

## Chapter 2

# Typology of Responses

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## Main Messages

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**Responses are human actions to address specific issues, needs, opportunities, or problems in ecosystem governance and management.** They encompass all policies, strategies, measures, and interventions that are established to change ecosystem status and processes directly, and those that modify direct or indirect drivers that shape ecosystem status and processes. Societies have been developing a wide range of responses to manage their interactions with ecosystems. They include legal, economic, social and behavioral, technological, and cognitive responses. An essential precondition for any response to work effectively is stable order based on social norms generally accepted by those at whom the response is targeted.

**The main typology of responses is organized according to the dominant mechanism through which specific responses are intended to change human behavior or ecosystems characteristics.** Most responses in practice involve an interaction of legal, social, economic, and technological elements to work effectively. Other dimensions along which responses can be classified are their effects on different direct and indirect drivers of ecosystem change, the actors typically using them, and the geographical scales and jurisdictional levels at which they are normally adopted.

**The starting place for understanding responses is institutions. Institutions are not responses in their own right but create the framework and the medium by which responses can converge on direct and indirect drivers.** Institutions, formal or informal, are found at multiples scales and are formed by various actors. In this sense, institutions are an important means for setting the rules of the game.

**Legal responses have an overall function of providing the formal rules by which all other responses are framed and operationalized.** Legal responses occur at a variety of levels internationally, nationally, and sub-nationally and are divided by well-recognized jurisdictional orders. International legal responses range across a variety of soft, customary, and codified rules, which in the last 30 years have materialized in a multitude of international agreements on environment and sustainable development. International responses rarely have direct effect at the national and sub-national levels without ratification or implementation through domestic legal responses. Domestic responses are also those made by decision-makers independent of international law making. Overall, nationally and sub-nationally, legal responses are typified by three broad categories of regulatory, administrative, and constitutional rules that either may be aimed directly at ecosystems change or could be rules outside the ecosystem sector but having direct bearing on ecosystems and human well-being (such as, economic sector responses). All of these rules remain static without implementation, compliance, and enforcement in their respective jurisdictions.

**Economic responses work through the self-interest of people and their effort to improve their economic welfare, an important component of overall well-being.** They either could be based on existing property rights or could create new ones. Economic responses interfere with the ways in which ecosystems services are traded in often-imperfect markets that also provide explicit valuation of traded items. Command-and-control instruments are straightforward and blunt when properly implemented. They are rarely cost-efficient, but in many cases they are the only feasible response option so cost-efficiency is irrelevant. Incentive-based instruments rely on the wisdom of the targeted individuals or groups (including private companies) to follow their self-interest and thereby find the cost-efficient way to reach the ecological target. Voluntarism-based instruments are based on self-control and they are often used either to prevent a stricter form of regulation or as a precursor to stricter regulation. Financial and monetary measures include diverse forms of transfer

payments in exchange for implementing ecologically benign practices. International trade policies influence ecosystems management by regulating the flows of ecosystems goods and services across national borders.

**Social, behavioral, and cognitive responses drive change by affecting the norms, values, attitudes, and knowledge of individuals and society.** The provision of political rights and liberties empowers people, increasing transparency and awareness over matters of eco-system degradation. Education and public programs influence attitudes and norms that invariably drive change in relationships between society and nature; they also increase participation in public fora and debate. The empowerment of youth, women, and minority groups in society adds to knowledge through participation and inclusion. Participation leads to learning. The inclusion and legitimization of traditional knowledge has been widely recognized as valuable for addressing ecosystem protection issues.

**Technological responses work through the products, devices, processes, and practices adopted in ecosystems management directly and in other human activities affecting ecosystems indirectly.** They are applied in managing ecosystems, preventing degradation, as well as rehabilitating degradation that has already taken place. Providing incentives for innovation and technological research and development is a powerful response option that can sometimes have unexpected negative side effects.

**Specific response options and their combinations can be used in different phases of ecosystem change for five main types of action: development, prevention, mitigation, adaptation, and rehabilitation.** Ecosystem *development* is aimed at increasing the provision of selected ecosystems services, often at the expense of others and/or by transforming important features of the ecosystem. *Prevention* is an attempt to foreclose unwanted changes in the ecosystem before their commencement. *Mitigation* aims at slowing down and halting an already on-going transformation process. *Adaptation* recognizes that some kind and degree of change is inevitable and attempt to cope with the changing ecosystem conditions. *Rehabilitative* responses strive to improve degraded ecosystems in general or to restore them to a specific earlier status.

## 2.1 Introduction

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The management of ecosystems, including the use of their services, and the regulation of human activities that impact ecosystems has been a major challenge for humanity through its long history. As long as human influences were limited to relatively small intrusions into ecosystems processes (below the maximum sustainable yield or the natural pollutant absorbing capacity of ecosystems), no intervention was required. However, as the scale of utilization of ecosystems services for human use and the magnitude of emissions of ecologically harmful materials have increased, the need for intervention and regulation of related activities has increased as well.

This chapter presents an overview of the wide range of responses societies have invented and use to regulate their interactions with ecosystems. The chapter introduces tools that can be used to respond to ecosystem-related problems and examines their links to human well-being and poverty reduction. It does not provide a formal assessment of the “state of knowledge” regarding the effectiveness of these various instruments (that is done in the chapters of Part II); rather, it defines and characterizes their enabling environment and interplay.

It is not possible to establish a typology of response options that can classify all interventions into strictly separated boxes. Most response options adopted in practice in contemporary socie-

ties combine elements from several clusters irrespective of whether the clusters are defined along disciplinary boundaries (law, economics, engineering, sociology); jurisdictional domains (financial, environmental, or public health regulation); or some other ordering principles. Accordingly, there are some overlaps in our typology as well. The basic principle underlying the classification system presented in this chapter is the primary intention and mechanism of the response. Is the intervention by public policy-makers and private stakeholders designed to change the behavior of the targeted community based on economic incentives, cognitive enlightenment and approval, or legal threat? In most cases, both the social execution mechanisms and the implementation processes entail components of several domains. For instance, most economic incentives need a legal framework to become effective, and many legal responses use monetary penalties as enforcement mechanisms even if their main effects work through legal threats.

The typology of response options draws on widely accepted typologies used in the disciplines we draw upon: law, economics, sociology, political science, engineering, psychology, social psychology, anthropology, and environmental ethics. Additional sources include interdisciplinary environmental studies that suggest typologies of responses in managing ecosystems, natural resources, and environmental problems, such as Kaufman-Hayoz et al. (2001) and Dietz and Stern (2002). All these typologies have their own merits and shortcomings. Since none of the typologies are sufficiently comprehensive to encompass the full range of response options relevant to the MA, we have combined and extended them, preserving adequate flexibility; chapters in Part II sort and appraise the response options in various sectors.

Depending on their main objectives, the response options can be adopted individually or combined in various ways to address problems in the five main types of ecosystem management: development, prevention, mitigation, adaptation, and rehabilitation. Ecosystem *development* aims to increase the provision of selected ecosystems services, often at the expense of others and/or by transforming important features of the ecosystem. *Prevention* attempts to foreclose unwanted changes in the ecosystem before they begin. *Mitigation* aims at slowing down and halting an already on-going transformation process. *Adaptation* recognizes that some kind and degree of change is inevitable and attempts to cope with the changing ecosystem conditions. *Rehabilitation* strives to improve degraded ecosystems in general or attempts to restore them to an earlier status. Any of these five types of actions may use different kinds of intervention (legal, economic, technological, etc.) at different scales (for example, international, national, local) by different actors (such as government, private sector, or community) to influence direct or indirect drivers of ecosystems change. Consequently, our typology and discussion of responses in selected contexts cuts across these five domains and contains relevant information for each.

In presenting a typology of responses, Chapter 2 first provides an overview of the range of intervention mechanisms. Subsequent sections look at the various response options by their impact on the various direct and indirect drivers of ecosystems change; by their availability to various actors to influence the ecosystems management activities of other actors; and by the scale of operation and jurisdictional context of the decision maker. Based on the relationships identified among response options on the one hand, and the drivers, actors, and scales on the other, the chapter's final section provides a synthesis of clusters of intervention opportunities by actors to influence specific drivers by using specific response options.

In each section, a matrix indicates the linkages between the response options and the components of disciplines, drivers, actors, and scales. These matrices demonstrate the multidimensional characteristics of most response options (for example, having roots in economics, law, and sociology or affecting institutions, individuals, and technologies simultaneously).

## 2.2 Typology of Responses by Nature of the Intervention

This section describes response options by the nature of the intervention, including legal, economic, social, technological, and cognitive instruments and measures. In each subsection, reference is made to relevant scales, actors, and drivers. The temporal dimension of the response options is also discussed. Subsequent sections will examine response options in greater detail, with special reference to their interactions and the integrative approaches.

### 2.2.1 Institutional Framework as the Basis for Intervention

Our discussion of available responses and their effectiveness is framed within the larger context of institutions and their effects on human interaction shaping ecosystems change. Institutions moderate human behavior and thereby powerfully shape the nature of human interaction with nature. Institutions operate at various levels and scales, such as global, national, and sub-national levels and on the basis of both formal and informal rules. Ethics, values, and attitudes usually ascribed to larger cultural contexts also operate to moderate institutional behavior. Institutions are either absent or work badly when human impact on ecosystems are not being regulated in a desirable manner. The responses discussed below operate to build and strengthen larger institutional settings governing human interaction with nature.

According to the most widely used definition, institutions define the "rules of the game," which are humanly devised constraints for shaping human action (Hanna et al. 1996; Ostrom et al. 1994; Young 2002). Recent interest in institutions stems largely from transaction-cost economics that takes into account the costs associated with the multitude of transactions among individuals, and the ways in which economic actors seek to mitigate those costs (North 1990; Williamson 1985). Since the effects of environmental harm carry costs for humans, people have incentives to change the rules of the game in ways that reduce costs. In this vein, Garrett Hardin (1968) highlighted the "tragedy of the commons" and suggested changes in the rules of the game from "free access" to a system of specified private rights as solution to stem the degradation of the commons.

Problems associated with ecosystems and the implications for well-being make ecosystem health a truly global concern requiring a high degree of international cooperation. States have to cooperate in order to forge governance systems to address common problems, but many states may find it convenient to shirk obligations because, unlike in domestic society, there is no established body compelling states to act in a certain way. Many global environmental problems, such as the loss of biodiversity, depletion of fish stocks, or climate change are problems that require cooperation. When institutions function well, shirking and opportunism are minimized and the powerful are unable to appropriate rules for selfish ends that harm the collective interest and reduce overall well-being. Given that state sovereignty is a governing principle within the international system, states are reluctant to have others dictate the rules that govern the use of resources claimed as one's own, making cooperation difficult but not impossible. "Gover-

nance without government” is possible, and selective regimes have proliferated in the international arena as a result of trying to do something about regional and global environmental problems (Levy et al. 1995; Young 2002).

