Chapter 18

Choosing Responses

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TABLES

Main Messages

The decision-making process itself, and the actors involved in it, influence the intervention chosen. Elements of decision-making processes related to ecosystems and their services that improve decisions reached and their outcomes for ecosystems and human well-being include: using the best available information; ensuring transparency and participation of important stakeholders; recognizing that certain important values cannot be quantified, but must be considered; striving for both efficiency and effectiveness in the decision-making process; considering stakeholder equity and vulnerabilities; ensuring accountability; providing for monitoring and evaluation; and considering cross-scale effects.

There is a cascade of uncertainties associated with legal, market, institutional, behavioral, and other responses. **Integration across response strategies can mitigate and reduce elements of uncertainty, but it is unlikely that uncertainty can be eliminated in any important context.** The choice of appropriate decision-making processes can help to address uncertainties inherent in ecosystem management and ensure more equitable and sustainable outcomes. A wide range of deliberative tools can now assist decision-making concerning ecosystems and their services. These include tools that facilitate transparency and stakeholder dialogue; information gathering tools, which are primarily focused on collecting data and opinions; and planning tools, which are typically employed for the evaluation of potential policy options.

The use of decision-making methods that adopt a pluralistic perspective is particularly pertinent, since these techniques do not privilege any particular viewpoint. These tools can be employed at a variety of scales. However, the context of decision-making about ecosystems is changing rapidly while old challenges must still be addressed. For national governments, the greatest benefits are likely to be gained from several types of actions. Economic incentives need to be aligned with the goal of sound ecosystem management. **In particular, two kinds of actions are needed: eliminating subsidies that promote excessive use of specific ecosystem services and correcting market failures.** Subsidies to agriculture, forestry, and fisheries in many countries lead to overproduction and promote overuse of inputs that may harm other services. Because many ecosystem services are not traded in markets, markets fail to provide appropriate signals that might otherwise contribute to the efficient allocation and sustainable use of the services.

The transparency and accountability of government and private sector performance need to be increased in ecosystem management through greater involvement of concerned stakeholders. **Institutions need to be developed that enable effective coordination of decision-making at multiple scales and across multiple sectors.** Problems of ecosystem management have been exacerbated both by overly centralized and overly decentralized decision-making. Many ecosystem services tend to be managed in a highly sectoral arrangement that does not provide for appropriate analysis of the cross-sectoral trade-offs inherent in decisions.

Increased emphasis is needed on both demand-side management and adaptive management. As the per capita supply of services drops and the costs associated with production increase, emphasis should shift from actions designed to increase production of the services to actions designed to reduce demand. Management interventions should always include a significant monitoring component, which allows for greater learning about the consequences of the intervention and improved management with time.

Businesses can take action which will both improve their "triple bottom line" (economic, social, and environmental gains) and reduce degradation of ecosystems. They can encourage, through business decisions and support for legislation, resource management policies that reflect the social value of the use of natural resources. They can promote technologies, which reduce demand for ecosystem services and reduce pressures on ecosystems. Human demand for ecosystem services will continue to grow. Significant increases in the efficiency of the use of ecosystem services will be needed to cope with that demand without undermining ecosystems.

To gain competitive advantage, business could take decisions that anticipate the eventual strengthening of regulations (or establishment of market mechanisms) to significantly reduce carbon emissions, reduce nitrogen and phosphorous loading, and increase water and energy use efficiency.

Businesses can provide objective information on their operations and encourage access to this information. Trust and transparency can help create a value-adding reputation. **Reporting environmental performance and meeting certain standards such as those found in eco-labeling and/or certification schemes are responses that leading corporations are pursuing with reputation and brand image in mind.** They can also pursue partnerships with civil organizations for the mutual advantage of all parties. Partnerships help accelerate learning and leverage resources.

Civil society organizations can take actions that further human well-being and the conservation and restoration of ecosystems. They can raise awareness among the public and decision-makers of "emerging issues" such as nutrient loading and invasive species or they can encourage greater access to information on the status and trends in ecosystem services and provide greater quantification of the nonmarketed benefits obtained from ecosystem services. They can facilitate the involvement of stakeholders at the highest risk and greatest vulnerability to the effects of ecosystem change. They can also help build coalitions and partnerships. The consensus-building coalitions of nongovernmental organizations and other like-minded stakeholders greatly increase the leverage of individual members. Partnership with businesses can encourage the best practices necessary to achieve environmentally benign products, support environmental innovation, and look into new "sustainable" business opportunities.

18.1 Introduction

The objective of this chapter is to identify the ingredients of good decision-making with regard to choosing responses regarding ecosystem services and human well-being. It draws from the responses identified and discussed in the chapters on ecosystem services and human well-being in Part II of this volume, and focuses on identifying the factors that enhance the quality of the processes for choosing responses and whose absence diminishes the quality of those processes. It also builds upon the chapters in Part I dealing with typology, assessment of responses, and uncertainties. In addition, this chapter builds on the MA conceptual framework (MA 2003). Chapter 8 of this report identifies the following issues:

- the desirable properties of decision-making processes such as considerations of equity, attention to vulnerability, transparency, accountability, and participation;
- primary influences in choosing among responses such as temporal and physical scale, cultural context, uncertainty, and considerations of equity;
- the key steps in the policy-making cycle, including problem identification and analysis, policy option (that is, response) identification, policy choice, policy implementation, and monitoring and evaluation in an iterative fashion;

- the range of analytical tools useful to the choice of responses and the contexts that will help determine the appropriate tool;
- the balance that must be struck between the need for policy adaptability and flexibility to hedge uncertainty and risk with the need for a predictable and stable policy regime against which to plan and invest; and
- the need for indicators to link policy and action with impacts on ecosystem services and human well-being and the role of traditional and practitioner knowledge.

The conceptual framework report (MA 2003) makes clear that some old challenges must still be addressed. Perhaps the most important of these challenges is the complex trade-off faced when making decisions about how to manage ecosystems with the goal of enhancing the flow of services while allocating benefits, costs, and risks equitably. Increasing the flow of one service from a system, such as provision of timber, may decrease the flow from others, such as biodiversity and the provision of habitat.

While some benefits of ecosystem services are hard to capture locally, some others may be easily captured by those who have access to the system. For example, it may be relatively easy for local people to capture the direct-use value of timber in a forest via market prices—they are capturing the value of provisioning services. At the same time, people around the world may benefit from the many aspects of biodiversity provided by the forest—an indirect-use value of a supporting service. Under many institutional arrangements, the people near the forest have no way to capture this other value. Because the direct-use value—revenues from logging—can easily be converted into income for local people, for local and national governments, and for local, regional, and multinational firms, there is a strong incentive to log the forest. In contrast, the value inherent in protecting biodiversity is much harder to translate into income for anyone. As a result, there will be a tendency for decisions to favor the direct use even though a full analysis of the total value of ecosystem services might favor preserving or enhancing the indirect use retained by not logging (MA 2003).

The characteristics of the ecosystem, the technologies available for using it and monitoring such use, and the institutional arrangements that distribute values across groups have consequences for decisions that are made (Ostrom et al. 1999). A great deal is understood about these problems, and the state of the science often provides guidance on the design of institutions to promote capturing the full value of an ecosystem (Costanza and Folke 1996; Stern et al. 2002; MA 2003).

The analysis of the process of choosing responses may be started by answering the basic question: Why is an intervention needed? Four possibilities arise:

Sustaining the existing ecosystem service. If the current level of a given ecosystem service is satisfactory then there may be a natural interest in safeguarding the service for any foreseeable future by managing the regular renewal of the service in concert with natural processes The sustainability of the ecosystem service may be threatened by overexploitation of the service or the degradation of the ecosystem because it provides some other service. An important consideration may be thresholds beyond which provision of the service may be severely diminished.

Enhancing existing services or developing new ones. This may arise in response to growing demand caused by increasing population, increasing wealth of the population, changing tastes of people, and/or the increasing need for human well-being. An effort to enhance the existing volume of a service may also be caused by purely economic reasons in order to exploit the comparative advantage established by a marketable product based on the given service. The same applies for the development of a new service, classical examples being the shrimp plantations in Southeast Asia or tourist development on many tropical islands. Another reason for an attempt to enhance ecosystem services may be social or political, for example, to help poor or vulnerable groups or, on the other hand, to benefit certain preferred groups of stakeholders, for example, the local elite.

Restoring degraded or damaged services. If an important or even vital ecosystem service is downgraded, an attempt may be made to restore it to its original state even if exact reconstruction is not possible. For cultural reasons (tradition, natural pride, regional trademark, etc.) the efforts may be much more costly than the value of the service recovered.

Adapting to the situation when a given ecosystem service is damaged beyond any sensible repair. Sometimes restoration is not physically possible for technical or financial reasons. The response may, therefore, be oriented toward some other measures, such as seeking substitutes, securing imports, or reducing (even to zero) demand for the given service.

When deciding what should be done, the choice of ''doing nothing'' should always be considered.

This chapter focuses mostly on explicit responses and interventions made by decision-makers in all sectors and at all levels. The typology of the responses, by the nature of the intervention, by the impact on drivers, and by the actors and their scale of operation, is the subject of Chapter 2, which also discusses that responses can be implicit, such as those made by consumers of products that depend on or impact upon ecosystems and their services.

When making decisions, the responses are evaluated on the basis of their costs, on the one hand, and their effects, on the other. The costs could be initial, short-term, or long-term (for example, the regular management or operational costs). They may be not only financial but also (sometimes more important) societal, political, cultural, or others. The response may bring not only benefits but also side effects with negative consequences. As we are dealing with ecosystem services where a long-time scale is the rule rather than an exception, the conflicts between short-term (political) and long-term (mostly ecological) perspectives occur quite often and may be very difficult to resolve. The effects of responses are discussed in depth in Chapter 3.

In addition, it should not be forgotten that various decision-makers (in a very broad sense) are making decisions on responses having very different needs and objectives. Many people seek benefits for themselves or the stakeholder group with which they identify (for example, a firm, an NGO, or a small community). On the other hand, some personalities do exist whose goal is to achieve benefits (or greater glory) for some abstract entity called ''Society,'' ''the Only True Belief,'' or ''Mother Nature.''

18.2 Decision-making Processes

There is a significant literature on the nature of the rational approach to decision-making in the environmental policy realm. Referred to as the ''decision-making'' or ''policy-making'' cycle, it consists of at least four stages: agenda setting, policy formulation, policy implementation, and policy evaluation (Barkenbus 1998; Dale and English 1998).

Feedback loops occur at each stage in the cycle. Further refinement of this concept suggests that the agenda-setting stage can be divided into ''problem identification'' and ''public awareness/problem acknowledgement'' (UNEP/DPCSD 1995; Moldan and Billharz 1997). In addition, the policy formulation stage suggests further sub-division into identification of alternatives, gathering

and analyzing of alternatives, and application of decision-making tools (Barkenbus 1998).

A synthesis of this research suggests that rational decision-making processes are comprised broadly of the following elements:

- defining the problem, including gaining public awareness and recognition of the problem;
- determining the range of options appropriate to the problem, taking into account the scale, actors, and primary and proximate drivers in play;
- assessing the efficacy of the options based on political feasibility, capacity for governance, economic and social impacts, and other barriers and limitations to their use;
- choosing the appropriate response option through the aid of decision-making tools whether they are normative, descriptive, deliberative, or ethical/cultural (MA 2003);
- implementation of the option chosen;
- monitoring and evaluating results; and
- adjusting the problem definition, and range, assessment, choice, and implementation of responses.

18.2.1 Problem Definition: Agenda-setting and Policy-formulation

There is, again, much research on the agenda-setting process for environmental policy formulation as well as the extent to which science and expertise play a role (Downs 1998; Kingdom 1984; Dearing and Rogers 1996; Barkenbus 1998). In idealized decision-making, evidence and scientific fact with respect to impact and risk play key roles in the setting of agendas and defining of problems. However, public perception has played an important role, as has scientific evidence. Events, as portrayed by the ''media'' (for example, Exxon Valdez, Love Canal), have been key contributors to public perception. Politicians, by virtue of their positions and responsibilities, have reacted to public perception/opinion as well as other pressures brought to bear by powerful constituencies such as NGOs and business communities. In this context, science and expertise have often been used to add legitimacy to agendas that are already established.

