what might appear to be a coherent response in one locale, may not be so in another (also called scale-matching and polycentric governance). Indeed, shortfalls in the interdependence and coherence of responses might explain, to some degree, the difficulty of crafting responses that fully address the range of

direct and indirect drivers, as these were described in all the sub-global assessments.

9.3.6 Technology and the MA Conceptual Framework

Technology has been posited by many as the answer to several ecosystem problems that we face today. The sub-global assessments as a whole provide few examples of “technical fix” responses. Where technological devices were mentioned (for example, by the Alternatives to Slash-and-Burn program in the Tropical Forest Margins assessment, or technological devices for the Barbados Coastal Zone in the Caribbean Sea assessment), these were explicitly adapted to the social-institutional context. This suggests that direct interventions, and technological innovations and dissemination, can only be assessed within a given institutional framework. Indeed, this applies to all responses; the sub-global assessments do not offer any blueprint for which types of responses are to be recommended. However, they do offer many insights into how to think about and organize responses.

In the MA conceptual framework, human well-being is the ultimate goal, and responses are defined as actions addressing ecosystem change, which in turn affect human well-being. However, some sub-global responses (notably in the San Pedro de Atacama assessment and also Sweden KW and Bajo Chirripó) addressed local social dynamics and conflict resolution, which *directly* enhance human well-being. This in turn increases the capacity to respond to ecosystem change. Indeed, this is more consistent with the literature on community-based natural resource management (for example, Hoff 1998) than the MA conceptual framework.

9.4 Lessons Learned for Future Assessments

The sub-global assessments, because they are still ongoing, can be expected to reveal many more aspects about the nature of responses. Several interesting patterns and lessons learned have already emerged from the 37 responses reported from 18 sub-global assessments. However, some pertinent issues have yet to be assessed and may be further addressed in future assessments:

- *The strategies of actors to identify and select responses.* The rational strategies pursued by actors when they accept trade-offs among different types of responses need to be explored further. They might focus on responses that give them the most desired results (in terms of conditions of ecosystem services and human well-being) for every unit of effort they exert; they might focus on features of a response that are likely to have the greatest effect on a driver, but which will command the fewest resources (social, political, financial, economic, and technological) from them; or they might be pragmatic in their choices, focusing on policy instruments within their immediate reach. If the latter is true, future assessments could focus on path dependency and institutional capacities of the regions that are assessed.

- *Actors' investments in responses.* The deployment of actors' investments in different responses or on different features of a response appears to be related to the robustness of their existing institutions and the resilience of their social-ecological settings. If so, future assessments need to employ a more coherent and rigorous approach to analyzing responses. Ideally, each individual assessment should identify responses *and non-responses* to the most pressing conditions and the most important trends and drivers, and assess the institutional capacity of the actors to make the appropriate responses.
 - *Adaptive capacities of actors.* The sub-global assessments tend to emphasize the adaptive capacity of sub-global actors to mitigate threatening conditions, trends, and drivers at the local scale. Yet, they offer little clue on the deeper dynamics of this adaptive capacity and what policy options at national, regional, and global levels may enhance it. Some aspects of enabling institutions may be expressed as “blueprints,” while other aspects may require a deep contextual understanding. Enhancing the adaptive capacities of actors would seem essential to help them craft effective responses.
 - *The spatial reach of responses.* The existing sub-global assessments have so far provided insufficient information on the spatial reach of responses. For instance, a response that was shown to be effective in reducing on-site ecosystem degradation may not easily be extended in scale. The social-ecological dynamics behind effective responses are site-specific and even if vertical (multilevel) collaboration exists, the spatial reach of complex responses may be limited.
- Future sub-global assessments may shed more light on, and provide a better understanding of, these four issues. This would further enhance our understanding of how to design and support effective responses to ecosystem changes in the future in many parts of the world, for human well-being.