International institutions moderate an anarchical state system and allow a high degree of cooperation by replacing power with legally binding rules (Slaughter et al. 1998). As many argue, international regimes remain an effective way of solving global environmental problems and the strengthening of these rules has many positive effects toward the evolution of a rule-based international system. In the past three decades since UNEP was created, the problems of ecosystems (natural as well as social) have generated a number of international institutions overseen by international organizations. The United Nations Environmental Program, for example, tackles global warming and the problem of biodiversity loss. Nongovernmental organizations lobbying for international regimes have contributed to the creation of a number of the new institutional arrangements. The concept of “sustainable development” first put forth by the Brundtland Commission report “Our Common Future” (Brundtland 1987) led to agreements on biodiversity and climate change and are enshrined in the United Nations Conference on Environment and Development process, which has produced two international regimes: The Framework Convention on Biological Diversity and the Framework Convention on Climate Change

Subsequent international discussions have highlighted the need to integrate socioeconomic concerns with purely environmental ones. For example the Millennium Development Goal process is an effort to bring the socioeconomic dimension and notions of human well-being into questions of addressing environmental change. Moreover, institutions around environmental concerns, such as UNFCCC, have also influenced the actions and behavior of other agencies, such as the International Monetary Fund and World Bank, which are striving to bring their programs of action in line with these new rules. The Global Environmental Facility, which spawns collaboration among international actors at various levels, is a good example of broader institutions’ influence on shaping the behavior of development actors in various arenas. Despite this rapid progress in global cooperative agreements, some demand an overarching institution, such as the World Trade Organization, to govern global ecosystem-problems.

Local institutions have the most direct bearing on many forms of ecosystem change. The degree to which national institutions affecting environmental problems exist and function effectively varies greatly from country to country. Much research on common pool resources addresses the question of rule-making among very small local communities that manage to “govern without government” (Ostrom et al. 1994; Powell 2000). There are hundreds of agreements on environmental issues that national governments implement effectively at the national level and many governments around the world now have ministries and other agencies devoted to safeguarding the environment.

Judging by the number of signatories to such conventions as well as participation in the GEF, there seems to be broad desire locally to accept the international rules of the game governing environmental issues. Global consensus and value change reflecting post-modern concerns seem to exert considerable pressure on governments to address environmental concerns and actively participate in regional and international environmental agreements. Local Agenda 21 is also a good example of how international agreements might be transformed into action at the sub-national level. National governments accede to international agreements like the Framework Conventions on Climate Change or Biological Diversity because of international and domestic pressure

brought on by the proliferation of actors, fora, and regimes concerned about the health of the planet and local ecosystems.

The global change in the acceptance of the values of democratic government seems to be exerting pressure on national governments. Civil society awareness is one of the driving forces on the re-assessment of ecosystem protection, use, and utilization. NGOs in developing and industrial countries are in the forefront of the discussion of urban ecosystems, conservation, and social well-being. In this sense, since the 1970s, the movement on environmental justice in the United States and in Europe has created the necessity to address problems such as the interrelationship between people and their rural or urban ecosystems.

There is widespread belief that democracy as an organizing principle is a good safeguard for protecting ecosystems health and ensuring ecological justice. Many questions remain as to what types of national-level institutional arrangements matter in environmental questions, although there is much literature addressing the question of democratic design and policy outcomes in the field of political science (Lijphart 1999; Powell 2000). Much analysis also depends greatly on how questions of national institutions are addressed. For example, utilitarian models tend to see institutions as valuable tools by which one moderates established behavioral patterns of individual (rational) actors. In such models, market mechanisms working through prices could be made to effect change and obtain the desired outcome. Thus, if a resource is being depleted, rising prices are expected to drive down demand and the market principle could be an effective tool.

However, an analysis considering social practice models might produce very different answers. Established tastes, cultural rites, and practices might be sticky and hard to change through price mechanisms, but perhaps more easily affected by education. Questions of effective transfer of information and education may in turn depend on questions of legitimacy. Are state schools or the temples and churches more effective purveyors of change? In such analyses, questions of social capital, networks, and informal economies tend to be more salient objects of analyses than simple market mechanisms around relative price change (DiMaggio 1994). For example, is the problem of addressing the destruction of rhinoceros horns in Africa one of price alone or one of broader institutional change involving education and cultural change? Clearly, interventions through institutional change apply at various levels, for various degrees of scale.

## 2.2.2 Legal Responses

Law plays an important role in environmental protection at both the international and the national levels. International law provides mechanisms, such as treaties, rules of customary law, judgments of international courts or tribunals, and general principles of international law, to protect the environment (Brownlie 1990). International legal agreements range from “gentleman’s agreements” that go back to the nineteenth century (Klabbers 1996) to legally binding agreements. In general, there are two approaches: “hard law” and “soft law.” Commonly, treaties and custom create binding international law (that is, hard law), although custom has not been consolidated as a tradition to protect the environment (Birmie and Boyle 2002). Domestic environmental laws, likewise, use a set of regulatory techniques to achieve environmental objectives; these are also reviewed.

### 2.2.2.1 International Treaties

“Hard law” refers to legally binding regulations that impose mandatory obligations on states, such as bilateral or multilateral treaties. In this case, participating states must implement and enforce

such law within their national legal systems (Birnie 1992). A treaty is “a written or oral agreement between states, or between states and international organizations, governed by international law” (Brownlie 1990). A treaty sets out a general policy framework or basic principles. Examples include the 1992 United Nations Framework on Convention on Climate Change and the 1992 Convention on Biological Diversity. Once a treaty is signed and ratified, it becomes binding on its parties (Birnie and Boyle 2002) and changing its substantive provisions is difficult. Some scholars consider this a shortcoming, but many environmental treaties are framework conventions where general obligations are established and they are in fact flexible. New information may be amended to the original treaty as appendices or annexes, as was done with the Ramsar Convention on Wetlands of International Importance (Birnie 1992; Susskind and Ozawa 1992; Kiss and Shelton 2004). The signatories to the convention develop further protocols to implement the objectives of the convention (Susskind and Ozawa 1992) and detail obligations (Chayes and Chayes 1991). Examples include the Kyoto Protocol (UNFCCC 1997) to the UNFCCC and the Cartagena Protocol (Cartagena 2000) to the CBD.

#### 2.2.2.2 International Soft Law

“Soft law” refers to non-legally binding instruments, such as guidelines, standards, criteria, codes of practice, resolutions, decisions, and principles or declarations, that states establish to implement their national laws (Birnie and Boyle 2002). Although not legally binding, soft law deserves attention because it can later be transformed into treaties (Sand 1991). It has some advantages, such as allowing states a considerable degree of latitude in interpretation. Thus soft law enables states to take on obligations they otherwise would not and is important in implementing their treaty obligations (Birnie and Boyle 2002). But since soft laws are not legally binding, noncompliance does not have any consequence. An example of a soft law is the Statement of Principles for a Global Consensus on the Management, Conservation, and Sustainable Development of All Types of Forests (UN 1992b). Although it is not legally binding, many countries have taken actions to promote sustainable management, reforestation, and afforestation (Hughes 1996).

#### 2.2.2.3 International Customary Law

International customary law is “a general practice accepted as law,” according to Article 38 (1) of the Statute of the International Court of Justice. The essential component is evidence of a general practice “*opinio juris et necessitatis*,” that is, it creates a legal obligation among states (Brownlie 1990). Customary rules are generally binding upon all states, although the rules do not need to be consented to by all states; in contrast, treaties only bind those states that ratify them (Cassese 2001; Jurgielewicz 1996).

Customary law has contributed to the protection of the environment. Transboundary pollution-related issues provide illustrations of how international courts have established the existence of customary rule; examples include the *Trail Smelter* arbitration, in which a Canadian smelter had caused air pollution damage to the United States; the *Corfu Channel* case, in which the ICJ held Albania responsible for damage caused to British warships in its territorial waters; and the *Lake Lanoux* case, in which the tribunal held as unlawful the diversion of water by the upstream state, France, which was opposed by the lower state, Spain (Birnie and Boyle 2002; Brownlie 1990).

In each of these cases, Principle 21 of the 1972 Stockholm Declaration on the Human Environment was taken into consid-

eration; it refers to the general obligation of states “to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction” (UN 1972b). This principle was restated in Principle 2 of the Rio Declaration (UN 1992a), and has been stated in the preambles of various multilateral environmental agreements, such as the 1982 United Nations Convention on the Law of the Sea (UN 1982), the United Nations Convention to Combat Desertification (UNCDD 1992), the UNFCCC, and the Vienna Convention for the Protection of the Ozone Layer (UN 1987b).

#### 2.2.2.4 International Agreements outside the Environmental Sector

Generally, environmental policies encompass other areas such as trade policy, creating an enabling environment for investment, human rights, and anti-corruption, which are intrinsically linked and vital to protecting the environment and to achieving sustainable development (United Nations 2003). Legislation and agreements in these areas are outside the environmental sector *per se*, but indirectly help to protect the environment.

International trade policies, when unregulated, can have adverse impacts on the environment. A number of the World Trade Organization agreements include provisions dealing with environmental concerns. The General Agreement on Tariffs and Trade establishes export restrictions for the preservation of natural resources; Article XX sections 18 (b) and (g) provide, subject to certain restrictions, for exceptions to trade rules where these are necessary to protect human, animal, or plant life or health, or where they relate to the conservation of natural resources. The General Agreement on Trade and Services provides that policy measures affecting trade and services necessary to protect human, animal, or plant life or health are exempt from normal GATS disciplines under certain conditions (Article 14 (b)). The Agreement on Technical Barriers to Trade recognizes countries’ rights to adopt technical regulations and standards to “ensure the quality of its export, or for the protection of human, animal or plant life or health, of the environment” (Preamble, Article 2, 2.2). The Sanitary and Phytosanitary Measures Agreement also sets out measures to protect human or animal life or health within the territory of the Member (Annex A). Moreover, the Agreement on Trade-Related Aspects of Intellectual Property Rights refers to the environment regarding intellectual property protection. According to Article 27, “Members may exclude from patentability inventions to protect human, animal or plant life or health or to avoid serious prejudice to the environment. . . .”

Multilateral environmental agreements relate to the WTO when they incorporate trade measures. Examples are the export of domestically prohibited goods, charges and taxes for environmental purposes, ecolabeling, and the effects of environmental measures on trade. MEAs that use trade restrictions to ensure compliance include the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (UN 1973), which controls trade in endangered species under the international permit system; the Basel Convention (UN 1989), which controls transportation and trade in hazardous wastes; and the Montreal Protocol (UN 1987a), which protects the ozone layer.

Various types of investment agreements exist to establish an environment for investment in other countries, namely bilateral and multilateral investment agreements such as the North American Free Trade Agreement, the ASEAN Free Trade Area, and the Southern Cone Common Market. Trade and investment agreements also play a vital role in protecting the environment and

ensuring sustainable development. Many investment agreements have recognized the need for parties to consider environmental issues, as is reflected in the preambles of various bilateral investment agreements. Thus they have incorporated the goal of “maintenance of health, safety, and environmental measures” in their provisions (TCC 2003). NAFTA also expressly states that the activities should be undertaken “in a manner consistent with environmental protection and conservation” and should “strengthen the development and enforcement of environmental laws and regulations” (NAFTA 1992, Preamble). Increasingly, investment agreements have incorporated environmental measures as part of their performance requirements, such as the need to protect human, animal, or plant life or health, and to conserve natural resources (NAFTA 1992, Article 1106).