A critical challenge for environmental decision-making is the integration of environmental considerations into virtually every major business, resource, or economic development decision. Because the wide range of decisions in every sector of the economy affects ecosystems, ecosystem management and environmental protection cannot be concerns of environmental policy-makers alone. Ecosystems must be the responsibility of private business as much as public agencies, and of financial investors as much as fisheries or forest managers. The ''integration principle'' has been known since the United Nations Conference on Environment and Development (UN 1992). However, only transparent and open decision-making regarding economic issues gives people with environmental concerns the chance to raise them (WRI 2003).

Nevertheless, the introduction of science (that is, comparative risk studies) to improve the process of setting agendas and defining problems is increasing in a number of jurisdictions (Barkenbus 1998). The success of these efforts remains unclear (Davies and Mazurek 1998). When it comes to helping the public form an opinion based on scientific knowledge, the role of clear, simple, and unambiguous information seems obvious. In addition, as certain environmental problems are not easily observed (for example, climate change), information is required to raise public consciousness. In each case, indicators that are understandable, valid and verifiable, relevant, and technically feasible/efficient can play a key role in rational decision-making (Moldan and Billharz 1997).

18.2.2 Implementation

Participation and accountability are two key concepts underpinning the principles and practice of environmental governance.

Meaningful participation brings influence. Those who participate in decision-making processes that affect ecosystems stand the best chance of having their interests represented. Public participation brings legitimacy, credibility, and effectiveness to the decision-making process. Public involvement in some form is required for any broad-based consensus behind the final decision, especially for large or controversial projects. Failure to provide for public input can bring just the opposite result: conflict and resistance. A common challenge to ensuring participation in environmental decision-making is that not all affected stakeholders are equally well positioned to express their views. For some people, there are still barriers of distance, time, language, literacy, and connectivity that might prevent full participation. To participate meaningfully, people need access to information: about the environment, about the decisions made and their environmental implications, and about the decision-making process itself. A recent survey shows that citizens, by and large, feel that governments do not provide them with as much environmental information, or opportunity to participate in environmental decision-making, as they would like (Petkova et al. 2002).

Good governance requires making decisions at the appropriate level. Generally, the appropriate level for decision-making is determined by the scale of the natural system to be managed. However, decision-making still tends to be centralized and isolated from the people and places affected. In many instances, drawing on local knowledge can result in more informed decisions that would serve local people and ecosystems better. This ''subsidiarity principle'' is often necessary; in many other cases it may be best to let a higher-level authority specify the outcome of the decision-making (maximum quota), while a lower-level authority specifies the procedure (how licenses are awarded).

The ability to seek redress or challenge a decision, if stakeholders consider it flawed or unfair, is of the same importance as access to information and appropriate level for decision-making. In practice, it requires public access to judicial or administrative remedies, existence of an independent arbiter, etc. (WRI 2003)

As already discussed, the effective implementation of responses is dependent on decision-making processes that have a wide input and consider all those that might be affected. In addition, the support of those affected, including the public, is required for successful implementation of responses (Moldan and Billharz 1997). Effective information flows, indicators, and reports are the key to maintaining the requisite support.

Accountability refers to the way in which the public and the private sectors are held responsible for their decisions and actions. Accountability involves the provision to sanction the responsible party. Also, effective implementation of responses and policies requires bringing scientific information and expertise to bear at the administrative level so as to add specificity and definition to regulations and standards that flow from more broadly stated policy mandates (Barkenbus 1998).

18.2.3 Monitoring and Evaluation

While monitoring and evaluation are often not given adequate attention, they are an integral part of an effective decision-making process, and a systematic approach is essential.

There are two types of evaluation—the ex ante and the ex post evaluation (EEA 2001). The ex ante evaluation of intended policies is part of the formulation/choice stage of the process with the use of scenarios as a possible tool. With regard to ex post evaluation, the legitimacy of the institution performing the evaluation is the key to facilitating any adjustments to the decision or policy that might be indicated.

Evaluation should start with the establishment of the ''base line,'' that is, the precise description of the situation before the policy was implemented. This starting place needs to take into account any change in status due to the announcement (or unintended statement) of a possible change in policy, as this can have a powerful effect on behavior.

The achievement (or non-achievement) of targets is the next key consideration. As monitoring and evaluation are key elements of the decision-making process, earlier stages should include the establishment of transparent and well-communicated targets, which are specified as objectively as possible.

Finally, the evaluation should examine the impact of unexpected factors that may have helped or hindered the achievement of objectives and targets or had other ancillary impacts.

The most important tools for monitoring and evaluating the effects of decisions and policies are ''performance indicators.'' It is critical that these indicators be specified at the time a response is chosen and targets are set and allow for an assessment of the ''distance'' between the actual state and the desired one (that is, the target). Use of this practice by nations and international bodies is increasing (Adriaanse 1993; EEA 1999). Consistent underperformance suggests a need to adjust the decision or policy.

The adjustment stage of the decision-making or policy-making process is really the link to a new decision-making process with the problem definition/agenda setting stages triggered as a result of the monitoring and evaluation stage of the previous one. This fact argues for the need for effectiveness, objectivity, and legitimacy when monitoring and evaluating decisions.

18.2.4 Some Practical Considerations

For most people, it is not obvious who is ''in charge'' of the environment, and how decisions are made about developing, using, or managing ecosystems. Decisions that shape environmental and natural resource policy are not made by a small group of enlightened government officials (WRI 2003). Many actors at different levels, in and outside the government make and/or influence the array of choices that form constantly evolving environmental and natural resource policies. Officials in different departments of the government, business representatives, environmentalists, politicians, scientists, and local communities are traditionally involved in the environmental policy process. Often they bring to the table conflicting interests, ideologies, knowledge, and levels of influence. Hence, the selection of response options to manage ecosystems is an inherently political process in which actors intensively compete to advance their economic, ideological, social, and cultural goals (Ascher 1999; WRI 2003; Rivera 2002).

The political nature of the selection of response options to manage ecosystems is also enhanced by the intrinsic uncertainty and complexity of the environmental and natural resource policy-making process. Contrary to the normative assumptions of economic and bureaucratic rationality, policy issues do not follow a linear pattern that is divided into specific well-defined steps (Lasswell 1947; Simon 1976 and 1985; Lindblom and Woodhouse 1993). Decision-makers, confronted with this highly uncertain and complex political reality, display behaviors that significantly diverge from the rational choice ideal (Simon 1985; North 1990; Rivera 2004). Beliefs, motivations, personalities, and ideologies (a person's cognitive base) that emerge from family upbringing, life experiences, education, religion, and economic interests are used by policy-makers to simplify reality (Cyert and March 1963; Hambrick and Mason 1984). This simplification process helps decision-makers to avoid lengthy assessments of all existing information and alternatives. Yet it can also generate biases and blind spots that significantly affect their preferences and decisions (Starbuck and Milliken 1988; Walsh 1988). Thus environmental decision-making is characterized by the following:

- environmental problems that are very difficult to identify and define as they are not easily separated from other issues and are seldom confronted in isolation;
- values and objectives of natural resource and environmental policy in conflict with other valid objectives such as funding economic development projects or protecting local producers from the pressures of global trade (Ascher 1999);
- a limited number of policy options;
- policy options and consequences not clearly defined or evaluated;
- policy selection favoring the influential, powerful, and well-connected (Lindblom and Woodhouse 1993; Lasswell 1947; Ascher 1999);
- little attention to implementation during the selection of policy alternatives (although intense political struggle during implementation can significantly change the impact of sound policy); and
- limited evaluation of environmental decisions and political influence with respect to that which is undertaken.

These characteristics of actual environmental decision and natural resource policy-making are exacerbated by the unique contextual conditions prevailing in developing countries. In some countries, democratic processes may not be fully in place. Environmental protection must compete with the need for economic development. Environmental groups are fewer in number, less powerful, and have limited channels to participate in the environmental policy process. Consequently, environmental policy decisions can be designed to pursue other goals and priorities as well.

Similarly, in developing countries, environmental agencies frequently lack clear mandates and their capacity to enforce and monitor natural resource and environmental regulations is very weak (Ascher 1999; Rivera 2002). Some communities and local groups view violence as a legitimate resource to oppose implementation of government regulations. Corruption is a more widespread problem than in industrial countries. On the technical side, developing countries, in addition, may have fewer highly trained people to deal with environmental problems. The quality and availability of scientific knowledge and information can also be poor. This can lead to the symbolic adoption of ''canned'' policy instruments designed by foreign experts that fail to consider the political, economic, administrative, and technical limitations intrinsic to environmental and natural resource agencies operating in the developing world.

18.3 Key Ingredients to Good Decision-making

As experience in decision-making for ecosystem management and in the analytical work to support the related decision-making processes accumulated over the past decades, increasing attention was devoted to questions concerning the key criteria for success (The Social Learning Group 2001; Clark et al. 2001). The bulk of ecosystems-related decision-making is deeply permeated with

complexity, uncertainty, and the incompleteness of science. Accordingly, any assessment process intended to serve decision-making needs to take these facts of life fully into account. This section draws on recent critical appraisals as organized into a synoptic framework by Toth (2004), partly inspired by Chapter 8 of the conceptual framework report (MA 2003) and also drawing on Dietz (2002). We also draw on results of recent research on decision analysis, decision-making, and environmental governance. Conceptual work, analytical efforts, and case studies presented in earlier chapters of this report are also important sources. The objective is to specify a set of ingredients that have characterized successful decision-making in the past and are likely to lead to environmentally effective, socially fair, economically efficient, and politically feasible decisions in the future.

Table 18.1 lists the fundamental criteria and their implications for the two large domains: the decision-making process per se and the decision analysis/support activities. These criteria and the implied guidelines may appear to be far too general at the first glance. Without doubt, the relative importance, feasibility, and practicality of the individual points differ from case to case. Yet the guidelines draw on a large body of critical appraisal of environmental management (NRC 1996; Ostrom et al. 2002; Dietz et al. 2003) so that they have general validity in the human management of environmental systems. In particular, these principles and criteria are valid for decision-making processes (and decision analyses conducted to support them) for all public policy-makers and private stakeholders.

The relative importance of many criteria differs depending on which social actor or group has the primary right or mandate to make the decision. Public policy-makers (local and national governments) are mandated to pursue the interests of the community as a whole and to give special attention to vulnerable or poor social groups, but they are also required to use public funds efficiently. In the mirror case: private stakeholders tend to pursue their own interests and focus on economic efficiency but many of them pay increasing attention to the social and environmental implications of their decisions in the spirit of emerging corporate responsibility and because of the increasing importance of their company's public image. Neither public nor private decision-makers who are concerned with ecosystems services can ignore the social context in which they want to implement their decisions. As subsequent sections in this chapter show, the actual fulfillment of these broad criteria varies immensely not only across societies and development levels but also across the types of decision-making entities.

A number of ingredients that are key to good decision-making with respect to the protection and enhancement of ecosystem services and human well-being are broadly and strongly supported by the chapters in Part II. The following discussion focuses on various ingredients of successful decision-making and analysis. It

Table 18.1. Ingredients for Good Ecosystem Management: Analysis and Decision-making (based on Toth 2004)

Criteria	Implications for Decision-making	Implications for Decision Analysis
Use the best available information about social context	design decision-making process consistent with prevailing social, economic, political, technological, and institutional situation	choose decision-making framework according to prevailing social, economic, political, technological, and institutional situation
Use the best available ecosystem/ biophysical information	devise decision-making process so as to allow using the best available information	choose the decision-making tool to allow the incorporation of best available information
Consider efficiency concerns and implications	devise an efficient decision-making process to save time and costs (procedural efficiency); respect the prevailing economic principles (outcome efficiency)	select the analytical tools and the decision criteria according to the relative importance of efficiency concerns in the decision-making context
Strive for effectiveness	devise an effective decision process with clear and flexible procedures that foster finding compromises	present complete results in understandable form
Consider equity concerns and implications	devise a fair decision-making process to allow stakeholder participation (procedural equity) and understanding of the outcome (transparency); respect the prevailing equity principles (consequential equity)	select the analytical tools and the decision criteria according to the relative importance of fairness concerns in the decision-making context; consider participatory assessment techniques
Use the best available information about values	recognize values, beliefs, aspirations of affected stakeholders in the decision-making process	choose the decision analysis tools and decision criteria according to the existing values, beliefs, and aspirations of stakeholders
Pursue accountability	establish clear responsibility assignments during and after the decision process	set up quality control and good practice regimes for assessments
Consider vulnerability concerns and implications	beware of the interests of vulnerable groups/ communities.	assess the implications of different options for vulnerable groups/communities
Consider uncertainties	conduct a flexible decision-making process to accommodate new information about the ecosystem and possible changes in values or positions of stakeholders	choose the analytical framework so that it allows an adequate representation of uncertainties; define decision options that allow policy corrections as new information becomes available
Consider cross-scale effects	expand the decision-making process to initiate/ comply with relevant policies at lower/higher levels	choose the analytical tools to incorporate constraints from higher decision-making levels and to explore decision needs at lower decision-making levels

is important to note the critical importance of judgment and scientific ignorance in these processes. NRC (1996) presents the concept of an analytic-deliberative process and argues that in order to understand policy choices involving risks to environmental quality and human health, it is necessary to employ a process in which scientists, decision-makers, and the interested and affected parties to the decision deliberate about the nature of the questions that require analysis, the forms of analysis that would be relevant and useful for the decision, the assumptions that should be incorporated in the analysis when the correct assumptions are unknown or disputed, the appropriate interpretation of the results of the analysis, etc. In other words, a process of public participation is required for decision analysis (not just decision-making) to ensure that decisions are well informed. These issues are further addressed in the context of ecosystems in NRC (1999b) and Dietz and Stern (1998). The main conclusions of NRC (1999a) are also integrated into other studies on environmental decision analysis (NRC 1999b; Stern and Easterling 1999). Other countries (CSA 1997; RCEP 1998) and international organizations (OECD 2002) also provide interesting sources.