Appendix 9.1. Thirty-seven Important Responses Reported by Different Sub-global Assessments

Sub-global Assessment	Major Issues Addressed	Reported Responses and Why They Are Important
San Pedro de Atacama	<p>declining quality and availability of resources (e.g., fiber, fuelwood, water)</p> <p>rising conflicts over resources and competing land uses and traditions</p> <p>problems with waste management</p>	<ol style="list-style-type: none"> 1. An Area of Indigenous Development (ADI) was designated and set up for the purpose of strengthening the social capacity of local communities to address the indicated changes and drivers. Comprehensive response in a neglected area. 2. A collective leadership structure (an Advisory Committee) was set up by the assessment team to widen and intensify stakeholders' participation across sectors in addressing the changes and their drivers. 3. Mining companies monitoring flamingos and water quality. Pressing problem acknowledged.
Caribbean Sea	<p>deteriorating marine ecosystems (fisheries, corals, mangroves)</p> <p>increased sea pollution</p> <p>die-off of important marine organisms</p> <p>rising levels of poverty, especially among fishers</p> <p>volatile job prospects</p>	<ol style="list-style-type: none"> 4. Many countries collaborated to achieve a UN Resolution on integrated management of the Caribbean Sea and are pursuing a further resolution to have it declared a "special area in the context of sustainable development." This provides a framework for collaboration among Caribbean states that remains to be exploited. 5. The Barbados Coastal Zone Management project protects coral reefs and beaches. Extremely pressing issue; Barbados is totally dependent on tourism. 6. An NGO is building local capacity to manage mangroves sustainably in St. Lucia by assisting in making them Marine Reserve Areas and meeting the needs for fuelwood by reforestation projects. Important role for an NGO. 7. Co-management arrangement of the fishery with community groups in St. Lucia to halt depletion of white-spined sea urchin; first example of devolution of management rights.
India Local	<p>forest management</p> <p>decline in biodiversity</p>	<ol style="list-style-type: none"> 8. Through the Biodiversity Act, Biodiversity Management Committees (BMCs) were created at the local level to coordinate local actions to document biodiversity changes; important devolution of power. 9. Joint Forest Management (JFM). Voluntary vertical collaboration that has become statutory, for improving the biological and physical status of forests. JFM has improved forest conditions and facilitated collaboration.
PNG	<p>population pressure on subsistence resources</p> <p>commercial overfishing</p> <p>droughts and famines</p> <p>waste management</p> <p>biodiversity</p>	<ol style="list-style-type: none"> 10. During the drought of 1997–98, the government food aid program failed to take account of local communities' responses that included migration and remittances. The government mitigated starvation but also reduced the authority of local leaders or experts who know how to exploit alternative sources of subsistence. Illustrates mismatch of knowledge systems. 11. More than 30 Wildlife Management Areas (WMAs) have been established; WMAs are the only legal instrument for conservation in PNG.
Laguna Lake Basin	<p>declining biodiversity, water quality, and productivity of rice and fish, affecting the livelihoods of more than 12 million residents living around the lake</p>	<ol style="list-style-type: none"> 12. Several multisectoral River Rehabilitation Councils (RRCs) were formed by the national government through the Laguna Lake Development Authority (LLDA); the RRCs are able to address social and ecological drivers. 13. In collaboration with multiple stakeholders, in 1989, the Laguna Lake Development Authority designed and implemented a lake zoning map to designate areas for fishpens, fish cages, navigational lanes, and fish sanctuary; this addressed the conflict between the fishpen operators and the open water fisheries arising from the adverse effects of fishpen fishery on open water fishery (i.e., decreased area for open water fishing, blockage of navigational routes, and blockage of water circulation).