The relationship between human rights and the environment has been recognized in various instruments in one way or another (UN 1945; UN 1948; UN 1966a; UN 1966b; OAS 1969; Council of Europe 1950). One of the basic links is that human rights are directly connected to the right to a healthy environment. Recently, the U.N. Committee on Economic, Social and Cultural Rights recognized that the “human right to drinking water is fundamental for life and health” (UN 2002). The right to a standard of living adequate for health and well-being (UN 1948, Article 25) is intrinsically linked with poverty. Poverty is at the core of human rights violations in a broad sense. Poverty reduction policies have a direct influence on environmental conservation policy because people depend on those resources for their livelihoods.

Agenda 21, Chapter 3, provides the policy framework for the United Nations’ efforts to implement poverty reduction policies (United Nations 1992). Those policies and actions include a range of sectoral interventions, such as the empowerment of communities (rights of women, role of youth, indigenous and local communities, as discussed below), the empowerment of civil society (democratic participation process) as discussed *infra*, improved governance at all levels to create policy for addressing the poverty-environment concerns in developing countries, and international support such as aid for development or debt relief (UN 2003). For instance, East and South Asia have adopted measures of employment generation programs and of providing rural support credits (UNEP 1999).

In addition, there are agreements outside the environmental sector *per se*, which influence the protection of the environment and conservation of biological diversity. These include forestry, international watercourses, agriculture, fisheries, and invasive alien species. As an example in forestry, the International Tropical Timber Agreement (1994) regulates timber trade, but it also encourages the sustainable use of tropical forests. Regarding international watercourses, the Helsinki Rules on the Uses of the Waters of International Rivers state that a watershed is an indivisible hydrologic unit that must be considered to utilize or develop any portion of its water (Caubet 1991). More recently, the 1997 Convention on the Law of the Nonnavigational Uses of International Watercourses (UN 1997, Articles 20 and 21) regulates the prevention, reduction, and control of pollution, and emphasizes the protection and preservation of ecosystems of international watercourses.

In agriculture, the International Treaty on Plant Genetic Resources for Food and Agriculture states its objectives to be the conservation and sustainable use of plant genetic resources for food and agriculture, and the fair and equitable sharing of the benefits arising from their use, in harmony with the CBD, for sustainable agriculture and food security (FAO 2001). UNCLOS

(1982) aims to promote better international fishery conservation and management.

The Agreement on the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UN 1995) implements some provisions of UNCLOS by providing a framework for negotiating specific regional agreements to guide the exploitation of minimally regulated fishery resources in international waters.

In yet another example, actions to regulate invasive alien species have been important to halt the loss of biodiversity and deterioration of the environment. Many global, regional and bilateral actions have been taken to prevent the introduction, establishment and unregulated spread of invasive alien species, which otherwise would be likely to cause significant harm. For instance, the Convention on the Conservation of European Wildlife and Natural Habitats (Council of Europe 1979) imposes strict control on the introduction of non-native species. The International Convention for the Control and Management of Ships’ Ballast Water and Sediments was adopted in London (IMO 2000–04) to minimize the transfer of harmful aquatic organisms and pathogens. In each of these cases, the objectives of the conventions are directly or indirectly connected to the preservation or conservation of ecosystems.

#### 2.2.2.5 International Enforcement System

*Dispute settlement* is a traditional way to enforce international obligations since international law lacks sanctions. In most conventions, dispute settlement is arranged through voluntary arbitration or referral to the International Court of Justice (Chayes and Chayes 1991). Note, however, that the ICJ, the U.N. organ of judicial settlement, has no compulsory jurisdiction, although a few agreements, such as the UNCLOS and the Antarctic Environmental Protocol, provide compulsory and binding settlement mechanisms (UN 1982; Birnie 1992).

Other peaceful dispute mechanisms such as negotiation, arbitration, mediation, inquiry, and conciliation are widely used (UN 1945). A new mechanism of dispute avoidance is the noncompliance procedure that was adopted in accordance with Article 8 of the Montreal Protocol (UN 1987a) and later formalized by the Fourth Meeting of the Parties in Decision IV/5, allows any state to address the performance of another state’s implementation. This noncompliance procedure has been a vital tool in influencing countries with economies in transition to comply with their obligations. States rely on financial or technical assistance to both induce and facilitate compliance. Under this system, assistance is contingent upon improved compliance and the resolution of problems reported to the Implementation Committee (UNEP 1995).

Traditional forms of dispute resolution for material breach of international agreements have often not been fully utilized (Redgwell 2001). However, review of the noncompliance procedure has shown that it has generally functioned well, but still needs streamlining (UNEP 1998). Due to the new procedure, there have been improvements in reporting of data (UNEP 2003). The noncompliance procedure has also been included in the Persistent Organic Pollutants Protocol to the United Nations Economic Commission for Europe’s Convention on Long-range Transboundary Air Pollution, the Kyoto Protocol, and the Cartagena Protocol, to prevent the breach of obligations. It is becoming an important instrument for improving compliance with MEAs.

Another nonlegal mechanism is the dispute settlement procedure adopted by the World Trade Organization. WTO panel decisions are automatically adopted by member countries unless

there is consensus against doing so. These mechanisms are not broad enough to address environmental issues directly, but they have handled disputes that involve trade and environment (Martin 2001). An amendment to GATT Article XX, or a quasi-judicial statement of understanding, is required to exempt any MEAs from trade rules (Jordan 2001).

Another promising regime for an amicable resolution is the new Permanent Court of Arbitration Optional Rules for Arbitration of Disputes Relating to Natural Resources and/or the Environment adopted in 2001. It will be of great value to conserving biodiversity (PCA 2004).

The CBD sets out a framework on liability and redress, including restoration and compensation, for damage to biodiversity (Article 14, 2.). The Cartagena Protocol on Biosafety to the CBD provides for a liability regime for damage resulting from the transboundary movements of living modified organisms (Article 27); In 2004, the Conference of the Parties decided to establish an open-ended ad hoc working group of legal and technical experts on liability and redress (UNEP 2004). Other international legal frameworks addressing redress issues in dangerous activities such as nuclear energy (the 1960 Convention on Third Party Liability in the Field of Nuclear Energy and the 1963 Vienna Convention on Civil Liability for Nuclear Damage); pollution (the 1977 Convention on Civil Liability for Oil Pollution Damage Resulting from Exploration for and Exploitation of Seabed Mineral Resources); and the transport of dangerous goods and substances (the 1989 Convention on Civil Liability for Damage caused during Carriage of Dangerous Goods by Road, Rail, and Inland Navigation Vessels and the 1999 Basel Protocol on Liability and Compensation for Damage resulting from Transboundary Movements of Hazardous Wastes and their Disposal).

These conventions each establish a strict liability regime, requiring demonstration of a causal link between the activity and damage. Few conventions on liability address the loss of biodiversity specifically, but the 1993 Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment is a comprehensive convention dealing with liability and redress for environmental harm. The term “environment” encompasses natural resources both abiotic and biotic—air, water, soil, fauna, and flora—and the interaction between them (Article 2). Not yet in force, it is a promising convention to ensure adequate compensation for environmental damage (UNEP/CBD/ICCP/2/3).

A *monitoring system* is also valuable to implement treaties. This is vital to the regulatory control of emissions (United Nations 2003). Reporting under the Basel Convention (UN 1989) and the 1971 Ramsar Convention (UN 1972a) has been effective in Western and Central Europe. However, at the domestic level, the lack of monitoring has resulted in poor enforcement in Latin American, Caribbean, and Central Asian (UNEP 1999).

For better implementation of MEAs, an *environmental impact assessment system* has also been widely used at the international level. In addition to the general objective of the EIA, which is to ensure that development will not damage human health and the natural environment (Spellerberg 1991), the Convention on Biological Diversity calls for EIAs when activities are likely to have significant adverse impact on biodiversity (Article 14, 1). Several international agreements have EIA provisions, including the 1982 UNCLOS and the 1985 ASEAN Agreement on the Conservation of Nature and Natural Resources. The 1991 ECE Convention on Environmental Impact Assessment in a Transboundary Context ensures that an EIA is undertaken for activities likely to have a significant adverse transboundary environmental impact (Article 2(7)), and the 1991 Madrid Protocol on Environmental Protec-

tion to the Antarctic Treaty requires prior assessment of the environmental impacts for all activities listed in Annex I (Article 8).

Enforcement is the major concern of effective regulation. Most environmental conventions leave enforcement to the parties, which must enact the necessary national laws and enforce them in their territory. The obligation to enact such measures is a crucial part of the enforcement system. Along with formal regulatory enforcement is self-enforcement. In this case, individual states take the required measures to serve their own interests (Birnie 1992).

#### 2.2.2.6 Domestic Environmental Regulations

Domestic legislation is critical since the implementation of treaties only occurs through the actions of the government agencies of each country. These agencies use a variety of tools to put the regulations into practice, both formally and informally. Formal methods emphasize coercive measures such as sanctions. Informal methods include certification systems or various voluntary measures (May et al. 1996). These measures rely on consumer preferences and corporate managers’ aversion to shame (Campbell-Mohn et al. 1993).

“Command and control” is the most common regulatory means to achieve environmental objectives. Government simply imposes requirements on the conduct of individual actors; for instance, a government may set standards for the maximum level of a pollutant allowed at a facility. Command-and-control standards are clear and easy to enforce for those engaged in potentially polluting activities. Command-and-control regulations typically entail licenses and permits, and usually specify the pollutant, such as industrial pollution, discharges to sewers, and land contamination (Campbell-Mohn et al. 1993; Wolf et al. 2002). In addition, economic instruments and market mechanisms are commonly used for environmental protection. (Such economic instruments and detailed command-and-control interventions are discussed below in the section on economic responses.) The command-and-control approach remains the primary means of enforcement in the majority of countries in Africa, Asia, and the Pacific. However, in North America the trend is towards a policy mix with an emphasis on market-oriented mechanisms, public-private partnerships, and voluntary mechanisms (UNEP 1999).

National laws related to the protection of nature, including terrestrial and marine living resources, go back to 1597 (Birnie and Boyle 2002). Many laws were established in the late nineteenth to the early twentieth century. For instance, the law for protection of nature in national forests was established in 1915 in Japan (User Survey b, n.d.); the Reich Conservation Law was established in Germany in 1935 (SDUD n.d.). However, many countries developed their laws and regulations regarding protection of the environment and management of natural resources in the early 1970s. Legislation at that time was largely concerned with pollution control (water, air, and soil); later, it was expanded to other areas, such as nature conservation, the protection of public health, and the control of toxic substances and hazardous wastes. The development of domestic environmental legislation is partially a response to the obligations under MEAs (UNEP 1999). The bases of environmental law at the domestic level are often found in federal constitutions. The nature of the environmental issue at stake defines which tools will be used at the domestic level for implementing the laws.