The proposition to use the best available information in the analytical work to support decision-making and in the decision process itself sounds rather obvious. Yet decisions concerning ecosystems services often suffer from information deficits ranging from insufficient effort to obtain relevant information to inadvertently ignoring or purposefully withholding information. Four main information domains are important to draw on for successful decisions: *biophysical information* about the ecosystem status and processes*; impact assessment information* about economic, social, and political consequences of both the ecosystems changes and of different policy options; *socioeconomic information* about the sociopolitical context in which and for which the decision will be made; and, as an important subset of the latter, *information about the values, norms, and interests of key stakeholders* shaping decisions and affected by them.

For most ecosystems and environmental risks, there is a large body of information available in natural sciences that should be identified and used. Similarly, social science can offer not only information about which policies would be acceptable and feasible, but also information about how ecological changes (whether or not policy-driven) affect such important human outcomes as economic growth, distribution of jobs, availability and price of food, organizational viability, cultural change, and the potential for social conflict. At the same time, however, it is important to recognize how much natural and social sciences do not know about ecological processes and their effects on the ecosystems goods and services that humans value. Therefore, when we argue below for using the best knowledge, it inherently implies making the best use of ignorance as well, that is, the knowledge of what is not known (Ravetz 1986). This underlines the importance of analytical methods (for example, decision analysis or value-of-information calculations) that can inform decision-makers about the implications of the different types of looming uncertainties, of the resolution of uncertainties in the future as knowledge improves, and of the potential course corrections that might be required in the light of new knowledge.

The metastrategy presented in NRC (1996) involves a process which entails the best decision-relevant information from the various perspectives of those involved or affected and which considers this information from a variety of relevant perspectives. This NRC report emphasizes the need to get the science right, but also the need to get the right science. The former requires that the ''underlying analysis meets high scientific standards in terms of measurement, analytic methods, data bases used, plausibility of assumptions, and respectfulness of both the magnitude and the character of uncertainty'' (pp. 7–8), whereas the latter implies that the analysis needs to address ''the significant risk-related concerns of public officials and the spectrum of interested and affected parties, such as risks to health, economic well-being, and ecological and social values'' (p. 8). For complex ecosystems-management problems that are plagued with profound uncertainties, interested and affected parties should, early in the process, be involved in defining the questions to be subjected to analysis.

The relative importance of the criteria in Table 18.1 differs depending on the temporal and spatial scale of the ecosystem or resource management problem, on the number and relative power of the stakeholders involved, on the institutional capacity to implement and enforce the emerging decisions, and many other factors. Yet, at least a modest amount of all these ingredients can be recognized in the assessment and decision-making processes that led to successful decisions. Similarly, it is easy to identify *a posteriori* which ingredients had been missing from analytical and decision-making processes that failed or were outright disasters.

In summary: this section argues on the basis of recent literature on environmental decision-making that the process of choosing a strategic intervention or a broader policy in response to potential or emerging environmental problems needs to be informed by the best available information that is responsive to the concerns of those who may be interested in or affected by the ultimate decision. Accordingly, the analytical work to support choosing responses should also incorporate the perspectives, values, and interests of those affected by the final outcome.

These ingredients are expanded and elaborated upon below in the context of the responses in the chapters of Part II. The order of discussion (as above) is a ''rough signal'' of the importance placed on these ingredients by the service chapter responses.

18.3.1 Using the Best Available Information on the Sociopolitical Context

The decision-making process must be realistic in the sense that it observes and accommodates prevailing social customs and practices, economic realism (power, interests), political situations (authority, control), technological conditions (availability, feasibility), and institutional status (implementation, enforceability). The same features influence the choice of analytical framework because its underlying principles must be congruent with the social situation. Moreover, these features also determine the range of options that can be meaningfully assessed to help decision-making because only strategies and measures viable in the given social and political context will be considered.

This is especially true when economic incentive and substitute economic opportunities are being considered. Regional plans, environmental impact assessments, and education and communications programs could consider which social context would be most effective. Obviously, decisions about responses that pertain to sustainable production practices must be taken with a range of stakeholders in mind beyond just producers and users.

The *social context* is defined as a large group of people who live together in an organized way, making decisions about how to do things and sharing the work that needs to be done. The *political context* is defined as the relationships within a group or organization, which allow particular people to have power over others.

So the *sociopolitical context* is defined as relationships and decisions between people sharing the work that needs to be done within the group with some people having power over others. The relationships will be different for different stakeholders and, in some cases, there will be more vulnerable people and, in oth-

ers, more powerful people. The relationships will not only be different at each scale level, both temporal and spatial, but will change as they are scaled up and will also change with time at the different scale levels.

Taking account of the sociopolitical context is important to decision-making in many areas. Beekeeping in southern Africa provides one example. Nel and Illgner (2004) show that social, economic, cultural, and natural landscapes can be combined and related to the complex and diverse relationships among rural people. Beekeeping is a commercial activity that supplements what rural people derive from subsistence farming and fishing but it is often overlooked (Quong 1993).

Responses with respect to wood also support the sociopolitical context as important to good decision-making (Chapter 8). National forest programs were devised in the context of favoring national action over an international approach. However, within this, institutional capacity to implement these national programs continues to be a key constraint. International forest policy processes and development assistance may be less effective given their focus at the national versus local level.

The sociopolitical context is a key consideration in deciding to allow direct management of forests by indigenous people or decentralizing authority for forest management to local communities. National forest governance initiatives and national forest programs make significant policy changes for participatory forestry. The greatest positive effects were felt in countries of low forest cover, such as Nepal and Tanzania where the capacity of the local people to manage forests was given greater policy support and the condition of the resource also improved (Brown 2002) Again, capacities to manage are the key issue here. Capacity is also the key issue when deciding whether forest-planning techniques will be effective in tropical areas. Public and consumer action is premised on sociopolitical calculations. Balancing the needs of the poor with respect to harvesting and using fuelwood versus forest protection must be undertaken in a political and social context.

Social and behavioral responses can play an important role in controlling infectious diseases while optimizing other ecosystem services (that is, with respect to sanitation).

In yet another example, the sociopolitical context is also important when it comes to the protection of local knowledge and devising landscape conservation and restoration schemes, especially when it involves the removal or the reintroduction of species, implementing eco-tourism enterprises, instituting certification programs, and establishing ''fair trade'' standards. For example, recreation and education are complementary. Cultural tourism can educate people about cultural diversity. Ola-Adams (2001) describes how the Omo Biosphere Reserve in Nigeria is creating programs for diverse audiences, ranging from school children to university students, from protected area managers to policy-makers.

18.3.2 Using the Best Available Ecosystem Biophysical Information

The decision-making process needs to open communication channels to the diverse sources of relevant information about the biophysical status and processes of the ecosystem concerned. In addition to state-of-the-art modern science, traditional knowledge should also be used where it is relevant and available. The mirror implication on the analytical side is the need to choose analytical frameworks that are capable of incorporating and handling the diverse sets of information from different sources required for the assessment of a useful range of decision options. Closely related to the criterion above, it is essential to collect and evaluate information about the socioeconomic implications of ecosystems changes as well as about the economic and social impacts of the feasible policies and measures to manage them. This requires integration of knowledge of widely diverging uncertainties from different scientific disciplines and sociopolitical perspectives and its consolidation in a form that is acceptable to all stakeholders. Complex decision problems can be usefully supported by analytical frameworks that are specifically developed to incorporate diverse sets of data, tools, and perspectives, like integrated environmental assessments (Rotmans and Vellinga 1998).

A solid body of reliable information on ecosystems and their function in the broadest sense is, clearly, the first and foremost prerequisite for any successful response regarding ecosystem services. This involves more than a mere collection of data and information on biological, chemical, and geological properties of the ecosystems, as it includes the transformation of such information into useable knowledge. It is knowledge that addresses the particular concerns of a user, deals with different spatial scales, time frames, and organizational levels. The principal findings are seldom easily transferable from one scale or level to another. One example is an evaluation of the regional or local impact of global climate change or other global phenomena. The recently stressed notion of a ''place-based'' science for sustainability—which should be relevant for local policy-making—points in this direction (ICSU 2002a). It is equally important—and difficult—to translate long-term impacts that may affect only future generations into terms that are relevant to day-to-day decision-making.

The majority of ''usable knowledge'' is in the form of numerical or other quantitative information (ICSU 2002b). Among various forms of such information, indicators play an important role. For example, an environmental indicator is air quality measured by ozone levels in parts per billion compared to its threshold value of 50 parts per billion. A component of the necessary knowledge system is the theoretical and institutional framework capable of handling the diverse set of information from different sources. Data gathering; their transfer, validation, and translation into useful information; and, finally, the presentation of the information are all part of such a framework.

Gaps may exist between the sources of usable knowledge and the potential users. Organizations that synthesize and translate scientific research and explore its policy implications are able to bridge this gap. They are sometimes called ''boundary organizations'' because they facilitate the transfer of usable knowledge between science and policy and they give both policy-makers and scientists the opportunity to cross the boundary between their domains.

Choosing responses should be based on both formal scientific information and traditional or local knowledge. To be credible and useful to decision-makers, all sources of information, whether scientific or traditional, must be critically assessed and validated as part of the assessment process through procedures relevant to the forms of knowledge. When speaking about the ''best'' biophysical information it should be made clear that in no case can such information be absolutely certain. Starting from the not fully assessed quality of basic data, the level of uncertainty increases up to the peak of the ''information pyramid'' (ICSU 2002b). The degree of uncertainty is mostly not known. Chapter 4 speaks on the ''cascade of uncertainty.''

With respect to responses regarding *biodiversity,* the use of concrete biophysical information on ecosystems is critical. Having the appropriate biophysical information is most important when it comes to responses that include the management of wild ani-

mals, in situ conservation (including the need to improve storage technologies), habitat restoration, and sustainable production. However, it is also important when it comes to regional planning, environmental impact assessments (including business biodiversity action plans), and devising habitat and area protection schemes (Chapter 5).

In relation to *food production,* all responses—if they are to be successful—must be based on precise and long-term biophysical information. Detailed information on local conditions, which are mostly incorporated in traditional knowledge, is critical. In particular, introduction of the new technology responses (biotechnology, genetically modified organisms, precision agriculture, integrated pest management) must be based on reliable and detailed biophysical information if failures are to be prevented (Chapter 6).

Valid biophysical information is critical for most of the responses regarding *water services* (see Chapter 7). In particular, the determination of environmental flows is based on such information. Decision-makers responsible for water allocation often seek the minimum flow that must remain in a river to maintain environmental quality. However, such thresholds of flow are very illusive and may not exist in reality. In any case, the desired condition should be decided prior to the application of an environmental flow methodology, preferably with the involvement of a broad array of stakeholders. Market-based incentives must also rely on very robust biophysical information to be successful.