Portugal	<p>nutrient loss from forestry practices changes in biodiversity forest fires high transaction costs for introducing certification system for sustainable agriculture</p>	<p>14. Consumer pressure has led the pulp and paper industry to take voluntary initiatives to improve its forestry management in eucalyptus plantations. 15. Abandoned wheat farms were acquired by a national NGO in specific “hot spot” areas to retain wheat production and maintain the pseudo-steppe ecosystem, which would otherwise be converted into secondary forest. 16. New responses to forest fires included the introduction of a simplified land registration system to change land tenure arrangements, and the creation of a forest investment fund by taxing fossil fuels 17. ExtEnSity is an on-going development of a more economically viable and efficient certification system for sustainable (extensive) agriculture which was initiated and is being coordinated by members of the assessment team; interesting collaboration.</p>
SAfMA Regional and Gariiep	<p>rising demand for ecosystem services equitable access to land and water political and economic changes are causing shifts in demand and supply of ecosystem services</p>	<p>18. The South African Water Act of 1998 revolutionized allocation rules; progressive solution focusing on human well-being. 19. Transboundary water co-management institutions, such as ORA-SECOM, which involves the four countries that share the Gariiep basin, have been established to address water-related conflicts and benefit-sharing among countries; good international cooperation. 20. Private ownership of wildlife. Experiments to transfer use rights to wildlife began in South Africa and Zimbabwe in the early 1980s. The economic returns from trophy-hunting (in the early phase) and private safaris (dominating today) often exceed the returns from marginal cultivation or cattle ranching, giving incentives to sustainable use of wildlife. Important attempt to foster private stewardship.</p>
SAfMA Livelihoods	<p>declining quality and availability of ecosystem services equity over benefits from ecosystem services rural livelihoods</p>	<p>21. Rural households and communities employ different coping and adaptive strategies (e.g., diversification of livelihoods and land use, and increased mobility and investments in social capital like neighborhood networks, kin, and friends). Rural households sometimes respond by disengagement from the market and politics.</p>
Sweden SU	<p>loss of green areas and functional biodiversity reduced capacity of ecosystems to sustain ecosystem services low institutional capacity to collaborate and organize effective responses</p>	<p>22. A substantial part of the green areas in Stockholm was declared in 1995 as the first National Urban Park (NUP) in the world; “set asides” have been expanded—the NUP and nature reserves and other protected areas now account for 13% of Stockholm county. 23. Citizen action to protect the local environment has widened and intensified. Some proposals for exploitation and urban sprawls within Stockholm have been stopped or delayed by local groups. There is no coherent collaboration for ecosystem management.</p>
Sweden KW	<p>erosion of biodiversity dependent on cultivated wetlands greenhouse effect increasing risks of flooding eutrophication in the Baltic Sea innovative network organization and collaborative learning for ecosystem management</p>	<p>24. The Ecomuseum Kristianstad Wetlands (EKW) was established in 1989; it put into practice a conceptual and organizational innovation of collaborative learning. Application of the ecosystem approach to transform management. 25. The Crane Project was launched in 1997 to forestall conflicts between farmers and bird watchers. Hence the trust-building and legitimacy of the ecosystem approach, invested in by the EKW, was not eroded but deepened; important conflict resolution. 26. Ecosystem-based strategies to buffer flooding were acknowledged by the municipal rescue service after the flood in 2002, as a result of the increasing legitimacy of EKW.</p>

(continues)

Appendix 9.1. continued

Sub-global Assessment	Major Issues Addressed	Reported Responses and Why They Are Important
Northern Range	<p>declining quality and quantity of surface and groundwater</p> <p>declining value of amenity sites</p> <p>exacerbated flooding in watershed and floodplains</p> <p>increased incidence of landslides</p> <p>forest degradation</p> <p>health risks</p>	<p>27. Official plans for ecosystem protection and development have been adopted, e.g., the Northern Range Hillside Development Policy (NRHDP).</p> <p>28. Civic and citizens' initiatives to protect and develop the Range have intensified; they are focused on advocacy, policy analyses, and improving awareness and empowerment of local residents. One example is Stakeholders Against Destruction (SAD) for Toco, which was responsible for stopping the construction of a port that would have changed the character of the community and had a negative impact on the environment. Illustrates increasing role of civil society.</p> <p>29. Two banks have initiated environmental projects with long-term commitment. Sustainable response by the corporate sector.</p>
Tropical Forest Margins	<p>local livelihoods</p> <p>land tenure</p> <p>forest losses</p> <p>biodiversity</p> <p>agronomic sustainability</p> <p>carbon stocks</p> <p>hydrology</p>	<p>30. The Alternatives to Slash-and-Burn (ASB) program was initiated by the Consultative Group on International Agricultural Research to mobilize national competence to address these issues.</p> <p>31. Land and tree tenure reform in Indonesia: the legitimacy and rights of community-managed agroforests in Lampung province were acknowledged in a government decree in 1998. This decree was the result of several years of dialogue and consensus-building involving research institutes, NGOs, local government offices, and the Krui community.</p>
Western China	<p>biodiversity</p> <p>food and water supply</p> <p>soil erosion</p> <p>desertification</p>	<p>32. An integrative government policy for Western China in 1999 addressed problems in five areas: reconstructing ecological resources, development of infrastructure, industry, trade, and education.</p>
Bajo Chirripó	<p>deforestation</p> <p>deteriorating quality of and inequitable access to natural resources</p> <p>erosion of indigenous knowledge on natural resource management</p>	<p>33. Indigenous peoples' leaders and some collaborating civil society groups are attempting to recover local indigenous knowledge on natural resource management. This includes putting pressure on the State to recognize ancestral domains, advocacy, and public education by indigenous peoples' leaders and their collaborating civil society organizations. Important for integrity and self-determination.</p>
Eastern Himalayas	<p>deforestation</p> <p>diversify livelihood options</p>	<p>34. Multisector Eco-Development Committees (EDCs) and Forest Protection Committees (FPCs) have been formed to promote wise utilization of natural resources.</p>
Sinai	<p>livelihoods of the Bedouins</p> <p>water scarcity</p>	<p>35. Bedouins cope by using water traps, crop selection, and diversified activities.</p>
India Urban	<p>loss of biodiversity, green area, and recreational and aesthetic values</p>	<p>36. A proposal by Pune Municipal Corporation (PMC) to convert wooded/forested hill tops and slopes to residential areas was withdrawn after a mass mobilization. PMC became aware of the issues and launched Biodiversity Management Plans instead.</p>
São Paulo	<p>rapid urbanization</p> <p>pollution</p> <p>loss of green space</p>	<p>37. The Green Belt has been acknowledged as a Biosphere Reserve by UNESCO. An integrated policy for environmental management of the São Paulo Belt is being developed but not yet assessed.</p>