#### 2.2.2.7 Domestic Constitutional Law

In many countries, the constitution lays the basic principles for environmental regulation. Generally, the constitution prescribes



the form of government, sets up political institutions, defines governmental functions, and establishes the rights and duties of citizens. Most legal interventions at the domestic level have some common features, that is, the constitution apportions power between the legislative, executive, and judicial branches of the government. The legislative branch enacts laws to regulate major environmental issues, such as air and water pollution, hazardous wastes, wetlands, endangered species, toxics and pesticides, energy reserves, and natural resources conservation (Jasper 1997). The executive branch converts the legal requirements and government policy into guidelines, memoranda, directives, and administrative orders and applies them. The judicial branch enforces the provisions of the environmental legislation (Bates 1995).

The constitutions of more than 100 countries guarantee a right to a clean and healthy environment (Kiss and Shelton 2004). They define adequate protection of the environment as essential to human well-being and to basic human rights. For instance, Article 225 of Brazil's constitution guarantees all citizens a healthy and stable environment (Brazil 1988). Peru also has environmental protection provisions in its constitution (Capítulo III, Peru 1993). Argentina's constitution states that "All inhabitants are entitled to the right to a healthy and balanced environment fit for human development" (Section 41, Argentina 1994). India's states that "the State shall endeavor to protect and improve the environment and to safeguard the forests and wild life of the country" (India 1949, Article 48A); in addition, Article 21 provides that no person shall be deprived of his life or personal liberty. The constitution of Bangladesh (1996) protects the right to life and personal liberty (Article 32), which implies the right to a safe and healthy environment (User Survey a n.d.).

Many constitutions establish procedures to assure the right to participation, right to information, transparency of process, and access to justice. Principle 10 of the Rio Declaration (1992) explicitly states the right of all concerned citizens to participate. It assures every individual access to information concerning the environment and the opportunity to participate in the decision-making process.

Public participation in the environmental decision-making process has been increasing in most countries. Nevertheless, levels of participation and procedures for involvement differ between industrial and developing countries. The participatory process has been stronger in industrial countries, but many countries still lack a minimal legislative framework for public participation. Industrial countries have adopted formal mechanisms for public participation, as with procedures for EIAs. These processes allow participation in the formulation, review, and evaluation of policies. Central and Eastern European countries with economies in transition in, and developing countries in Latin America, Asia, and the Pacific have improved in their public participation. But generally most regions need to improve their overall quality and breadth of participation in areas such as EIA and environmental decision-making.

In eastern and southern Africa, public participation comes through co-management of natural resources, as with the Communal Areas Management Programme for Indigenous Resources. Another practical example is that local people take part in reporting on the state of the environment in Lesotho, Malawi, South Africa, and Zimbabwe. Regarding the availability and access to environmental information, African countries are implementing information systems and networks at the national and regional levels. In Africa, however, the participation of women and youth in decision-making is still seriously lagging (Eckerberg 1997; Pantzare and Vredin 1993; UNEP 1999).

Furthermore, the participation of NGOs has been vital to environmental protection. Their roles have ranged from raising public awareness to shaping policies through extensive participation in the negotiation of treaties, particularly in the area of climate change. Despite their observer status, they have influenced the content of the text (Sands 1994). Some NGOs provide legal assistance to citizens and indigenous communities. They also promote compliance with MEAs. They have raised awareness nationally and internationally in several ways; for instance, in Sri Lanka, NGOs have prevented logging and stopped the construction of a thermal plant; in India, a social movement protested the construction of the Narmada dam; in the Philippines, a consortium of 17 environmental NGOs has implemented a seven-year Conservation of Priority Protected Areas Project (UNEP 1999).

#### **2.2.2.8 Environmental Impact Assessment as Measure for Regulation**

The implementation of environmental law is carried out through a variety of regulatory techniques, the most widely used of which is the environmental impact assessment. An EIA is often required for activities that are likely to have a significant adverse impact on the environment and are subject to the purview of a competent national authority (UN 1992c).

Basic EIA requirements include the alternatives to be considered, the dissemination of information on projects, and public participation in the decision-making process. As discussed earlier, there is a trend to incorporate biodiversity considerations into EIA procedures. (See Chapter 4 for more detailed discussion.) Although most countries have legal provisions on EIA for major projects, biodiversity considerations are often insufficient in the EIA process because they are given low priority compared with economic and development considerations (UNEP 2001). At the domestic level, for instance, the Brazilian constitution requires that states and counties carry out EIA as a tool of environmental monitoring (Brazil 1988). In short, many countries have relied on command-and-control instruments rather than economic incentives, which are becoming more widely used (UNEP 1999). The major challenge is to determine which instruments need to be combined for the optimal effect in each country. Countries need to find the right mix of social control, regulation, and economic instruments for their situations (Hirakuri 2003; UNEP 1999). There is no substitute for sound public policy, however.

#### **2.2.2.9 Domestic Legislation outside the Environmental Sector**

Laws and public policies outside the environmental sector should be considered that are critical to the protection of the environment and sustainable development. These laws are usually linked to the public policies of the countries that promote economic development. Many of them are associated with infrastructure-related areas, such as agriculture, forestry, settlement and mining. In many cases, the main causes of deforestation in Latin America have been policy choices by governments and subsequent laws to implement those policies. For example, governments have often favored the conversion of the forests into agriculture or shift cultivation, cattle ranching, and other land uses through subsidies (Repetto 1990; WRI 1985). The agricultural expansion now causing deforestation in Africa and Asia is related to population growth (FAO 1997).

Other proximate causes of forest loss relate to industrial development, such as palm tree plantations or shrimp farming, shift cultivation, particularly in Asia (Inoue and Isozaki 2003). In Asia and the Pacific, land use law allowing conversion of forest to agriculture and commercial logging has caused environmental de-

struction. Further causes of environmental destruction include laws related to mining, construction of roads, irrigation, construction of hydroelectric dams, and urban expansion (FAO 1997). The settlement and exploitation of the Amazon rain forest, for instance, has been facilitated by the construction of highways cutting through the forest. Mining activities can seriously affect the environment. The extraction of minerals creates imbalances in nature. If the mining occurs in forested areas, the environmental impacts are major, leading to a change in the water balance and pattern of rainfall, sedimentation, river pollution, disruption in wildlife and fishery habitats, variation in the microclimate, and general disruption of the ecosystem. Thus to guarantee sustainable development, it is necessary to develop legislation that considers the protection of the environment (FOE 1989).

The mentioned subsidies can be characterized as “perverse” in that they cause damage to the environment and the economy rather than help society achieve desired goals (Myers and Kent 1998). As Myers and Kent (1998) point out, perverse subsidies are mostly seen in five main sectors—agriculture, fossil fuels, road transportation, water, and fisheries. Ultimately, these subsidies destroy biodiversity. Aware of this, the Fourth Conference of the Parties to the CBD stressed taking appropriate action against those incentive measures that threaten biodiversity. The COP encouraged Parties and international organizations, to identify perverse incentives and to consider removal or mitigation of their negative effects on biodiversity (Decision IV/10).

The next step in removing perverse subsidies, or mitigating their negative effects, was a call for the Fifth COP to the CBD to set up a Programme of Work to engage on this issue (Decision V/15). This led the Sixth COP to request that the Executive Secretary specify how to remove or mitigate perverse incentives in collaboration with relevant international organizations (Decision VI/15). The Seventh COP accepted the proposals as providing a useful general framework to address the perverse incentives in various economic sectors and ecosystems. The COP also encouraged parties and governments to use, on a voluntary basis, these proposals in implementing the incentive measures of Principles 2 and 3 of the Addis Ababa Principles and Guidelines for the Sustainable Use of Biodiversity (Decision VII/18 and its annex).

#### 2.2.2.10 Domestic Enforcement System

*Judicial review* is a commonly used tool at the domestic level to ensure accountability of the regulators under command-and-control measures. Judicial review is used by persons with direct interest in the subject of the complaint. The courts merely have supervisory jurisdiction over the decision-making activities of the regulators; the final decision on the merits is made by the regulatory agency (Wolf et al. 2002).

*Liability* is a tool to compensate entities for economic harm and natural resources damage and, in some cases, to restore them. Violations of environmental regulations may result in civil or criminal liability (Campbell-Mohn et al. 1993; Handler 1994; Wolf et al. 2002). The violation of an international obligation generally gives rise to a victim’s right to compensation for damage. However, it is difficult to ensure state responsibility in the field of environmental law. Few treaties provide the specificity needed, as in defining the exact nature of the violation that would give rise to liability. In pollution-related cases, it is easier to establish state responsibility because the violation can be measured easily. The loss of biodiversity, however, is difficult to quantify, as is the exact degree to which it will adversely affect the ecosystem (Birnie 1992).

In addition to traditional legal enforcement, *public environmental awareness raising*, *information dissemination* through education courses or publication of reports (for instance, TRAFFIC Report on illegal trade in endangered species), and *the participation of stakeholders* are other enforcement measures widely taken at the domestic level. Participation of environmental NGOs at regime meetings would improve effective implementation, which would ultimately relate to enforcement. Some NGOs have exercised the right to petition for court judgment before national courts to stop or prevent environmental harms. Such judicial procedures can help victims and facilitate the development of more effective domestic environmental policies and laws. Furthermore, experts, academicians, and mass media also play important roles in enforcement and in increasing public awareness of environmental needs (Rosendal 2000; Wuori 1997; Somsen 1998; Wolf 2002).

The *ombudsman system* is another tool to enhance enforcement and aid dispute resolution (Bertran 2002). Many countries have established ombudsman laws, which include the protection of the environment, including Greece, the Netherlands, and New Zealand. Although many countries have not enshrined the ombudsman in laws, their governments have established ombudsman offices (Yannis 2001). At the supranational level, the European Union set up an ombudsman in 1995 to deal with complaints about mal-administration by European community institutions and bodies (Seneviratne 2000). This is a voluntary, nonbinding and non-adjudicatory set of dispute settlement procedures that can be implemented by the United Nations. The ombudsman can deal with disputes among states or between states and citizens, including multinationals, indigenous groups, and NGOs (Koh 2004).

#### 2.2.2.11 Summary: Legal Responses

The international law tradition recognizes that legal responses take place at many different levels, such as international treaties, soft law, and international customary law. These various levels of legal instruments are interlinked. Indeed, in order to implement environmental policies, we must pursue the different levels concurrently, and parallel hard law (international treaty with concomitant protocol) with soft law (Resolutions or Guidelines). The key elements to be considered at all these different levels of legal response are implementation, compliance, and enforcement. *Implementation* refers to the actions that states adopt to comply with international treaties through domestic regulations. *Compliance* means the extent to which countries abide by the obligations, both procedural and substantive, set out in international treaties; an example of procedural obligation is the requirement to report; whereas, the obligation to cease or control an activity is a substantive obligation (Jacobson and Weiss 1997). *Enforcement* means the actions taken by competent authorities to ensure compliance with the laws. The basic question is how to put the regulations into practice. To this end, domestic legislation plays a vital role in the implementation of/and compliance with environmental laws.