A number of the responses regarding *wood* take biophysical information as a key ingredient to good decision-making. In some cases, responses such as national forest programs have not been successful because of a lack of sound information and there is a need for research into traditional knowledge and improved forest information systems. With respect to the understanding of the effectiveness of direct management of forests by indigenous people there is little information on outcomes upon which to make assessments. A key gap in our biophysical information is in measuring biodiversity. With respect to responses such as small-scale private ownership and private-public partnerships in forest management, dissemination of existing information to the practitioners in the field is an important issue. Obviously, biophysical information is the life-blood for improving wood technology and biotechnology responses. It is critical in improving forest plantation development and management especially with regard to the impact of monocultures, as well as determining how traditional forest planning techniques might be applied to tropical forests. Finally, understanding the promise that forests hold for carbon capture depends greatly on biophysical information (Chapter 8).

With regard to *nutrient cycling,* an example of the response that is very much dependent on biophysical information is the management practices aiming to minimize leaching and run-off of nitrogen and phosphorus fertilizers from agriculture fields (Chapter 9).

All responses to *floods and storms,* in particular, to the use of natural environment and non-structural measures in order to reduce negative impacts, depend on detailed information on biophysical conditions. Elements of the natural environment such as wetlands act as buffers against floodwaters. Coastal mangroves have been found to be very effective in providing protection against storms and surges in Bangladesh, India, and Southeast Asia. These measures include land-use planning through zoning, setbacks, and flood-proofing with emphasis on regulation or modification of the built environment, often urban. Insurance, as a response option, is as critically dependent on this type of information as any other response option (Chapter 11).

Since the elucidation of the life cycles of parasites and the recognition that insects transmit infectious agents, the vectors (insects, ticks, and snails) have been the targets through which the control of diseases has been attempted. Initial attempts at *vector control,* before insecticides became available and application techniques were developed, depended on environmental management to reduce vector population. Considerable success was achieved by draining swamps, by the use of oil to prevent larval mosquito respiration, and by the selective destruction of savannah and riverine forest habitats of these vectors. The advent of insecticides in the 1940s resulted in less emphasis on environmental and biological methods of control and the reliance, for a period of two decades, on insecticides (Chapter 12).

Having appropriate biophysical information is also important when it comes to all the identified responses with respect to *cultural services*. Protection of local knowledge has the protection of biophysical information at its core. Landscape conservation and restoration schemes including the introduction and removal of species, ecotourism, sustainable production practices, and locally based management schemes rely on biophysical information. Multilateral science initiatives, local data gathering and integration programs, and knowledge diffusion efforts all have biophysical information as an objective (Chapter 14).

Biophysical information is inevitably an important element within all *integrated responses,* but it is a critical factor for responses at the local level and cross-scale issues as well as for multilateral environmental agreements. In particular, the new generation of MEAs is critically dependent on precise biophysical information as they deal with difficult cross-cutting issues like climate change or loss of biodiversity.

Sustainable forest management is an example of an integrated response at the local level. In forestry, a range of examples can be found that address more than one ecosystem service at the same time. Sustainable forest management is an approach that seeks to integrate several ecosystem services and different stakeholders through innovative institutional arrangements, methods, and tools. Another example is integrated coastal zone management. Coastal zones involve a diverse set of ecosystems and habitats, which provide rich services and functions to society, and are associated with multiple uses and users (Chapter 15).

18.3.3 Pursuing Efficiency and Effectiveness

The basic principle of devising efficient decision-making is to conduct fast and thrifty decision processes (procedural efficiency). This implies designing the decision process so as to allow for fast and clear exchange of information and views, to allow flexibility for shifting positions, while progressing towards compromise solutions. The assessment activities can enhance and support the efficiency of decision-making by presenting the multitude of feasible decision options with all relevant implications, uncertainty features (qualitative characterization and quantitative ranges), and preconditions for and possible pitfalls of implementation and enforcement.

However, there is often a trade-off between the principles of procedural equity and efficiency. There are conflicting claims about stakeholder participation and the efficiency of the decision-making process. Some maintain that stakeholder participation is cumbersome and slows down the process while others claim that such involvement is controllable and may even turn out to be faster if the consensus-based outcome is implemented as soon as the decision is made as opposed to the long delays resulting from several rounds of rebuffs and revisions instigated by excluded stakeholder groups. Moreover, the emerging policy or regulation

needs to be compatible with prevailing economic values and principles (outcome efficiency). This is especially important in cases when (re)distribution of public funds is involved. In order to help fulfill these objectives, the assessment framework and the decision criteria should be chosen so that they can properly handle the relative importance of economic and financial concerns in the given decision-making context. Typical efficiency criteria include balancing costs and benefits or identifying least-cost solutions under a given set of constraints. An important but often neglected factor in cost and efficiency calculations are the transaction costs required for implementation, enforcement, etc.

Effective decisions result in policies and measures that can be, and will be, realistically implemented to achieve the intended outcomes. The effectiveness of the decisions is, therefore, dependent on the extent to which the decision-making process is able to fulfill all the criteria above, ranging from the acquisition and use of the best available information to accommodating the appropriate mix of concerns (efficiency, equity, etc.). Decisions based on appealing ideals but void of pragmatic aspects are bound to fail and are, therefore, ineffective. The assessment process can foster the effectiveness of the decision by performing ''reality checks'' of the policy options by adopting analytical tools from disciplines like political science or game theory.

Responses discussed in Part II of this report illustrate that the efficiency and effectiveness of decision-making is important for achieving desirable outcomes. A number of responses to the issue of *biodiversity* provide good examples. Habitat protection schemes through indirect incentives such as integrated conservation and development projects are designed to integrate, optimize trade-offs, and create synergy. The same can be said of regional planning approaches to habitat protection. Eco-agriculture techniques including organic farming, integrated crop management, and conservation farming are also designed and pursued with integration, trade-off, and synergy as objectives (Chapter 5).

In a related way, the *food* responses in Chapter 6 recognize fundamental trade-offs that can arise from the demands placed on agricultural systems to produce food efficiently while sustaining ecosystem health and sustainability. For example, natural resource constraints include shortages of arable land, water, fisheries, and biodiversity. However, current trends in a significant number of agricultural indicators suggest threats to long-term economic, social, and environmental sustainability of the food system. Further, the overall effect of agricultural trade liberalization on the environment is ambiguous, and trade-offs must be weighed in order to find ways to limit the adverse effects of trade while enabling the collection of its benefits. There are similar concerns about the development and use of genetically modified organisms. Given the complexities that abound in this domain, efficient and effective decision frameworks need to allow both for the interaction between a large number of sectors and actors at multiple scales and for uncertainties at these different scales, both spatial and temporal.

The chapter on *water services* (Chapter 7) highlights responses that, increasingly, have the efficiency and the effectiveness of the decision-making process as objectives. Basin-wide river management schemes that are integrative are becoming prevalent. Also, market-based incentives for the provision of freshwater services are increasing in popularity, partly because of the fact that market forces are inclined to reduce transaction costs and delays as against those found with government intervention and regulation.

The chapter on *wood* (Chapter 8) points to missed opportunities to pursue responses that are more efficient, integrative, and synergy seeking. It also points out numerous opportunities to improve outcomes through responses that have these attributes. In general, the realm of multilateral agreements and initiatives has lacked the facility to cross cut, integrate, create synergy, and gain economies of scale. However, many of the responses that operate at a more localized level can be highly integrative. For example, company/community partnerships are premised on ''win-win'' ideas with each party taking away benefits suited to its particular needs. Responses for improving the technology of growing or using wood work in much the same way by trying to accomplish economic as well as environmental objectives. Plantation forests can be highly integrative and synergistic by satisfying wood demand, addressing lost habitat, combating desertification, and providing carbon sinks.

The success of the small-scale private owner as a forest management response may depend to a large extent on whether lack of economies of scale can be overcome. One solution to this situation is to band the small operators together into cooperative arrangements. This, of course, will depend on the receptivity of the small operators to such an organizational form. Certification programs are seen as expensive for small producers and local communities. In addition, there has been a proliferation of certification programs, which adds to cost and to confusion in the minds of consumers. Rationalization approaches may have large benefits for all stakeholders.

The positive *vector-borne disease control* outcomes discussed in Chapter 12 rely on integrative social, behavioral, and environmental responses and, therefore, decision-making processes reflect this need for integration, trade-off, and synergy. For example, the extent and prevalence of gastrointestinal infections throughout the world pose a massive problem. Only an integrated approach via mass treatment, safe disposal of waste, and provision of latrines effectively address this problem. Health education has been a vital element in successful outcomes. Environmental hygiene through protection of food from cockroaches and flies can also play a significant role. Effective decision-making processes consider this wide portfolio of responses.

Finally, the integrative and synergy-building aspects of good decision-making are found in several of the *cultural service* responses in Chapter 15. The consistent message is that decision-making and outcomes with respect to ecosystem services would be enhanced if local cultures were given a larger say in the process. This is particularly true when considering landscape restoration and eco-tourism schemes, and certification programs. Good examples of highly integrative and effective decisions and responses found in the chapter include the cultivation of medicinal plants in India and the Rhön Biosphere Reserve in Germany. In these examples, ecosystem conservation has been well integrated with local culture and economies.

18.3.4 Using the Best Available Information on Values

A crucial field of the social context for ecosystems decisions is information about the norms, beliefs, values, and aspirations of the affected communities. Even the best intended and, from a different perspective, perfectly rational decisions or measures will inevitably fail if they run counter to the norms and rules, which the affected stakeholders follow. These aspects need to be recognized in decision-making. Accordingly, prevailing norms and values influence the choice of the decision analytical tool and the decision criteria adopted in the assessment.

The responses that have been reviewed make it clear that this ingredient is very important to good decision-making. In these responses the concept of ''values'' goes beyond quantifiable costs and economic benefits and includes a broad range of determinants

of human well-being, that is, all that humans value or need. Therefore, ''values'' range from personal security, sustenance, and health to material and economic goods to beliefs, traditions, rituals, and aesthetics. However, ''values'' also go beyond the individual to the collective to include organizations, corporations, communities, and even nations, and bring in the concepts of influence, power, tenure, and reputation. In this way, the use of the best available information on values is strongly related to the use of the best available information on the sociopolitical context discussed above.

Different stakeholders (or sets of stakeholders) bring different mixes of values (value systems) to particular circumstances, problems, or decisions. Also, different stakeholders have differing stakes in any particular issue. The responses discussed in the chapters in Part II provide evidence that participation and transparency in decision-making is the most effective way to develop the best information on values and respective stakes.

Chapter 5 demonstrates that *biodiversity* responses that seek to change the nature of use of habitat (that is, area protection) or species or provide alternatives to the use of targeted habitats or species are most effective when built with human values as a central theme. Biodiversity responses that seek to change productive behaviors to those that have greater sustainability (that is, certification and labeling schemes) take into account human values. A particularly good example of a mix of human values in choosing a response deals with reclamation where costs are incurred to restore aesthetic values. Local knowledge of biodiversity is another type of human value that can be considered in making decisions about ecosystems.

According to Chapter 7, values are an ingredient that is important for all responses in connection with *water services*. Property rights, and the human value systems they imply, are seen as an important response for sharing the benefits of freshwater services. These rights determine whether those who pay the costs of management have access to any of the benefits and, therefore, have an incentive for cooperation in the conservation activities needed to provide them. In the case of watershed services, which play a critical role in the provision of freshwater, rights over both land and water have been considered. In addition, there are compelling reasons to consider the use of markets for incorporating values into choosing responses for the provision of fresh water. Tradable water rights create a ''visible or discoverable'' value for water, and the concept of full cost recovery pricing incorporates externalities and, thus, a broad range of values (despite the inherent difficulties in quantifying all costs). Water exchanges, banks, and leasing and trading programs have developed to address water quantity and quality issues. Although recognition of the right of access to water for basic human needs may be undecided as a matter of international law, a number of nation states have directly or indirectly given formal recognition to the right of access to water as a fundamental human right. South Africa is one example. Therefore, this human value is being ''wired'' into its water responses.

Values including economic values are highlighted as key to good decision-making with respect to *wood and fuelwood* (Chapter 8). Efforts such as national forest programs and international forest policy processes have been either more or less effective depending on the extent to which local values and human well-being have or have not been incorporated into their development. Small-scale private ownership and forest management schemes are based on the premise that property rights lead to greater stewardship. The delegation of public forest management rights through conservation concessions is based on determining the full opportunity cost of lost public use and enjoyment. Organized public and consumer action as a response is based on both the value that politicians/companies place on reputation and the value that consumers place on environmentally sensitive production practice. Dendro power and fuelwood activities are grounded in the need for poverty reduction and economic development. Finally, calculations and decisions about forest protection are being aided by the ''internalization'' of the value of sequestering carbon by way of a developing carbon trading market under the Kyoto regime.