Appendix 9.2. Features of the 37 Most Important Responses Reported by the Sub-global Assessments (Knowledge Markets in Prague and Alexandria, October 2003 and March 2004, respectively). In 21 of the 37 responses, governments at the national and/or district level(s) initiated the response.

Sub-global Assessments	Short Description of Response (see Appendix 9.1 for detail)	Actors Initiating								Actors Involved								Organizational Level				Knowledge Systems			Instruments of Action				Effectiveness							
		National/district governments	International organizations	Research institutions	Business sector	Communities	Individuals/households	National/district governments	International organizations	Research institutions	Business sector	Communities	Individuals/households	Local	Sub-national	National	Regional	Global	Scientific	Local	Indigenous	Direct Interventions	Technological innovations/dissemination	Legal/economic devices	Organizational devices	Social, behavioral, and cognitive change	Effective	Promising	Ineffective	Bringing Organization						
San Pedro de Atacama	ADI Advisory Committee	•				•			•		•		•								•															
			•																																	
Caribbean Sea	UN resolution	•																																		
		•																																		
India Local	BMCs	•																																		
		•																																		
PNG	Food aid	•																																		
		•																																		
Laguna Lake Basin	Zoning map	•																																		
		•																																		
Portugal	Pulp/paper industry	•																																		
		•																																		
Portugal	Forest fire response	•																																		
		•																																		
Portugal	ExtENSty	•																																		
		•																																		

(continues)

Appendix 9.2. continued

Sub-global Assessments	Short Description of Response (see Appendix 9.1 for detail)	Actors Initiating						Actors Involved						Organizational Level					Knowledge Systems			Instruments of Action					Effectiveness				
		National/district governments	International organizations	Research Institutions	Business sector	Communities	Individuals/households	National/district governments	International organizations	Research institutions	Business sector	Communities	Individuals/households	Local	Sub-national	National	Regional	Global	Scientific	Local	Indigenous	Direct interventions	Technological innovations/dissemination	Legal/economic devices	Organizational devices	Social, behavioral, and cognitive change	Effective	Promising	Ineffective	Bridging Organization	
SAIMA Regional	Water Act of 1998	•					•											•				•			•						
	ORASECOM	•					•											•					•			•					
	Private wildlife	•					•				•							•													
SAIMA Livelihoods	Coping strategies					•					•												•								
Sweden SU	NUP, reserves	•					•																•								
Sweden KW	Citizen action					•																	•								
	Ecomuseum					•																	•								
	Crane Project					•																	•								
	Flood buffer					•																	•								
Northern Range	NRHDP	•					•																•								
	SAD for Toco					•																		•							
	Bank projects								•															•							
Tropical Forest Margins	ASB program					•																	•								
	Tenure reform					•																	•								
Western China	Integrated policy	•					•																•								
Bajo Chirripó	Indigenous						•																•								
Eastern Himalayas	EDCs and FPCs					•																	•								
Sinai	Coping										•																				
India Urban	PMC						•																								
São Paulo	Biosphere Reserve						•																•								
	TOTALS	21	9	2	4	19	6	29	16	10	16	26	16	15	21	5	3	34	25	13	13	10	21	27	20	20	10	7	7		

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