As already noted, enforcement varies in intensity and quality among countries, according to the degree of strictness of enforcement policies. The foremost obstacle has been the ineffective implementation of legislation. The major reasons identified in many countries are the lack of trained staff, political will, monitoring, and enforcement; in some countries, appropriate and applicable standards are lacking as well. Also, the lack of coordination among government institutions and inadequate funding have been stumbling blocks (UNEP 1999).

On the other hand, the cooperation of environmental authorities with the public is now being required in several instruments.

In particular, access to information and justice, and public participation in decision-making processes, contribute to effective monitoring, compliance, and enforcement. International obligations need to be reflected in domestic policy, which will ensure the effectiveness of the regime. The compliance and enforcement approach will be successful only if it takes into account the interdependence of the economic, environmental, social, political, and cultural factors that bear on the management of natural resources.

### 2.2.3 Economic Responses

A wide range of opportunities exists to influence human behavior with detrimental effects for ecosystems and their services in the form of economic and financial instruments. Some of them establish markets; others work through the monetary and financial interests of the targeted social actors; and yet others affect relative prices. The *feasibility, effectiveness, and efficiency* of such interventions depend on the *biophysical characteristics of the problem and the socioeconomic circumstances* in which they are adopted. This section summarizes economic and financial response options ranging from hard regulatory forms mainly applied at small geographical scales to softer mechanisms used in the larger geographical and/or jurisdictional context. The classification of economic responses draws on standard categories in the environmental economics literature (Pearce and Turner 1990; Tietenberg 1992; Perman et al. 1996; Wills 1997; Common 1996; Hanley et al. 1997; Stavins 2000; OECD 2001), but it also includes novel groups to draw attention to new tools and approaches in ecosystems management that have a decisive economic component (Dietz and Stern 2002).

Many ecosystems problems are caused by what economists call “perverse subsidies”; they entail various forms of direct or indirect monetary transfers that are economically inefficient and environmentally harmful. Subsequent chapters in this volume list numerous examples ranging from deforestation to the depletion of fisheries. The precursor of any new intervention to protect ecosystems services should be to check existing regulations and eliminate or at least mitigate perverse subsidies. The environmental effectiveness and the economic efficiency of new response policies and measures depend crucially on the extent to which perverse subsidies are still part of the regulatory regime.

If one considers the diversity of the uses of ecosystem services, the pollutants affecting them, their impacts, social and political situations, economic and institutional conditions, and other factors, it becomes clear that no single instrument is the best for all types of ecosystems problems and socioeconomic situations. The criteria for assessing and choosing the intervention options include the following (partly based on Perman et al. 1996):

- *Cost-efficiency*: the extent to which the response option can achieve the desired environmental objective at the lowest possible cost;
- *Dependability*: the extent to which the intervener can rely upon the instrument to achieve the specified target (in this context, the relative slopes of the functions depicting the costs and benefits of interventions are an important consideration in choosing between quantity- or price-based instruments);
- *Information requirement*: the extent and nature of information required for formulating the intervention and the cost of gathering this information;
- *Enforceability*: the kind and level of monitoring needed to keep track of the implementation of the response chosen; type of measures available to enforce the intervention;
- *Long-term effects*: the long-range impacts of the chosen response, that is, whether its influence is constant, increasing, or decreasing over time;

- *Dynamic efficiency*: whether the response option is providing a continued incentive to improve performance with respect to the original ecosystem management objective;
- *Flexibility*: whether the chosen response option can be adapted quickly and cheaply when new information becomes available, the underlying conditions change, or targets need to be modified; and
- *Distributive impacts*: how the response option affects the welfare of different social groups and what the prospects are that winners can compensate losers.

The relative weights of these criteria depend on the ecosystem problem and its management context. These weights will influence considerably the choice of the response option. (See Chapter 18.)

#### 2.2.3.1 Command-and-Control Interventions

These response options prescribe specific forms and/or quantities in restricting access to and regulating use of ecosystems services or emitting environmentally harmful substances. While legal command-and-control interventions are primarily enforced by threatening noncompliance with anti-criminal measures (imprisonment of individuals, temporary suspension, or complete disbanding of the legal entity), their economic counterparts are promoted by (often increasingly severe) monetary penalties. The classification of command-and-control interventions into the legal or economic categories is difficult because there is considerable overlap between the two. Most command-and-control interventions imply financial penalties in cases of initial or minor noncompliance and most apply increasing penalties for persistent noncompliance. Some regulations might even extend the penalty to criminal instruments but this does not justify their classification as legal instruments.

*Prohibition* is the strictest form of command-and-control response. This instrument bans all or certain clearly defined forms of ecosystem use. In acute cases, harsh forms of prohibition bar physical access or entry to the protected ecosystem.

*Explicit controls* are usually introduced to protect landscapes, terrestrial or water-based ecosystems in an ecologically valuable region. Typical forms of explicit controls prescribe certain types of land use.

*Zoning and designation* can also imply some form of prohibition, but their main concern is to direct various types of ecosystem uses to clearly demarcated geographical areas.

*Direct provision of ecosystem services* implies that the intervener takes full control of the resource, determines the amount to be appropriated, and distributes the resource to the entitled community. This option is often used by communities to maintain the productivity of their resource base or by government agencies under the circumstances of severe shortages when rationing of an ecosystem service becomes necessary. Since the use of most ecosystem services is difficult to control and supervise directly, the success of these arrangements requires either a high level of moral cohesion among community members or a strong policing and penalty threat operated by the regulator.

*Fixed quota systems* can be used both for controlling the use of ecosystems services by individuals, households, or other users, and for regulating the amount of harmful emission from individual sources of pollution. The former entails establishing the total amount of ecosystem service that can be taken and setting up a quota or license for each resource user. The latter involves apportioning the emitted quantity to the various sources in order to derive a quota or license for each source as a fixed quantity allowed to be emitted. The success of this type of response requires

effective monitoring and harsh penalties for noncompliance. If monitoring and penalties fail, the effectiveness and therefore the dependability of the quota-based instrument will be reduced. The attainment of an economically efficient regulation with a fixed quota system is possible in principle, but rather unlikely in practice. In controlling pollutant emissions, economic efficiency would require the regulator to know the marginal abatement cost function for each polluter (that is, the cost of abating an incremental unit of pollutant). The costs of collecting such information are in most cases prohibitive. In practice, fixed quota systems often lead to arbitrary distribution of the emission quotas, resulting in inefficient allocation. Moreover, this response option provides very weak incentives to foster dynamic efficiency because once a polluter meets the allocated emission quota, there remains no incentive whatsoever to reduce pollution any further.

*Technology regulation* is another possibility to protect ecosystems from overexploitation or excessive amounts of harmful pollutants. To reach these ambient standard values, the regulator targets the production process or the equipment emitting the pollutants. This takes the form of specifying minimum technology requirements. Prescriptions for dust removal from flue gas, specifications of minimum stack-heights, requirements that cars have catalytic converters, and cooling or treatment technologies for wastewater are examples of technology regulations via command-and-control systems. This response option is easy to implement and cheap to administer because monitoring and administration costs are low relative to the enforcement costs of other options. It can be effective when “end of pipe” solutions are easily available but not used by the polluter. The instrument is also dependable. However, in most cases it is not cost efficient because it is not focusing on the least-cost abatement opportunities (although this may be less important in special cases when the exact location of the point of discharge matters for the impacts). Moreover, this intervention is inflexible because once the prescribed technology or equipment is in place, it is in most cases difficult to undertake additional modifications. Technology regulation also does not promote dynamic efficiency, because the changes required by the regulation are completed with the installation of the prescribed technology or equipment.

The need for interventions in the use of ecosystems services and for responses to changes in ecosystems emerges in extremely diverse social, economic, political, and biophysical contexts. Different ecosystems issues require different policy instruments. The relative merits and shortcomings of the command-and-control instruments compared to those of other economic response options become extraneous when they are the only feasible or environmentally effective interventions. The name “command and control” does not imply any negative connotation. It simply specifies that with these instruments the regulator prescribes or prohibits some actions and controls compliance.

### 2.2.3.2 *Incentive-based Interventions*

The second range of economic response options uses economic incentives to entice users of ecosystem services to limit their resource use to the socially optimal level. Defined here in a simple social cost-benefit context, the socially optimal level of control is where the marginal cost of abatement equals the resulting marginal benefit. In the presence of market failures, the market price does not reflect those social marginal benefits and the polluter has no incentive to invest to reach the optimal level of control. The regulator can impose an emission charge to provide the incentive for the producer to increase the level of control to the social optimum. Such optimal taxes are called Pigovian taxes. Using eco-

economic incentives in this way may involve increasing the delivery of selected ecosystems services (for example, community woodlots) or combining the solution of economic problems with measures to address environmental concerns (for example, ideas to reform the European Union’s Common Agricultural Policy to reduce the pressure of excess production and to foster biodiversity).

*Tax and subsidy schemes* can be uniform or differential. They have been widely used to close the gap between the socially optimal level of using ecosystem services and the level of use based on more narrow private benefits. Taxes are charged for each unit of appropriated ecosystem service (per cubic meter timber cut or per cubic meter water diverted) or for each unit of pollutant discharged (kilogram of sulfur dioxide emitted, milligram of water pollutant released), whereas discharge taxes are sometimes based on an input that can be easier and more precisely measured (carbon content of the fuel instead of carbon dioxide emission). In a subsidy scheme, the regulator pays subsidies to the polluter for the abatement effort. The introduction of taxes and subsidies produces the same effects: they both modify the relative prices of the products with which the appropriation or the use of ecosystem services or the emission of pollutants are associated. Due to distributional implications, however, the long-term effects of taxes and subsidies differ. Taxes close the gap between the social and the private marginal benefits of using an ecosystem or emitting pollutants. The efficient level of the tax is equal to the difference between the marginal private benefit and marginal social benefit so that users of ecosystem services will consider what they have been ignoring before the tax and thereby internalize the formally external costs of their activities. Accordingly, profit-maximizing actors will adjust their use of ecosystem services so that the marginal social benefit will be equal to the marginal social damage, because their post-tax marginal private benefits of the resource use will be equal to the marginal social benefit.

The principles and the operational mechanisms of instruments under many other names are similar to those of taxes and subsidies. On the levy side, the list includes incentive, distributive, user, product, and administrative charges, as well as deposit-return systems. Explicit user charges include license fees (harvesting, hunting, fishing), entrance fees, severance, and resources taxes. The arrangements on the grant side incorporate compensations, tax incentives (reducing tax burden), relief, exemptions, and tax deductions.