18.3.5 Considering Equity Concerns and Implications

The most direct way of using ''the best available information about values'' is to devise a fair decision-making process and to involve stakeholders directly in it. Different disciplines and different schools in ethics define what is fair in many different ways (Rayner and Malone 1998; Toth 1999). In the present context, ''fair'' is simply what those who are involved in or affected by the decision-making find to be fair. This entails giving a fair chance to all affected groups to participate, to present their values and concerns, and to protect their interests (procedural equity). Participation has become a buzzword in recent years and evidence is accumulating that it increases the overall quality of decisions concerning environmental assets and natural resources (World Bank 1996). In addition to the possibility of mobilizing local knowledge that is not otherwise accessible, and of increasing the acceptance of the decision, broad participatory approaches also facilitate dealing with the diversity of values, interests, conflicting interpretations of biophysical and social science analyses, and perspectives on how to cope with uncertainty.

Even if the participation of all stakeholders is impractical or impossible, the decision-making process needs to be open so that all affected parties can understand how a decision came about, its rationale, and how it affects different social or stakeholder groups (transparency). Irrespective of whether direct participation is possible and/or meaningful, the decision outcome needs to obey prevailing fairness principles in the society (consequential equity). The corresponding axiom in the analysis domain is the requirement to choose the assessment framework and the decision criteria according to the relative importance of fairness concerns in the decision-making context. Exploring outcomes under different criteria provides valuable insights into the trade-offs among them while multicriteria frameworks can help progress towards compromise solutions. In recent years, a variety of participatory assessment techniques have been proposed and are being increasingly used (Toth and Hizsnyik 1998) in which stakeholders jointly investigate the problem and the range of available options in preparation for the decision-making process. Participatory techniques are particularly worth considering in complex and controversial decision-making situations.

A review of the responses discussed in the chapters in Part II supports the importance of including a concern for equity, participation, and transparency in the decision-making process.

For example, with respect to *biodiversity,* Chapter 5 points out that habitat and area protection responses that rely on indirect incentives such as alternative economic development opportunities, integrated conservation and development projects, or ecotourism are designed with equity concerns as key considerations. Habitat and area protection responses that rely on direct incentives, such as the purchase of easements, tax incentives, tradable development rights, or direct land acquisition, also incorporate equity considerations because the focus of these responses is that of sharing the benefits of global biodiversity values locally with

those whose well-being is tied to some exploitation of the targeted habitat or area. Participation of local people and communities in the design of such responses is also important for successful outcomes. Equity is a key aspect of the Convention on Biological Diversity's explicit protection of local knowledge. Also, equity is a key consideration when the reintroduction of fauna is a response option (for example, between cattle ranchers and wolves).

Failure to consider questions of equity and participation with regard to *water services* (Chapter 7) can cause a major problem for several important responses such as sharing water in a transboundary context, command-and-control regimes, assigning property rights in freshwater services, making changes to infrastructure, or using market-based incentives. For example, a specific response to the challenge of transboundary water management is the strengthening of provisions for public involvement, which includes access to information, public participation, and access to justice or legal recourse. An important tool for public involvement is the development of a process for transboundary environmental impact assessment. Given the general heterogeneity of environmental and socioeconomic conditions, effective management of freshwater resources to support multiple uses often requires numerous site-specific responses that are beyond the capacity of centralized authorities. Although a basin-wide approach is necessary for some aspects of management of freshwater resources (that is, flood forecasting), many aspects may best be resolved locally because it allows for more direct engagement of stakeholders. Although the use of water for basic human needs has not been recognized as a fundamental human right in international law, there should be no debate about the fact that human beings cannot survive without access to potable drinking water. This is an important issue of equity with respect to water responses.

Many of the responses on *wood,* found in Chapter 8, discussed equity as the key consideration while making decisions. The need for full participation of the affected parties and for multistakeholder processes was cited numerous times. The discussion of multilateral processes that have led to national programs delineates between success and failure based upon the degree of participation afforded by local people. Public-private partnerships likewise have been more or less effective to the extent that the economic rights of local people are considered and protected. The same can be said of traditional forest planning approaches applied in the tropics as well as plantation developments. Insuring that proceeds from royalty concessions find their way to those most affected by the change in the use of a public forest was highlighted. Attempts at collaborative forest management and decentralization have equity considerations at their core. It is also acknowledged that when company/community partnerships are pursued getting the right balance of benefits between the parties is often difficult because the nature of the respective benefits may be very different. Forest certification schemes have been criticized for failure to include the views of local people or to consider small producers who do not have the economies of scale to be able to afford to participate in what have been very expensive programs. In fact, the ''paper-based'' approach to certification is often a barrier to indigenous peoples who do not have the resources or skills necessary to comply with the detailed reporting requirements. Finally, some see the competing uses of wood (as between products and fuelwood) as an issue of gender equity with men relying on the former use and women on the latter.

With respect to *flood and storm services* (Chapter 11), equity may play an increasing role in deciding whether and how disaster relief and aid will be provided as the concern about extreme hydro-meteorological events tied to climate change grows.

Considerations of equity are an important influence with respect to finding responses for *vector-borne disease control* (Chapter 12). The role of the community and health education is a vital element of success with respect to sanitation. Dissemination of information to all people plays an increasingly important role generally.

Cultural service responses found in Chapter 14 are tied closely to considerations of equity in ways very similar to both the biodiversity and wood responses. The focus of these responses is the sharing of the benefits of global value locally with those whose well-being is tied to the exploitation of a local resource that might be restricted or those whose culture is being ''marketed.'' These responses allow local people to share the fruits of tourism and ecotourism schemes in a substantial way. They also include proper participation in decisions that might affect the continued habitation of a particular area or decision about production standards incorporated in certification schemes that might have an impact on local practices. In addition, these responses suggest participation by local people in decisions that would lead to the exploitation of a group's culture (that is, for tourism purposes).

One outcome of such participation might be revenue sharing with respect to the use of a group's cultural symbols. Another important aspect of the responses is the building of capacity to allow for the aforementioned participation in a meaningful way. Equity is a key motivator of the CBD's explicit protection of property rights regarding local knowledge. It is also a key consideration in the reintroduction of fauna or the elimination of alien species when it comes to landscape restoration. (For example, with respect to this latter point, equity might dictate the compensation of livestock farmers when wild animals such as bears and wolves are reintroduced to an area, or to fruit farmers when a non-indigenous tree is eliminated from a restored landscape).

18.3.6 Assigning Clear Accountability and Providing for Monitoring and Evaluation

Responsibility for ecosystems decisions and their implications is an elusive issue if one takes into account the multitude and magnitude of uncertainties about the biophysical process, social behavior, and the poor controllability of the underlying processes in both domains. Yet a reasonable level of accountability for at least the manageable aspects of the decisions would encourage decision-makers to use the best available information, involve relevant stakeholders, and keep the decision process transparent. In relatively simple regulatory or resource allocation cases, the responsibility rests with the decision-maker who has the ultimate authority to put policies and measures in place. In more complex situations involving several organizations, each should be accountable for the formulation and implementation of the decision component in its own domain or mandate. Similar principles of accountability would motivate analysts to use the most suitable tools and the best available data and to expose their results to extensive reviews.

Decisions with respect to responses are made within a complicated web of different levels of governance in different sectors and at different scales. Some decision-makers have both official and genuine power while others are mere representatives for others with power who stay in the background. Moreover, the consequences of decisions may be so remote, indirect, and time-lagged that it is very difficult to clearly assign accountability for their outcome. Aligning accountability with decision-making will improve this process, and attaining transparency in the decision-making process is a way of achieving this alignment.

A prerequisite for effective accountability is a full evaluation of policies based on reliable monitoring. However, to monitor properly and objectively the outcome of policies is difficult to accomplish. First, there is always a lack of money and other resources that are mostly assigned to other, more visible purposes. Second, some people may not welcome monitoring as it may reveal irregularities (including corruption). Evaluation of the effects of a measure or action requires establishment of a causal link between the action and its impact (for example, introduction of catalytic converters in cars—reduction of carbon monoxide emissions). It is certainly not so simple to distinguish between causality and simple association. A careful analysis to discount the effects of confounding factors is necessary.

The achievement (or non-achievement) of targets is one of the key considerations. A crucial prerequisite is that the targets are transparently and clearly stated, preferably in quantitative terms. If this is done, the evaluation is a relatively easy task provided that proper indicators both for the targets and for the actual state are available. The evaluation should also examine the impact of unexpected factors that may have helped or hindered the achievement of objectives and targets or had other ancillary impacts.

To cover properly the overall impact of a given policy is probably the most difficult part of the evaluation. First, the different scales (spatial and temporal) must be taken into account. In particular, the evaluation process must take in account long time scales. Second, there could be direct but also indirect effects. Third, most policies have impacts in all the environmental, economic, and social realms. Fourth, many stakeholders may exist as a result of which the impact may be very different (distributive effects). Even if it is sometimes stressed that a certain action will result in a ''win-win'' situation there always are some losers. In this context, these questions—among others—should also be answered: Are the achieved objectives justified in terms of financial and other costs? Are the impacts enhancing human well-being and/or bringing economic benefits besides improving the environment? For example, has reduction of emissions had any effect in decreasing health problems? (Clancy et al. 2002; WRI 2003)

Insurance and other financial markets play an increasing role in the area of environmental accountability and performance monitoring (UNEP 2004). With respect to accountability, insurers and providers of financial capital are beginning to charge premiums in accordance with expected environmental liability. In addition, trends in overall premiums and claims will provide an explicit signal with regard to the success of the responses.

Central to the responses on *biodiversity* is monitoring and evaluation of policies, especially in the habitat and species protection schemes based on direct incentives. For example, property rights that have been created or regulations that have been promulgated need enforcing. Sustainable production practices as embodied in certification programs require that standards be maintained. An important problem in many cases is the lack of clear baseline indicators and quantitative targets (Chapter 5).

An example of an important response regarding *water services* is the basin-wide river basin management. Management of river basins is mostly performed by different river basin organizations, of which several examples are given in the Chapter 7. A pattern that is often observed is the tendency of basin-level management to be dominated by more tangible and economically dominant interests. However, recently, the integrated approach is more prevalent. Also important in this respect is the so-called shared water in a transboundary context. An important tool for public involvement is the development of a process for transboundary environmental impact assessment. The issue of water resources management is presently high on both the international environmental and development agendas. In part, this is due to necessity—261 major river basins are shared by two or more sovereign states worldwide. The accountability issue is essential when assigning rights to fresh water services and applying market-based incentives.

In the area of *forest management and protection,* accountability, monitoring, and enforcement are important aspects of response design and selection. Multilateral agreements and initiatives recognize the necessity of accountability including the codes of conduct for the private sector. The International Tropical Timber Organization has created indicators and has tried its hand at enforcement of sound forestry practice. Neither traditional forest planning (when applied to the tropics) nor reduced impact logging approaches can be effective without adequate enforcement regimes and resources. It is often the failure to provide adequate resources for monitoring where enforcement breaks down. Certification responses are based on standards and monitoring. Conservation concessions tie royalty payments to the maintenance of certain parameters of protection (Chapter 8).

Financial services regarding *flood and storm* responses include insurance, disaster relief, and aid. Insurance, in particular in connection with floods, is an increasingly important response. Its significance has grown in recent years, with more frequent threats of extreme hydro-meteorological events in connection with global climate change. Disaster relief and aid is getting more international recognition. Connected with these responses are large sums of money. Therefore, the requirement of accountability is very important (Chapter 11).

Because large financial resources are attached to international programs, accountability issues play an important role with respect to *vector-borne diseases* (Chapter 12).

18.3.7 Considering Vulnerabilities and Risks

A crucial aspect of equity issues is related to vulnerable groups and communities. Vulnerable here refers to people who are sensitive to changes in ecosystems services and lack the ability to cope with those changes, that is, recognize preliminary signals in time, consider response options, and adapt to emerging changes or counteract them. The interests of the vulnerable communities are much better respected when defended by a credible, legitimate advocate, coming ideally from the concerned community or communities. Yet vulnerable groups are often unable to engage even in open and receptive decision-making processes because they lack the basic knowledge, or the necessary information and communication tools. Special representatives or legitimate assigned advocates are, therefore, required to speak for their interests in order to prevent top-down decisions being imposed on them. In the assessment work, extended analyses framed from the perspectives of vulnerable groups are required to estimate the implications of the different options for them.