*Tradable resource use and tradable emission permits* have become increasingly popular in recent decades. This response option has four elements. The first involves a decision about the total amount of resource use or pollutant emission to be allowed. In a socially efficient regulation, the total amount of resource use or pollutant emission permits should be equal to the efficient level of resource use or pollution. If the efficient level is not known, some other basis should be used to define the total amount of permits. The second element of a tradable permit scheme is regulation. Any resource user or polluter is allowed to appropriate the resource or emit the pollutant only up to the quantity covered by the permits available to him; above that level, a serious threat of an expensive fine or penalty must be installed and implemented. The third element is a decision about the initial allocation of the total amount of permits among the resource users or polluters.

The final element is the need to guarantee free trading of the resource use or emission permits. An efficient control of ecosystem service use or pollutant emission can be achieved either via a tax rate or by issuing a certain quantity of tradable permits. Taxes set the price of emission or ecosystem service use while the tradable emission permits set the quantity of the allowed resource use

or the quantity of pollutants to be emitted. The profound difference compared to quotas, licenses, or standards is the transferability and marketability of the use or emission rights. If a permit market is free, then both the price and the quantity of the ecosystem service use or the pollution will be efficient. Moreover, if the amount of permits corresponds to the economically efficient level of resource use or pollution, then the equilibrium price of the permit will indicate the shadow price of the ecological service or pollution at the socially optimal level. In terms of cost-effectiveness, the effects of permits will be the same as the effects of the optimal tax for subsidy scheme. The main difference is in the distributional effects.

The establishment of a tradable permit system is essentially equivalent to creating a market for ecosystem services that were used more intensely than the socially optimal level. Tradable permits can take the form of ambient permits, emission permits, pollution offset systems, tradable harvest, or catch quotas.

A comparison between command-and-control versus market instruments indicates that command-and-control responses directly regulate the quantity of ecosystem service use or quantity of pollution emission or regulate the technology that is leading to pollution emissions. In contrast, market-based instruments alter the relative prices or generate price incentives to achieve socially desirable levels of ecosystem service use or pollution emission. A closer look at the market instruments reveals that a resource use tax or an emission tax scheme can achieve the efficient target at the lowest social cost; in fact, it can achieve any target at the least social cost. Moreover, a tax set at any level can achieve some reduction in ecosystem service use or some level of pollution abatement. In addition, market instruments generate dynamically efficient incentives for behavior. Since all users or polluters face the same tax, these outcomes emerge from the profit-maximizing behavior of the affected actors.

In contrast, command-and-control instruments are blind to cost-efficiency. They would achieve a cost-efficient solution only by coincidence. Commenting on environmental standards, one of the most widely used command-and-control instruments, Pearce and Turner (1990, p. 103) point out that “[T]he problem with standard-setting is that it is virtually only by accident that it will produce an economically efficient solution.” The basic reason is that the regulator does not know the marginal abatement cost function of each polluter. Tietenberg (1992:403) reviews eight empirical studies; Perman et al. (1996, pp. 238–9) add two more analyses in which the costs of pollution abatement using alternative instruments are compared. The ratios of the actual command-and-control costs to those of theoretically expected least-cost market-based instruments found by these studies vary between 1.07 and 22, with a median ratio of 4.18. Even if one considers that the cited dozen-or-so case studies compare actual command-and-control costs to theory-based calculations of the costs of market-based instruments and it is unrealistic to expect the latter to operate at the theoretical minimum costs, these studies provide obvious evidence that market-based instruments are overwhelmingly superior to command-and-control instruments in terms of cost-efficiency.

An important consideration in comparing the response options is concerned with the transactions costs. The expenses associated with establishing and operating the necessary monitoring schemes, administrating the behaviour of the targeted actors, and enforcing the implementation of the chosen instrument can be substantial. These transaction costs often influence the choice of the least-cost instrument. Since transaction costs may be substantially lower for technology standards, regulators often prefer this response option irrespective of their actual social costs in the

broader sense. Yet command-and-control instruments might be required in special cases where the pollutants involved are not uniformly mixing and their exact places of emissions matter. Moreover, in many areas of ecosystems management, these instruments are the only feasible environmentally effective response option, making the question of cost-efficiency irrelevant.

Another crucial consideration in the choice of instruments is dependability. Comparing the main market-based instruments shows that if the aggregated abatement cost function is known with certainty, then the tax rate can be determined to reach the desired level of abatement and the instrument will be completely dependable. Similarly, under these circumstances the amount of permits can be determined, the permit price will be predictable, and the tradable permit scheme will also be completely dependable. The situation is different if the marginal abatement cost function is not known with certainty. In this case, the tax rate can be set but the amount of ecosystem service reduction or pollution abatement will be uncertain; under these circumstances, the tax scheme has uncertain effectiveness and is not dependable. In the same situation, a permit scheme will be dependable for the quantity of ecosystem service use or pollution emission, but the associated costs will be uncertain. In this case the permit price cannot be predicted.

Different response options have different distributional consequences. In the case of tradable permits, the distributional effects depend on the initial permit allocation method. If the permits are sold by auctioning them out, then the equilibrium permit price will be equal to the aggregated marginal abatement cost associated with the total number of permits. In this case, the net transfer of funds flows from the resource users or polluters to the tax authority. In contrast, if the permits are distributed freely based on some arbitrary rules (grandfathering based on historical records or equal per capita allocation), then some resource users or polluters will sell part of their permits and gain from the transaction, while others will need to buy permits and thus lose compared to the unregulated situation. Free distribution of permits also results in no net transfer from resource users or polluters to the tax authority. In comparison, resource or pollution taxes represent clear transfers from the users/polluters to the tax authority; therefore, their distributional effect is the same as that of auctioning out the permits. Under a subsidy scheme, on the other hand, funds are transferred from the government to the polluters or ecosystem service users to change their respective behaviors.

There are serious competitiveness concerns associated with ecosystem or environmentally oriented interventions. A unilateral tax is perceived to harm international competitive positions irrespective of whether it targets ecosystem service use or pollutant emissions. This fear often leads to perverse regulation when activities associated with internationally traded commodities are either not regulated or regulated only lightly, whereas goods and services not traded internationally are subject to fierce regulation.

### 2.2.3.3 *Voluntarism-based Instruments*

Recent years have seen an upsurge in new approaches to responding to problems associated with uses of ecosystem services and pollution emissions. They all rely on implicit sources of behavioral change and thus tend to be specified as voluntarism-based options (OECD 2003; Dietz and Stern 2002).

*Information provision and education* intends to influence the behavior of targeted individuals or communities by providing solid and scientifically based information about the ecosystem implications of certain behavior, with the expectation that this will trigger behavioral change when resonating with broadly established

and accepted ethical norms and principles. Many educational and information-based responses go beyond this and attempt explicitly to trigger a change in values and preferences that, in turn, will lead to behavioral change toward a more benign use of ecosystem services.

Ecolabels represent a specific and prominent form of information provision. By drawing the consumer's attention to the environmental implications of using or consuming a specific product, ecolabels have become an effective form to promote green consumer behavior among environmentally conscious people (Dietz and Stern 2002).

*Voluntary measures* take the form of explicit and formal agreements between the regulator and the targeted agent. They can also take the form of agreements among actors otherwise competing in the provision of the same range of goods and services, concerning their own management of ecosystems or pollution emissions or setting the same rules and regulations for their suppliers. Among the range of voluntary measures, government-promoted voluntary programs and industry-wide codes of practice represent the two main clusters.

The crucial feature of voluntarism-based instruments is that they are not put in place as formal or compulsory intervention. Yet it is often the case that users of ecosystem services negotiate voluntary agreements among each other or with their regulator to prevent a more stringent or more costly regulation being imposed upon them. These kinds of response options are particularly useful in previously unregulated areas of ecosystem management. Stakeholders can experiment with different technologies and management procedures to comply with the voluntary agreement without running the risk of having to pay high penalties if they fail. At the same time, regulators can monitor the process and collect information about the technological options and economic costs of reducing the pressure on ecosystems. These positive features also imply important limitations. If consumers find the price differences too large and do not choose ecolabeled products, or if the companies fail to achieve their voluntary targets because they find it too expensive, more effective instruments will be needed.

#### **2.2.3.4 Financial and Monetary Measures**

Financial and monetary response options include a broad array of measures ranging from small-scale, locally oriented actions to grand international schemes. In some cases, the small locally oriented instruments are needed to implement the large-scale arrangements.

*Microcredits* can support arrangements to directly reduce the pressure on ecosystem services or to start-up alternative forms of livelihood that will reduce the pressure on ecosystem services indirectly. Microcredits are particularly attractive instruments in those cases when they simultaneously contribute to ecosystem protection and poverty alleviation.

*Loans* are usually provided at a somewhat larger scale. They can help local ecosystem users or resource operators make the, often modest, investments required to change their technologies from a harmful to a more benign one.

*Funds* set up with private endowments and public resources, can be sources of microcredits and loans, but they often also provide the resource for changing management practices of a targeted ecosystem. Depending on the nature and internal regulation of the fund scheme, the requirements for commercial viability of the sponsored activities and the conditions for repayment are usually less stringent than those of bank loans or other commercial credit forms.

*Public financing* can take the form of direct and indirect intervention. Direct public financing is explicitly oriented toward the protection, replacement, or provision of an ecosystem service. Indirect public financing can take the form of state guarantees or government indemnity. This arrangement reduces the risk premium charged by the credit provider to resource operators and makes the acquisition of the required financial resource more affordable to them.

*Debt swaps* are a relatively new international financial response option. Many developing countries reached high level of indebtedness in the 1980s and 1990s. In order to service their debts, they were forced to overexploit and sell their environmental resources. Debt swap is an arrangement to help these countries out of the debt trap. Foreign debts are cancelled in exchange for commitments to set aside and preserve valuable ecosystems.

#### **2.2.3.5 International Trade Policy**

The economic incentives to overexploit local ecosystems often stem from the effective demand for their goods and services in remote geographical regions. Harvesting, processing, and exporting such ecosystem services in developing countries is an important way to alleviate poverty, improve quality of life, and start the accumulation of local capital resources to foster economic development. Yet it remains a challenge both for providers and recipients of such ecosystem services to avoid exploitive use and degradation of the resource base and to manage the use of ecosystem services to satisfy distant demand in a sustainable way.

*International trade agreements* are the legal form of controlling the economic incentives for exploitive use of ecosystem services. They involve both source and recipient countries. Such agreements can include qualitative characteristics (for example, species, size, or age of the natural resource that can enter international trade), quantitative limitations (for example, the amount of the ecosystem service that can be removed and allowed to enter international trade flows), or technological characteristics (for example, the equipment or process adopted, the management practices followed—ranging from the size and grid density of fishing nets to selective versus clear-cut harvesting of timber) of the ecosystem goods and services that are allowed to enter international trade.

*Import restrictions imposed by recipient countries, typically industrial countries*, either restrict or ban altogether the amount of ecosystem goods and services permitted to enter their domestic markets. These policies can target specific ecosystem goods in general (like products associated with endangered species from any country) or exports from certain countries for clearly defined ecological/environmental management reasons.