Vulnerability and risk pertain to human populations as well as ecosystems and their services. Vulnerability is defined as the capacity to be wounded by socioeconomic and ecological change. It has three main elements: exposure, sensitivity, and resilience. Resilience is particularly important—if resilience is not maintained within the system or the person then they will become more vulnerable. Vulnerability is, therefore, a property of coupled social-ecological systems. An example from South Africa illustrates the point.

In the South African Development Community (regional level) during 2002–03, the complex system of outside pressures contributed to the complexities associated with climate stress and food insecurity. Many donors have provided early warning sys-

tems and are managing food insecurity and risks, thus reducing vulnerability in the region. However, the contributions of adverse synergies including droughts and politics that have precipitated famines have become more prevalent and endemic in sub-Saharan Africa. In the Vhembe District in Limpopo Province (district-local scale) research results have shown that there are gaps and weaknesses with regard to improved resilience to climatic risk.

Identifying the reasons for the lack of action is the key to understanding the drought effects that occurred at the national and regional levels specified above. First, it is clear that forecast alone is not enough. There needs to be more activity in broadcasting the forecast by different media, for example, the radio, newspapers, videos, to district institutions, and to the community level. Second, farmers may be constrained by lack of resources from responding to information about climate stress. The resource constraints include lack of access to credit, land, and markets as well as lack of decision-making power. There are, however, encouraging signs in the Vhembe District and at the national level for building adaptive capacity under conditions of climatic and environmental stress. There are signs that research on ways to improve adaptive capacity in South Africa will produce generalized recommendations that will improve policy (Vogel and Smith 2002).

Vulnerability and risk considerations may go directly to the heart of several of the *biodiversity* responses (Chapter 5). Habitat protection schemes that are based on direct incentives such as easement and land acquisition target vulnerable places, ecosystems, and species. The participation of the local people and communities in the design of any responses to biodiversity is also very important for successful outcomes. An example is the Misiones Region in northeastern Argentina where the forest has been replaced with agriculture although the soils are fragile (Rosenfeld 1998). Two major types of peasants are distinguished and they have designed very different farming systems and control strategies that interact in the wider context in which they operate.

With respect to *food,* agricultural research could be prioritized with the participation of farmers and begin with an integrated evaluation of their socioeconomic needs and their natural resource endowments in order to provide an equitable and effective process (Chapter 6). For example, poverty and vulnerability among smallholder farmers is high because the soils are of poor quality and are drought-prone. Low productivity affects hunger and poverty and leads to low economic growth. This leads to poor health, which, in turn, leads to low productivity. A response might be to apply integrated pest management to reduce the need for pesticides, but this may be subject to uncertainty as IPM has not been very successful in the past. In Kenya and Tanzania, indigenous plants were a source of raw material to allow people to cope when the harvest failed. This provided a crucial safety net; for example, indigenous fruits provide important nutrients for children when meals are reduced at home. The sale of livestock and poultry and engaging casual labor are often indirectly dependant on ecosystem services. Data in MA *Current State and Trends* show the increasing percentage of households who depended on indigenous plants in Kenya and Tanzania (Eriksen 2000).

With respect to *wood,* the vulnerability of human well-being arises in the context of multilateral agreements and initiatives and any objectives for poverty reduction (Chapter 8). Environmental vulnerability is raised explicitly in the context of the protection of habitat as an objective of certain public-private partnerships and conservation concessions. The drive to better manage forest resources is implicitly directed at the vulnerability of those resources and vulnerable people and the risk that we may pass some tipping point with respect to ecosystem services.

Vulnerability of ecosystems and human populations are prominent when it comes to *flood and storm control* (Chapter 11). Flood plain and coastal zone development increases the number of people at risk. Human beings are increasingly occupying regions and localities that are exposed to extreme events, and are likely to become more poverty-stricken as a result. Many of the datasets on extreme events show that impacts are increasing around the world, and studies show that human vulnerability is the primary factor explaining trends in impacts. Case studies at the local scale have shown that human interactions with ecosystems have increased the vulnerability of humans and impacts on human well-being, and that appropriate management of ecosystems can reduce vulnerability and contribute to increased human well-being.

With regard to ecosystems and *vector-borne disease control* (Chapter 12), responses that affect the state of ecosystems are also likely to affect the health of people, thereby putting them at risk. On the other hand, responses aimed at promoting human well-being through the eradication of vectors can have profound effects on vulnerable ecosystems such as wetlands. All responses should be measured in terms of their effectiveness on human well-being in its broadest sense, including the provision of ecosystem services. The International Red Cross Federation (2002) has shown that the death toll from infectious diseases such as HIV/AIDS, malaria, diarrhea, and respiratory diseases was 160 times the number of people killed due to natural disasters in 1999.

With regard to *climate* regulation, there is a close interrelationship between climate and ecosystems (Chapter 13). When climate variation increases outside its ''normal'' bounds, vulnerability increases. Adaptation serves to reduce vulnerability to climate change by minimizing exposure or maximizing adaptive capacity. The poor will have less capacity to adapt and mitigate the impacts of climate-induced changes to ecosystems. Desertification is an example of a coupled socioecological system that threatens livelihoods. It is a good example of issues in understanding vulnerability (Downing and Ludeke 2002). Diversifying and strengthening local livelihoods will contribute to climate change policy by providing greater adaptive capacity and reduced vulnerability to change.

The *cultural service* chapter (Chapter 14) views vulnerability and risk in the context of fragile cultures or those without capacities or sufficient power to be meaningful participants in decision-making or negotiations. Therefore, the chapter stresses that responses such as those dealing with certification of sustainable production practice or fair trade should address this issue in decision-making. It does so, likewise, with respect to responses that involve relocation of local cultures in the light of landscape restoration or that which involve eco-tourism that capitalizes upon elements of local culture. Responses that seek to protect local knowledge and language directly address the vulnerability of traditional cultures and the risk to society in general from their atrophy or absorption. Conversely, UN programs designed to diffuse knowledge and best practice are intended to protect the viability of indigenous and local human well-being and, thereby, indirectly, their cultures.

With regard to *integrated responses,* the well-being of people around the world is strongly related to the environment in terms of livelihoods, health, and vulnerability (Chapter 15). The poor are highly vulnerable to droughts and floods, the frequency and severity of which may be expected to increase with climate change. The chapter stresses the need for more fresh water, the absence of which can lead to illness, malnutrition, famine, and greater incidences of floods and droughts. UNDP (2003) formulates a disaster risk index to assess global patterns of natural disasters and the relationship to development. The disaster risk index

calculates the relative vulnerability of a country to a given hazard as the number of people killed by the hazard divided by the number of people exposed to it.

The best available data on a global scale confirm that during the past four decades the number of great disasters has increased four times, while economic losses have increased by ten. (Swisse Re 2003; Munich Re 2003; CRED 2002) Although comprehensive global databases are not available for smaller-scale hazards the significance of these more common events to the social vulnerability of exposed human populations is a significant concern among vulnerability analysts (ISDR 2002; Wisner et al. 2004).

18.3.8 Dealing with Uncertainties

Decision-making about ecological management and the use of ecosystems services is plagued by inherent uncertainties. Even if the functioning of an ecosystem is relatively well understood under the prevailing conditions, the ecosystem behavior might shift as a result of changes in some external driving forces or conditions (Walker and Steffen 1996). Moreover, the values and valuation of ecosystems and their services by the relevant communities might change or stakeholders may revise their positions. The implication of all these uncertainties for decision-making is that both the process and its outcome must be flexible so that they can respond to newly available information about the biophysical system (ecological or scientific uncertainties), about the social system (value- and behavior-related uncertainties), and about the effectiveness of the decision itself (regulatory uncertainties) (NRC 1996).

The sources, nature, and magnitude of uncertainties involved in a given decision-making problem also have implications for choosing the analytical framework (Morgan and Henrion 1990). In order to provide useful insights, the assessment tool needs to be suitable for accommodating decision-making under uncertainty and hedging, and multiple decision criteria reflecting differing values of the different stakeholder groups. Ideally, a single assessment framework should be chosen that is sufficiently flexible to accommodate and help consolidate a diversity of relevant perspectives on ecosystem change. If this is not possible, multiple frameworks are needed but this raises the important problem of how to consolidate their results. The range of decision options explored by the analytical tool should also take adaptation possibilities into account, including the feasibility and costs of midcourse corrections in the light of new information and give special consideration to irreversibilities, uncertain thresholds, etc. Dealing with risk and uncertainty is considered a very important part of the overall framework for the whole millennium ecosystem assessment. (See MA 2003, Chapters 4, 8.)

First of all, uncertainties arise regarding information both on the biophysical systems and the social and economic contexts including changing values and behavior. Second, the effectiveness of the decisions themselves and their implementation introduce uncertainty to outcomes. Decisions at all levels and scales should, therefore, allow for the policies to be flexible and adaptive, to allow learning, to incorporate results of evaluation, and to make necessary adjustments to accommodate new situations and/or new information. On the other hand, there is always a trade-off between flexibility and responsiveness of the policy and its stability without which it loses credibility and, therefore, all effectiveness. There is a difference between rigid policies that insist on nonessential requirements and policies that are reliable such that rules do not change in the middle of the game.

In contrast to human perspectives, ecosystem services issues are long-term and, therefore, the uncertainties caused, starting with the limited knowledge of the evolutionary processes and external influences, are inherently large. In this context, one of the solutions is the use of the precautionary approach defined by Principle 15 of the 1992 Rio Declaration (UN 1992).

With respect to *biodiversity* responses, better information on levels of uncertainty about biodiversity and its values could greatly assist decision-making. For example, we do not know which species are most likely to go extinct but we may say with *high certainty* that the rapid loss of biodiversity threatens the functioning of natural systems and human welfare. Many sources of uncertainty affect decisions in this case (missing data, random sampling errors, unknown functional relationships within ecosystems and between ecosystems and humans, unknown future consumption patterns, etc.) and due to complexity of the issue, our ability to choose the right options will be always imperfect. Thus it is necessary to avoid irreversible actions until uncertainty is resolved. Also integration across response options can mitigate and reduce uncertainty. Regional planning approaches to habitat protection and environmental impact assessments will be much more effective if uncertainty and adaptability are the key elements. Reclamation and rehabilitation in and of themselves demonstrate the quality of adaptability. However, the most telling example of the importance of considering unintended consequences and uncertainty comes when the introduction of a non-native species is chosen as a response to eradicate another invasive and damaging species (Chapter 5).

The aspect of uncertainty, flexibility, and adaptation is not strongly expressed within the responses regarding *food*. However, new approaches such as novel technology like introduction of genetically modified organisms and biological control methods should be guided by a principle of precaution as the level of uncertainty is high. Flexibility and adaptation is very much needed in successful development of effective and environmentally sound methods of aquaculture (Chapter 6).

Responses regarding *water services* are inherently chosen under the condition of high uncertainty due to rapidly changing and highly unpredictable hydro-meteorological conditions. High levels of flexibility and adaptability can be achieved by decentralization of management and decision-making (that is, democratic decentralization, deconcentration, and privatization). Given the general heterogeneity of environmental as well as socioeconomic conditions, effective management of freshwater resources to support multiple and often conflicting uses often requires numerous site-specific responses that are beyond the capacity of centralized authorities.

Although a basin-wide approach is necessary for some aspects of management of freshwater resources such as overall water allocation, flood forecasting, and emission of persistent pollutants, others, such as problems associated with land and water relationships, and operations and maintenance of irrigation canals, may best be resolved locally because it allows for more direct engagement of stakeholders and more appropriate responses to site-specific circumstances. For example, in North America, the United States and Canada are developing and advancing a number of large-scale watershed ecosystem approaches along their extensive inland border, which are moving toward carrying out holistic approaches that include addressing the interrelated challenges, goals, and problems of water flows, quantities and levels, water quality, and protection of aquatic wildlife and their habitats. This long-term Canada-U.S. cooperation on shared watershed ecosystems helps respond to many calls from national, international, regional, and global levels to develop and implement sustainable development approaches between and among countries (Chapter 7).

With respect to *wood,* considerations of uncertainty are important in the context of forest management strategies, in particular, of both indigenous people and small-scale owners/managers. These types of managers tend to diversify the products and benefits they take from the forest resources they manage and, therefore, they are able to adapt to unforeseen circumstances and cope with uncertainty. Unintended consequences arise in the context of public delegation of forest management rights through conservation concessions in that governments/communities have ceased other conservation efforts in the face of granting these concessions (Chapter 8).

In response to the highly uncertain nature of *flood and storm* only such non-structural measures such as forecasting and warning have the characteristic of flexibility. Most of the other responses are relatively rigid and non-flexible. The modern types of physical structures like dikes, weirs, and barriers are striving to achieve some flexibility through modern technology. Even if the physical structures, in general, are not adaptive as such we will continue to rely on them through the twenty-first century. The important point is to place them within an integrated system including warning and other measures (Chapter 11).

Unintended consequences are prominently illustrated by the failure of insecticide use when it comes to controlling *vector-borne diseases* (Chapter 12).

18.3.9 Considering Cross-scale Effects

The overwhelming majority of new decisions about ecosystems management have to be incorporated in the hierarchy of existing policies and regulations. Accordingly, the decision-making process needs to be open to comply with relevant policies already in place or to initiate appropriate changes in them. Similarly, the decision-making process has to be extended to initiate relevant decisions at lower levels that might be required for effective implementation. On the analytical side, the selected tools must be capable of incorporating the hierarchical conditions of the decision-making problem at hand. They must be able to accommodate constraints provided by higher-level regulations and to explore decision needs and options at lower levels required to achieve the goals of the decision problem explored.

With respect to choosing responses to protect, conserve, and enhance habitat and species, the more important scale dimension is, in fact, that of time. Obviously, multilateral environmental agreements such as the Convention on Biological Diversity work across jurisdictional and geographic scale, primarily global to national. Regional planning approaches to habitat protection are, in fact, intended to integrate scale (that is, regional to local to site-specific responses such as certification programs that target sustainable practice in forestry and fisheries work from global to regional to local scales). See Berkes (2004) relating to cross-scale interactions and certification programs. With regard to *biodiversity* the incorporation of biodiversity policies into integrated regional planning will promote cross-scale effects and make sound trade-offs between all the different scales. Local biodiversity may be useful but global biodiversity ignores the local biodiversity values. Vermeulen and Koziell (2002) see the focus on global values as a consequence of the fact that the global consensus relates to wealthy countries that recommend biodiversity in terms of services derived from it and not as an end in itself (Chapter 5).

Scale is a very important concept with respect to *water.* Management of river basins that stretch across jurisdictional bounds is mostly performed by different river basin organizations. A specific response to the challenge of transboundary water management is the strengthening of provisions for various aspects of public involvement, which includes access to information, public participation, and access to justice or legal recourse. Because 261 major river basins are shared by two or more sovereign states worldwide (Wolf et al. 1999), the development of a process for transboundary environmental impact assessments is an important tool for public involvement. In Africa, where 57 shared international river basins cover 60% of the continent (Gleick 1993), management of transboundary water is not a new challenge and the local people are encouraged to cooperate and manage in a transboundary context. The issue of water resources management is presently high on both the international environmental and development agendas (Chapter 7).

With respect to *wood,* the time scale comes prominently into play when considering the stewardship motivations (perpetuating the family asset) of the small-scale private owners and managers of forests. However, the size of forests is also the key to their management strategies, and influences their abilities to satisfy requirements associated with certification programs. The duration of the term is a key issue when discussing the delegation of public forest management through conservation concessions. Finally, the time scale is important to proper forest plantation development and management (Chapter 8).

With regard to *nutrient cycling,* the problem of nitrogen pollution manifests itself at the local to regional scale, so local and regional governments clearly have a role to play. For example, the technologies for nitrogen removal for sewage treatment in the Tampa Bay have led to water quality improvement but to a lesser extent in Chesapeake Bay (NRC 2000). These U.S. examples are at a local scale (Chapter 9).

Physical responses to *flood and storm control* such as dams and levees may cause net harm to ecosystems in the longer time-scale in terms of restoration and resiliency. In turn, this may reduce the anticipated (or expected) benefits of the responses (Chapter 11).

In terms of *cultural services,* multilateral environment agreements such as the CBD work across jurisdictional and geographic scales, primarily global to national. Responses such as certification and fair trade programs work from global to regional to local scales (and vice versa). Local organizations can take advantage of emerging global institutions and conventions to bring their case to wider political arenas (Chapter 14). An example is ''The Samarga Declaration'' to prevent the granting of industrial logging in an area they consider theirs (Taiga Rescue Network 2003; Molenaar 2002).

Scale issues are critical in *integrated responses* and cross-scale responses may be necessary. Integrated responses are long-term in nature, and require fundamental shifts in governance institutions with regard to skills, knowledge, capacity, and organization. Integrated responses also occur at different geographic and jurisdictional scales and across scales and use a range of instruments for implementation. However many attempts at integration are sector-based and do not address multiple ecosystem services and human well-being simultaneously. Implementing integrated responses may be resource-intensive but the benefits can outweigh the costs. Thus it requires the bringing together of many different stakeholders at different levels and the need to provide decision-making and management procedures at all levels. Integrated responses do not necessarily bring about equitable distribution of benefits to stakeholders (Chapter 15, especially Table 15.1).

18.4 Considering Business Motivations

Business is positioned to be a positive force in the resolution of key trade-offs. It can play a role through the development and

deployment of new technology, pursuit of new business models, reduction of operational footprints, provision of leadership, setting of examples, and coalescing of partnerships. For example, as environmental pressures build up, the developed world and its consumers may begin to demand more cyclic models of activity and begin to define quality of life in less material ways such as leisure, experiences, knowledge acquisition, and relationships. Changes such as these could create business opportunities in service, ''reverse flows,'' education, and travel. In addition, supporting public policy that raises industry environmental performance standards could advantage leaders and first movers while raising the standing of the industry as a whole with its important constituencies. Business leadership with respect to reducing poverty, improving human well-being, and protecting the environment can be in business' self interest. For example, this leadership could help secure stable and safe societies, preserve open and free markets, insure access to critical resources, provide new product and business opportunities, optimize social and environmental transitions, and, for the most astute and agile, carve out competitive advantage.

18.4.1 Reputation and Brand Risk, Partnerships, and Investor Confidence

In a fast changing business and market environment, a firm's reputation can be the certainty that it can provide customers, investors, employees, suppliers, and communities. In this way, reputation, as signaled through its brand, acts as a magnet. A good reputation can help differentiate a firm in crowded markets, both product and capital. A very tangible indicator of the value of reputation can be found in market shares, price premiums for otherwise similar products, or higher price/earning multiples for companies in the same sector. The right reputation can attract the best employees and partners and, therefore, provide access to the best ideas. In this way, reputation might be considered a key corporate asset to defend and enhance (Ottman 1998).

''Value adding'' and strategic partnerships can be important to successfully achieving corporate objectives. Partnerships help accelerate learning and leverage resources. Important relationships must be designed for the mutual advantage of all partners, and with the idea that a ''bigger pie'' may be more important than a ''bigger slice.'' Finding good partners can be a source of competitive advantage (Rondinelli and London 2003).

Investors of capital do not like uncertainty or surprises and, therefore, steer investment away from sectors or from firms within those sectors whose risks and potential contingent liabilities are not well understood. In order to attract capital, these sectors and firms must pay higher rates. The uncertainties introduced by questions of sustainability, potential costs and liabilities for the use of common environmental resources which are currently not taken into formal accounting statements, potential regulatory constraints on products and operations, and the prospect of restricted access to natural resources or sites are playing a larger role in the investors' calculus. Corporations are increasingly aware of the impact that reputation for business practices that address these risks and uncertainties can have on their cost of capital (Reed 2001).

Trust and transparency can help create a value-adding reputation, and environmental performance reporting (that is, Global Reporting Initiative) and meeting certain standards such as those found in eco-labeling schemes are responses that leading corporations are pursuing with reputation and brand image in mind (Chapter 8).

18.4.2 Access to Raw Materials and Operational Impacts

The availability and access to clean water is likely to change the way private enterprises in the developing world and the industrial countries conduct business in the twenty-first century. For industries as different as food and agriculture and high technology (for example, semiconductor plants require enormous amounts of water for chip production), water will increasingly be a factor in determining where, how, and with whom private enterprises conduct their business (MA *Scenarios,* Summary).

While ecological degradation is often portrayed as a conflict between ''public environmental interests'' and ''private business goals,'' different types of ''business conflicts'' are likely to emerge in the future. For example, with tourism becoming the world's largest employer and an important economic factor in many developing countries, native forestland and other natural resources will be increasingly perceived as ''vital business assets'' of many private companies (MA *Scenarios,* Summary).

Non-point source pollution associated with agriculture is under greater scrutiny (Chapter 6).

Development of farm wood-lots and large-scale plantations is an increasingly widespread response to the growing demand for wood, and the decline of available natural forest areas. Not all afforestation projects have positive economic, environmental, social, or cultural impacts. Without adequate planning and management, the wrong growers, for the wrong reasons, may grow forest plantations in the wrong sites, with the wrong species. In areas where land degradation has occurred, afforestation may play an important role in delivering economic, environmental, and social benefits to communities reducing poverty and enhancing food security. In these instances, forests and trees must be planted in ways that will support livelihoods, agriculture, landscape restoration, and local development aspirations. There is increasing recognition that semi-natural, mixed-species, and mixed age plantings can provide a larger range of products, ''insurance'' against unfavorable market conditions or insect and disease attacks, diversity of flora and fauna, protection against the spread of wildfires, and provision of greater variety and aesthetic value in the landscape (Chapter 8).

18.4.3 Opportunities and Incentives

18.4.3.1 Technology

Technology has helped to increase food production from cultivated ecosystems and is expected to continue to do so in the future. The experiences of the last Green Revolution, combined with the best of new agricultural sciences, could support a future agricultural revolution to meet worldwide food needs in the twenty-first century. Increased pressures on the resource base (land, water, fisheries, biodiversity) and the potentially serious effects from climate change add to the importance of the role technology can play (MA *Current State and Trends,* Summary).

Technology has made possible a rapid rate of ''development'' of water resources with a view towards maximizing freshwater provisioning services (for example, water supply, irrigation, hydropower, and transport) to meet rising populations and human needs**.** However, it is the re-examination and alterations of existing infrastructure that offers the most opportunity in the short and medium term (Chapter 7).

An extensive array of technologies is now available in the energy supply, energy demand, and waste management sectors, many at little cost to society. Significant reductions in net greenhouse gas emissions are technically feasible given a portfolio of

energy production technologies including fuel switching (coal/oil to gas), increased power plant efficiency, carbon dioxide capture and storage, pre- and post-combustion, and increased use of renewable energy technologies (biomass, solar, wind, run-of-the-river and large hydropower, geothermal, etc.) and nuclear power, complemented by more efficient use of energy in the transportation, buildings, and industry sectors (Chapter 13).

Similarly, technical tools exist for reduction of nutrient pollution at reasonable cost**.** That many of these tools have not yet been implemented on a significant scale suggests that new policy approaches are needed, but also that business opportunities may exist (Chapter 9).

18.4.3.2 Market and Other Economic Incentives

Market-based approaches have the potential to unlock significant supply- and demand-side efficiencies while providing cost-effective allocation of scarce resources. Supporting legal and economic institutions need to be in place. Also, market driven instruments do not automatically address poverty and equity issues related to the use of provisioning ecosystem services.

Functioning water markets can provide price signals for reallocation not only between different uses, but also signals to guide conservation activities. Water exchanges, water banks, and water leasing have emerged as arrangements for promoting market activity (Chapter 7).

Market mechanisms and economic incentives can significantly reduce the costs of mitigation in the context of climate change (Chapter 13) and market-based instruments hold the potential for better nutrient management (Chapter 9).

Consumer preferences operating through the market have resulted in some important forest and trade policy initiatives and improved practices in some large forest corporations. Forest certification has become widespread in many countries and forest conditions (Chapter 8).

Reforestation, improved forest, cropland, and rangeland management, and agroforestry provide a wide range of opportunities to increase carbon uptake, and slowing deforestation provides an opportunity to reduce emissions. Land use and its change and forestry activities have the potential to sequester about 100 gigatons of carbon by 2050, which is equivalent to about 10–20% of projected fossil emissions over the same period. Evolving markets for carbon reduction credits raises the prospect of market opportunities (Chapter 13).