*Export restrictions* are put in place by source countries in the form of outright ban, export tariffs, or quotas in order to protect their own ecosystem.

#### **2.2.3.6 Summary: Economic Responses**

Economic and financial interventions provide powerful instruments to regulate the use and avoid the overuse of ecosystem goods and services. The adoption of economic instruments usually requires a legal framework and, in many cases, a social or institutional intervention as well. The various types of economic interventions are combined in many cases to achieve an effective regulatory regime. For example, import restrictions (as part of international trade policies) are typically complemented by information provision such as ecolabeling (a voluntarism-based instrument), debt swaps, and/or loans from the recipient country to the exporting country to entice sustainable management of the underlying ecosystem (financial and monetary measures).

The choice of a viable and effective economic intervention mechanism is determined by the socioeconomic context. Resource taxes can be a powerful instrument to guard against the overexploitation of an ecosystem service but an effective tax scheme requires well-established and reliable monitoring and tax-collection systems. Similarly, subsidies can be effective to introduce and implement certain technologies or management procedures but they are totally inappropriate if the prevailing pattern of using public funds is “take the money and run.”

## 2.2.4 Social and Behavioral Responses

Social and behavioral responses including population policy, public education and awareness, empowerment of communities, empowerment of women, empowerment of youth, and civil society disobedience have been instrumental to a certain extent in shaping ecosystems and human well-being. These are interventions stakeholders initiate and execute through exercising their procedural or democratic rights (Douglas-Scott 1996; also see discussion above) in efforts to improve ecosystems and human well-being. Such measures are for by major global environmental policies such as Agenda 21 (United Nations 1992) and the Plan of Implementation of the World Summit on Sustainable Development (United Nations 2003).

These kinds of responses demonstrate the commitment and participation of a wide range of actors. Support structures have been used also to facilitate positive outcomes, as seen in the Amagasaki and Kawasaki pollution lawsuits in Japan, where through courts, good lawyers, medical experts, and scientists were mobilized to assist in successfully fighting for victims and preventing pollution. Furthermore, the lawyers' association and the pollution victims raised money for the legal battles. In these cases, commitment and support structures made victory possible, but there may be situations where resources are lacking and failure is possible. Moreover, social and behavioral interventions can be instrumental in conservation efforts when facilitated with the appropriate resources.

### 2.2.4.1 Population Policies, including Family Planning

Population growth can be a contributing factor to many social problems including environmental issues. For example, population pressure on arable land in the Asia Pacific region is partly responsible for land degradation (UNEP 1997). The same could be said for deforestation and the ever-decreasing biodiversity. Population growth since 1950 has been on a steady rise meaning that there will be more mouths to feed and resources will continue to deplete. The world's population in 2001 was 6.2 billion (Worldwatch Institute 2002) and it is predicted to stabilize at 7.8 billion in 2025, but only when appropriate policies and family planning measures exist (Worldwatch Institute 2001).

A range of stringent (fines and punishment) and lax or incentive-based measures (contraceptives, family planning, and educational programs) are already available to countries. China's one-child policy is one illustration of the stricter measures that has proven successful by reducing the number of children per woman from 6 to 2.5. Despite its success, there are criticisms on the restriction of individual rights and freedoms. India pursues softer measures, including birth control and education programs to curb population growth, and has been also successful (User Survey a, n.d.). Furthermore, it must be noted that while population policies can be beneficial in achieving their primary objective(s), they can also affect adversely social and economic aspects of countries, such as the human rights violations seen in China or the fear of less man-

power to support the older generations in the future as is predicted for Japan.

### 2.2.4.2 Public Education and Awareness

Public education and awareness can play important roles in improving conservation efforts (Goodale 1995). A learned and informed society can make sound decisions about conservation (UNEP 1999). Both textbook learning and the media can facilitate this need. However, there are many who are denied formal education, access to the media, access to schools, teachers, and effective learning methods. In response, Chapter 36 of Agenda 21 (United Nations 1992) and paragraph 109 of the Plan of Implementation of WSSD, among others, stress the need to improve inadequacies in public education and awareness. Poverty of resources, ineffectiveness of the general education system (UNEP 1999; UNESCO and the International Association of Universities 1986), and the deficient utilization of full parameters of both formal and informal education (Goodale 1995) tend to be setbacks. Given the practical sociocultural, environmental, and economic difficulties in many societies, an emphasis in moving learning from classrooms and educational centers to more accessible settings can be more effective. Approaches and methods used tend to be impractical. Some educationists stress that effective learning involves proactive and participatory approaches (OECD 1993).

Despite challenges, countries and organizations alike have begun addressing environmental education and awareness (UNEP 1999). India's Lower House for instance, passed a bill in 2001 to make education a fundamental right. Other programs in India promote informal education and awareness about the environment including eco-clubs or enviro-clubs for first-hand experiences (TERI 2003). OECD reports that countries in Europe including Austria, Italy, Netherlands, Norway, and the United Kingdom have integrated environmental education into their systems. It also reports cases of both formal and informal environmental education and public awareness in developing countries, including Kenya, Senegal, Malaysia, the Philippines, Brazil, and Ecuador. IUCN, the World Wildlife Fund, and UNESCO's Man and the Biosphere Program all run environmental education and awareness programs (OECD 1993). Furthermore, the Ubuntu Declaration, which calls for greening school curriculums, is also a progressive step (UNU 2003).

Efforts are made but deficiencies still prevail, especially poverty of resources including infrastructure, teaching staff, and finances. Learning can be encouraged more at all levels across different age groups using all methods in a variety of settings. More importantly, constancy in some of the initiatives in public education and awareness is lacking. The need now is for stakeholders to address these issues in efforts to institutionalize environmental education and awareness to a greater extent wherever it is seen to be lacking (UNEP 1999).

### 2.2.4.3 Changing Values and Attitudes: Empowerment of Communities, Women, and Youth

As new concerns about environmental problems emerge, values and attitudes of people may transform simultaneously to meet the demands. Changes can be induced internally or imposed externally by factors including technological advancement, crime, gender issues, war, religion, education and awareness (UNEP 1999), and regulation. Also, changes depend on perceptions, experiences, and opportunities. For instance, environmental pollution and loss of biodiversity have caused many to change their values and attitudes toward the environment. The series of global and environmental policy initiatives that evolved during the 1970s,

including the Stockholm Declaration on Human Environment, the minimum environmental regulation at the domestic levels, and stakeholders ranging from governments to industry designing and implementing solutions to environmental problems, signify the change in values and attitudes of society toward environmental concerns (Worldwatch Institute 2003).

A specific example is the “polluter pays” principle where certain environmental goods and services that were once considered as free are no longer free to use; polluting industries now are required to internalize costs for using environmental goods and services. A second example is the case of mechanisms for recycling of wastes in countries including Japan (Clean Japan Center 1999) Germany, and the United States (Council on Environmental Quality 1997) where some are required by law to recycle wastes. Some geographic regions, including the Arabian Peninsula have mechanisms to recycle wastewater, solid waste, and waste paper (UNEP 1999). But where values and attitudes are critically important to the improvement of environmental protection and sustainable development, their progress is by no means ever assured.

#### 2.2.4.3.1 Empowerment of indigenous and local communities

Anthropologists and ethno-botanists claim that indigenous and local communities are experts in their environment and know well how it functions (Hugh-Jones 1999). Their practices may not be the best, but they have some beneficial attributes for biodiversity conservation. In fact, some practices of indigenous and local peoples are partly responsible for the remaining biodiversity. Despite these facts, indigenous and local communities have been struggling with oppression. Their participation in decision-making processes is limited. Their practices, beliefs, and ideologies have been disregarded. Their rights to land and property have been confiscated, disconnecting them from their land and environment.

Recently, however, indigenous and local communities—with their practices, knowledge, and innovations that contribute to conservation—have been given some recognition at the global level. Article 8 (j) of the CBD, for example, laid foundations for the use of practices of indigenous and local communities in biodiversity conservation (CBD 2003). Principle 22 of the Rio Declaration, Chapter 26 of Agenda 21, Principle 5 of the Forest Principles, Articles 16 and 17 of the CCD, and the World Heritage Convention (IUCN 1997) have all taken some measures to enhance the participation of such communities. Participation goes beyond the mere presence in processes and meetings to include the use and incorporation of some of practices, ideologies, values, and laws into the mainstream processes and systems. Possessing stronger land and property rights is one factor that can contribute to indigenous and local communities’ participation in conservation efforts. These communities are among the least likely to receive some form of education. Occasionally, some of them may be unsustainable (Forrest 1999), but through education and awareness raising, unsustainable practices could be corrected. Finally, funding is needed to encourage conservation, but indigenous and local communities are one of the underprivileged groups that do not possess the funds to carry out activities. (See Box 2.1 for an example of sustainable resource management in Papua New Guinea.)

#### 2.2.4.3.2 Empowerment of women

Women are most knowledgeable about their environments through tasks such as food gathering, gardening, washing, clothes making, and preservation. They are also the first educators of their children; what they learn through their interaction with their en-

#### BOX 2.1

#### Case Study: Land and Environmental Ethics in Melanesia

The Melanesians and their ancestors were never ecologists, but their land and environmental ethics are based on reciprocity and balance. This has contributed to conservation and sustainable use of biodiversity and their well-being to a certain extent. Consequently, Papua New Guinea now maintains approximately 7% of the world’s biodiversity. The contributing factors for biodiversity conservation in Papua New Guinea are social norms, rules, values, and animistic beliefs. In Papua New Guinea, certain tribes believe that they have descended from certain animals or plants, which compels them to preserve the plants or animals. Furthermore, when cutting banana leaves, one is encouraged to use the mature leaves rather than the younger ones. Some of these practices contribute to conservation and sustainable use. As more than 70% of people in Melanesia live in villages and practice these lifestyles, encouraging the use of management practices people are familiar with might be an effective way forward rather than imposing externally designed management practices.

vironment they pass on to their children. Women are also traditional healers who are knowledgeable of medicinal plants. They not only know about using medicinal plants, but are also in a better position to manage medicinal plants and the general environment in a sustainable way. (See Box 2.2.) Despite their knowledge about the environment and the potential they possess, they have been among the most suppressed groups. Participation of women in decision-making has been restricted by social and cultural structures. For example, in most societies, women are excluded from land tenure. However, recently there is a growing recognition of the role of women in conservation of biodiversity. They are beginning to organize themselves in numerous ways to contribute to development. Their empowerment and participation in shaping ecosystems and human well-being is crucial.

#### 2.2.4.3.3 Empowerment of youth

Today’s youth are tomorrow’s leaders. For them to determine and lead society, they must be physically, spiritually, and mentally fit. Although there is the obvious need for empowering youth, a se-

#### BOX 2.2

#### Case Study: WAINIMATE and Traditional Medicine

The WAINIMATE is an association of female traditional healers with the purpose of recognizing and valuing women’s knowledge of conservation of medicinal plants. Studies conducted in Fiji and other parts of the world showed that women knew more plants than men. The WAINIMATE is one such group whose members are knowledgeable on medicinal plants and their uses. Using plants shows that one possesses the traditional knowledge associated with the plants and also the know-how to conserve and use them sustainably. One of the tasks of the WAINIMATE is ensuring that women know that traditional medicines are safe and effective for treating diseases. This initiative is also found to benefit local people in Fiji who cannot afford chemical drugs. Women could contribute tremendously to society if they had the opportunity. WAINIMATE is said to put out their first traditional medicine handbook.