Biological resources supply all of our food, much of our raw materials, and a wide range of goods and services including genetic materials for agriculture, medicine, and industry. Potential future uses convey option values. In the light of current and future uses of biological resources, it is important to understand the implications of the loss (at an accelerated pace) of species. The private sector is showing greater willingness to contribute to biodiversity conservation, due to the influence of shareholders, customers, and government regulation. Many companies are now preparing their own biodiversity action plans for biodiversity conservation, supporting certification schemes that promote more sustainable use, and accepting their responsibility for addressing biodiversity issues in their operations (Chapter 5).

18.4.4 Examples of New Business Opportunities

Organic farming can contribute to enhancing sustainability of production systems and agricultural biodiversity. In several industrial countries, organic agriculture contributes a growing portion of the food system. Agroforestry, which is a low-input farming system with greater sustainability than ''slash-and-burn'' or high-input monocultures, is an alternative technology for increased food production, using nitrogen-fixing trees to increase soil fertility and nutrient cycling. New crops developed from indigenous trees producing traditionally important foods and other marketable products enhance food and nutritional security, and also allow farmers the opportunity to increase the productivity of their staple food crops. Aquaculture is an example of a novel food production system that has evolved into a well-known production system, but the present situation is accompanied by serious impacts on ecosystems, including loss of vegetation, deterioration of water and soil quality, and loss of biodiversity (Chapter 6).

Environmental awareness and educational programs have been successful in allowing consumers and resource users to make well-informed choices for minimizing waste in their purchasing decisions. Employers have introduced programs to encourage and recognize initiatives by the community to reduce waste. In Japan and other industrial countries, ''industry clusters/technology platforms'' have been planned where the waste of one industry is the resource of another. The sale of products from waste, whether by simple re-use, recycling, and recovery, or by more complex technological processing, has helped to create jobs appropriate to the socioeconomic conditions of various localities or countries (Chapter 10).

There has been a significant growth in some non-wood forest product markets with the extension of the market system to more remote areas; a growing interest in natural products such as herbal medicines, wild foods, handcrafted utensils, and decorative items; and development projects focused on production, processing, and trade of non-timber forest products (Chapter 8).

If technology continues to develop, industrial-scale fuel derived from forest products could become a major contributor to sustainable energy sources. Consumption of fuelwood has recently been shown to be growing less rapidly than had been estimated earlier. Increasing urbanization and rising income have contributed to a slowing in the rate of increase in the use of fuelwood as users switch to more efficient and convenient sources of energy. In some regions, including much of developing Asia, total consumption is now declining. Efforts to encourage adoption of improved wood burning stoves have had some impact in the urban areas of some countries, but there has been little success in rural areas due to cultural and economic obstacles. Recent attention to improved stoves has shifted from increasing efficiency of fuelwood use to reducing damage to health from airborne particulate matter and noxious fumes associated with the burning of wood and charcoal. In industrial-country contexts, as renewable options gather more momentum, and the technology becomes more fine-tuned, it can be expected that ''dendro power'' options will become more competitive and investor-friendly (Chapter 8).

The biggest challenge for conservation in the twenty-first century is for it to take place outside parks and other protected areas and, thus, become integrated into agricultural and urban systems. Conservation outside parks could become important in opening new economic opportunities. Ecotourism could provide important opportunities to link conservation and development. An example is agrotourism, which could help conserve cultural landscapes, add value to farming systems, and address economic needs (Chapter 14).

Recreation, conservation, and environmental education can go hand in hand. Cultural tourism can serve to educate people about the importance of cultural diversity, as well as the importance of the latter for the conservation of biodiversity, provided the risks mentioned above are taken into account. Tourism and recreation can be linked to environmental education, fostering knowledge about the functioning of ecosystems and provoking

tourists to critically examine human–nature relations. Environmental education may serve very diverse audiences, ranging from schoolchildren to university students, protected area managers, policy-makers, and representatives of the private sector. In all cases, top-down education is less effective than education that is based on sharing experiences and attempts to reach a joint understanding of the dynamics of human–nature interactions (Chapter 14).

18.4.5 Considering Business Impacts in Public Policy

Despite the potential to positively engage business in providing solutions to questions about pressures on ecosystem services and human well-being, the financial impact that different response options have on corporations has received relatively little attention by the MA and by the public policy literature in general (Andrews 1998; Khanna 2001; Rivera 2002). This oversight is specifically highlighted in MA *Multiscale Assessments,* and arises, perhaps, because estimating business benefits is seen as more important for corporations than for decision-makers interested in ecosystem management. For instance, Chapter 3 of this volume does not explicitly address how to evaluate the cost and benefits of the response options for corporations.

Yet taking into account private sector benefits and costs is critical for the selection and implementation of response options. Response options that are too costly for firms exacerbate the traditional resistance from the business community to ecosystem protection measures making their enactment and implementation very difficult (Andrews 1998; Henriques and Sadorsky 1996; Highley and Leveque 2001; Rivera 2002). Conversely, win-win alternatives that promote ecosystem protection and provide direct incentives for businesses are more likely to have successful implementation (Chapters 2, 5, 8, and 15). For example, guaranteeing the sustainability of supplies may present one of the most persuasive cases for businesses to proactively protect biodiversity (Chapter 5).

The reaction of corporations to different response options is also affected by the combination of regulatory enforcement and consumer preferences. South Africa and Costa Rica are examples that exhibit the synergetic potential between ecotourism demand, increasingly stringent protection of national parks, and proactive environmental protection by tourism-related business (Chapter 5). On the other hand, firms operating in countries or regions with weak oversight from government, environmental groups, and/or other stakeholders show little interest in adopting ecosystem management practices even when they may have a positive effect on their bottom line (Cashore and Vertinisky 2000; Khanna et al. 1998; Henriques and Sadorsky 1996; Rivera 2001; Rivera and deLeon 2004).

Empirical findings from studies implemented in different parts of the world consistently suggest that besides offering financial incentives to corporations, traditional mandatory pressures are key ingredients for encouraging the proactive protection of ecosystems by the business sector (Chapter 15) (Wheeler 1999; Cashore and Vertinisky 2000; Khanna et al. 1998; Henriques and Sadorsky 1996; Rivera 2004; Rivera and deLeon 2004). Consumer preferences can also reinforce the pressures from regulators and stakeholders to promote proactive ecosystem management by the private sector. Markets with sizeable segments of environmentally aware (or ''green'') consumers significantly increase the incentives for proactive protection of ecosystems by corporations (Reinhardt 1998; Rivera 2002). For example, certification programs have taken advantage of increased demand for environmentally friendly wood products to promote sustainable forestry management practices in different parts of the world (Chapters 8 and 15).

Finally, empirical research also highlights the importance of training and technical assistance to promote proactive ecosystem protection practices among businesses. Virtually all chapters of the MA highlight that the lack of ecosystem management expertise is a fundamental barrier to improving protection of ecosystems. Higher education and environmental expertise appear to increase CEOs' recognition of the intrinsic value of nature and their perceived sense of ethical duty to protect it (Ewert and Baker 2001; Rivera and deLeon 2005; Cottrell 2003; Wiersema and Bantel 1992; Hambrick and Mason 1984). CEOs with higher education and natural resources management expertise can also be expected to be more aware of innovative technologies that lead to cost savings in the form of reduced waste, energy savings, and use of recycled materials (Hart 1995; Rivera and deLeon 2005). These CEOs may also have a better understanding of how an enhanced ''green'' reputation, generated by proactive ecosystem management, would create differentiation advantages in the form of price premiums and higher sales for their companies (Reinhardt 1998; Rivera 2002).

18.5 Summary Conclusions for Governments and Civil Society Organizations

Decisions or responses regarding ecosystem services are made at different levels by decision-makers identified in Chapter 2 by their scale of operation. This section briefly summarizes the main messages for decision-makers in governments (including, in principle, not only national but also international and sub-national levels) and civil society.

Government decision-makers should consider the factors that can facilitate effective responses. The most important ones include:

1. *Developing institutions that enable effective coordination of decision-making across multiple sectors*. Many ecosystems are managed in a sectorally arranged structure, (for example, by various ministries such as agriculture, environment, or industry) which is not conducive to effective horizontal coordination. In this way, the cross-sectoral trade-offs are difficult to resolve.
2. *Strengthening of institutions at a lower level of governance*. Regional and local governments often lack both sufficient capacity and empowerment to work properly. The decision-making at the sub-national and community level is better suited to holistic approaches. On the other hand, overly decentralized decision-making could also lead to poor ecosystem service management.
3. *Extending participation procedures focusing on the earliest phases of the decision-making cycle*. This includes increasing transparency and accountability of government decision-making, encouraging and supporting independent monitoring and assessment of government performance, and securing access to information and justice for all stakeholders.
4. *Promoting ''win-win'' solutions by creating an economic framework that supports proper management of ecosystem services*. This includes correcting market failures and internalizing negative environmental externalities. Because many ecosystem services are not traded, markets often fail to provide appropriate signals for optimal allocation of services. This unfavorable situation is exacerbated by harmful subsidies that promote the excessive use of some ecosystem services.

Agriculture subsidies promoting overproduction and/or overuse of fertilizers and pesticides are an example.

5. *Increasing emphasis on demand-side management and on the reduction of negative trade-offs*. As the per capita supply of services drops and the costs associated with production increase, greater gains can often be achieved through actions designed to reduce demand for harmful trade-offs rather than actions aimed at further increases in production. For example, in agriculture, the net economic gains from steps taken to reduce post-harvest losses, to reduce water pollution associated with fertilizer use, or to increase water use efficiency may often exceed the net gains from further investment in increased productivity.
6. *Building human and institutional capacity to assess the consequences of ecosystem change for human well-being and to properly manage ecosystems*. Current human and institutional capacity is extremely limited in all countries. To improve the situation, more and better-trained natural and social scientists and appropriate institutions are needed, as are effective mechanisms for incorporating local and traditional knowledge, dissemination of information, and dialogue with involved stakeholders.
7. *Requiring companies to publicly report on their environmental performance*. Asking companies to report on emissions in key areas and disclosing environmental liabilities (such as hazardous materials use) increase incentives for improved ecosystems management.
8. *Increasing emphasis on adaptive management*. Management interventions should always include a significant monitoring component, which would allow greater learning about the consequences of the interventions and improved management with time.

Civil society organizations should consider the following (based on WRI 2003):

1. *Stimulating demand for access to information, participation, and justice*. There may be gaps in national practices of access and so the corrective actions have to be encouraged. It is necessary to build the capacity of the community to engage in the public participation system.
2. *Providing objective information*. As many opinion polls show, the public considers the information provided by NGOs to be the most reliable. Undertaking independent assessment and regular monitoring of the activities of both the governmental and private sectors regarding the management of ecosystem services and their statutes is one of the main tasks for the civil society organizations. An important prerequisite for such an activity is sufficient capacity (knowledge, interests, the right and the ability to participate, etc.).
3. *Raising awareness among the public and the decision-makers of ''emerging issues'' such as nutrient loading*. Civil society organizations play a unique role in bringing new issues to the attention of the public and the decision-makers through public education and lobbying. The implications of many of the changes underway in ecosystems are simply not known by the public or by decision-makers. Without greater public support it will often be difficult for government officials to take actions that they know are important. Moreover, civil society organizations can help to hold decision-makers accountable for the actions that they do take.
4. *Encouraging greater access to information on the status and trends in ecosystem services, greater monitoring of those services, and greater quantification of the non-marketed benefits obtained from ecosystem services*. Civil society organizations can also help to ensure that appropriate consideration is given to non-utilitarian values in decision-making.
5. *Embracing the same policies of accountability and transparency about its own operations as are advocated for governments and corporations*. The policy of full openness about the funding, purposes, goals, activities, and accomplishments should be a cornerstone of any civil society group. First of all, it shall be accountable to the community it lives in.
6. *Building coalitions*. The consensus-building coalitions of NGOs and other like-minded stakeholders greatly increase the leverage of individual members. Priority attention should be given to enhancing alliances with NGOs from developing countries. The involvement of stakeholders who are at the highest risk and most vulnerable to the effects of ecosystems change is essential. The coalitions can also provide assistance to such groups including detailed information on ecosystems and their services.
7. *Partnering with corporations*. NGOs are often effective public watchdogs by compiling, analyzing, and publicizing corporate environmental performance data. In addition, they may partner with industry to encourage the best practices necessary to achieve environmentally benign products, support environmental innovation, and even encourage various forms of environmental philanthropy.
8. *Initiating and implementing certification schemes*. NGOs are the most trusted institutions regarding certification of sustainably manufactured, harvested, or extracted products. In the case of forest products, the NGOs' actions are highly successful (Chapter 8).

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