(Communication with Wana Domokamica, Traditional Healer and Member of WAINIMATE, June 2001.)



ries of problems act counter to their empowerment. The youth of today face problems including unemployment, lack of support (Neumann 2000), lack of proper education, disease, and crime. In 2000, the International Labor Organization estimated that 70 million young people, mostly in industrial countries, are unemployed and the number is increasing. A number of sexually transmitted diseases, including HIV/AIDS, are common among youth. The Henry J. Kaiser Family Foundation reported in May 2000 that teens and young adults comprise one third of the 40 million people living with HIV/AIDS throughout the world. The Foundation predicts that this is only a tip of the iceberg and the figure will rise in the future (Henry J. Kaiser Family Foundation 2003; UNFPA 2002).

In many developing countries, deteriorating economic conditions have made education an expensive proposition, and youth do not attend school because parents cannot afford fees. A “user pays” policy in some countries (for example, Papua New Guinea) further exacerbates the problem. When youth are not in school or employed, they generally do not get much attention; when their energies are not adequately channeled, they may end up engaging in criminal activities. In the United States, for example, crime among youth is high; a report in 2000 by the Federal Bureau of Investigation indicated that 55.1% of the crimes committed throughout the country were by people below the age of 25 (FBI n.d.). Many issues threatening the youth today in both developing and industrial societies work counter to their empowerment and need special attention.

#### 2.2.4.4 *Civil Society, Disobedience, and Protest*

Paragraph 150 of the WSSD Plan of Implementation calls for partnerships and the participation of all actors. History has witnessed major civil disobedience and protests associated with numerous issues ranging from the French Revolution to the Civil Rights Movement in the United States. Martin Luther King, Jr., Mahatma Gandhi, Nelson Mandela, Chico Mendes, and Rosa Parks have all participated in various forms of civil disobedience that have left milestone changes in human history.

While boycotts and bans initiated by NGOs may not always be effective, the role of civil disobedience and protests in guiding the world back to the right track when it is heading in a risky direction has historically been a significant one. Thus civil society disobedience is not about breaking the rule of law, but about alerting governments to the consequences of their inaction and bringing to light some of the hidden issues. There have been various successful as well as unsuccessful movements, both violent and nonviolent in nature, throughout the world. A few examples of such movements are The Ogoni people of Nigeria agitating against the oil company polluting their environment (Beauchemin 2001), the Bougainville people of Papua New Guinea opposing the government and an Australian mining company to stop environmental degradation and claim compensation for use of customary land (William 1998), Chico Mendes and his people in Brazil fighting to protect the rain forest of Brazil (see Box 2.3), and the Chipko Movement in India. Another recent example is Greenpeace protests on behalf of the environment that led to the bombing of its ship, the Rainbow Warrior, by the French Intelligence Agency. Although civil society disobedience and protests have been instrumental in driving change and maintaining balance, violent acts are not encouraged.

#### 2.2.4.5 *Summary: Social and Behavioral Responses*

No one social and behavioral intervention alone can influence conservation of ecosystems effectively and enhance human well-

#### BOX 2.3

#### Case Study: The Chico Mendes Extractive Reserve

(My Hero 2003; Environmental Defense 2003)

A rubber tapper, environmentalist, and union leader, Chico Mendes lived with his people in the Brazilian Amazon tapping rubber and collecting Brazil nuts for the last 100 years. Around the same time and area, rich cattle farmers and industrialists began expanding their activities into the rain forest, causing major threats to the forests. In response, Chico Mendes and his people started a group to prevent the destruction of rain forest caused by the cattle ranchers and miners. His group fought for an extractive reserve. During peaceful protests they often encountered opposition and threats from their opponents and the government. The confrontation eventually led to Chico Mendes' assassination in 1988. After his death, pressure from both within and outside prompted Brazil to consider the work and concerns of Chico Mendes and his people leading to the establishment of the Chico Mendes Extractive Reserve, which now covers 97,057,000 hectares.

being positively. A combination of interventions is necessary. To induce social and behavioral change, a step-by-step process is required. For instance, for women, civil society, local communities, and youth to be able to change their attitudes and mentality toward conservation and well-being, incentive-based initiatives can be useful. One such incentive that is lacking is balancing rights and responsibilities of stakeholders. Clear rights and responsibilities create an intimacy that can be the driving force for change. Education and awareness campaigns are also crucial and have been used to stress the positive and negative consequences of why one has to behave in a certain manner. Thus in education and awareness campaigns, up-to-date and accurate information can facilitate the tasks effectively. Furthermore, without support structures, social and behavioral interventions cannot succeed.

#### 2.2.5 Technological Responses

Technological responses are intended to influence the tools (hardware) and procedures (software) people use in their direct interventions with ecosystems goods and services (for example, fishing and logging) and in all other activities that affect ecosystems indirectly (for example, emissions of pollutants). Technology can play a critical role in responding to ecosystem-related problems by providing a link between human activities and the natural resource base. When harnessed to its full potential and developed with ecosystem objectives in mind, technology can provide sustainable alternatives to polluting industrial processes and harmful commercial practices. With applications ranging from cleaner and more efficient production processes; to oil and chemical pollution control, containment, and recovery; to the potential for sustainable agricultural, forestry, and fisheries practices, technology can provide many environmental and economic benefits.

For the purposes of this chapter, technology is defined as the products, devices, processes, and practices associated with the management of ecosystems with special emphasis on harvesting and using their goods and services, or human activities emitting harmful substances into the ecosystems. In this sense, technology-related command-and-control responses comprise a subset of the more general class of technological responses discussed below.

Technology-related aspects are often included in other response options, for example, prescribing technological specifications as part of command-and-control interventions or under international trade policies. Nevertheless, most technological re-

sponse options are concerned with local interventions in biochemical processes of the ecosystems or in harvesting their services. This section reviews technological response options along two ordering principles: the target and the timing of interventions. We draw on a diverse range of technology and technological development literature, including Rosenberg et al. (1992), Stoneman (1995), Rosenberg (1994), Grubler (1998), Grubler et al. (2002).

### 2.2.5.1 *The Target of Responses*

*Products* are targeted by technological responses in the form of restrictions concerning the quantities and/or quality of the ecosystem product allowed to be removed. They range from specifications of the age and size of living organisms that can be harvested to the complete ban on harvesting endangered species.

*Devices* can be an effective target of technological responses. Banning the use of harmful devices or prescribing the use of environmentally benign devices are convenient ways both to protect the targeted species of the ecosystem service (leaving the young generation of the targeted species behind for regeneration) and to prevent the removal of other species that comprise important components of the ecosystem.

*Processes* are another domain where technological responses can be effective. The sequence of certain operations in the field or the timing of harvest can make the difference between sustainability and collapse while removing the same amount of ecosystem goods and services for human use. ISO 14000, which is a series of voluntary standards in the environmental field, is a good example of such a response option.

*Practices* as technological responses represent a broader range of interventions often involving a combination of devices, processes, and practices. Purposeful or unintended introduction of new or alien species in an ecosystem or biological control of ecosystem processes as well as the clear cutting versus selective cutting of forests are examples of practice-related technological responses.

### 2.2.5.2 *Timing of Responses*

Different types of technological responses are appropriate, effective, and promising in different phases of ecosystem status.

*Preventive* technological interventions can be effective when the first signs of unfavorable ecosystem changes or deterioration of ecosystem quality are detected. Whether direct interventions in the biophysical processes or indirect regulation of the harvesting technologies and practices, preventive measures can help guide toward stewardship and sustainable management that satisfies human needs and at the same time preserves the integrity and productivity of the ecosystem.

*Operative* technological interventions incorporate a wide range of responses that have been or could be used as part of a meaningful adaptive ecosystem management strategy. They involve: monitoring the response of the ecosystem to human interventions; monitoring changes in the underlying biochemical processes; assessing the unfavorable or undesirable trends; and introducing appropriate technological measures to correct them.

*Rehabilitative* technological responses intend to correct the consequences of earlier mismanagement or misuse of ecosystem services. An explosion of technological measures has taken place over the past two decades to renew, restore, or rehabilitate degraded ecosystems. Literally hundreds of technological measures have been devised to redevelop soils, surface and subsurface water bodies, forests and other terrestrial ecosystems, mangroves, wetlands, fisheries, and animal populations.

### 2.2.5.3 *Summary: Technological Responses*

The targets of technological responses include products, devices, processes, and practices. Any or several of these are required in different stages of ecosystem management including preventive, operative, and rehabilitative phases. In order for technology to serve as an effective option for resolving ecosystem-related problems, an enabling environment needs to be nurtured that allows environmental technologies to be pursued, developed, disseminated, and integrated into society. The creation of such an enabling environment involves social, legal, and economic aspects and their interactions.

Technological responses represent powerful intervention mechanisms in ecosystems management. Yet in the past, they have often turned out to be a double-edged sword. Most technological interventions provided solutions to the targeted problem, but some have created undesirable side effects that may have been more severe than the original problem. As experience accumulates and technological assessment practices improve, such risks are expected to decline. Nevertheless, the ecosystems themselves are changing and it will never be possible to eliminate all uncertainties associated with technological interventions; therefore a reasonable degree of precaution is warranted when considering and adopting them.

### 2.2.6 *Cognitive Responses*

Arguably, the principal cognitive responses to ecosystem-related problems are either traditional in nature or scientific knowledge. While other cognitive responses, such as society's reaction to environmental change, and different actors' experiences and skills in addressing ecosystem-related problem must be noted, this section focuses on traditional wisdom and scientific knowledge. The section reviews the legitimization of traditional and scientific knowledge, as well as the acquisition of scientific knowledge, and considers how both types of knowledge can be used to respond to ecosystem-related problems.

*Traditional knowledge* refers to knowledge held by members of a distinct culture and to which numerous members of the culture contribute over time. It is acquired through past experiences and observations, and through means of inquiry specific to the culture, and generally concerns the culture itself or its local environment. *Scientific knowledge* stems from experimental and theoretical studies about the natural and social sciences. *Legitimization* is official acceptance and/or recognition that can lead, in the case of traditional and scientific knowledge, to the development of policies and measures based on the knowledge legitimized.

#### 2.2.6.1 *Legitimization of Traditional Knowledge*

Traditional knowledge is relevant to responding to ecosystem-related problems as it encompasses extensive understanding of local flora, fauna, and ecological processes; the practice of selective breeding; utilization of plant and animal species for medicinal, agricultural, and other purposes, and consequently provides traditional peoples with the ability to contribute to the implementation of conservation policies (Mugabe 1999, p. 4; Roht-Arriaza 1996, p. 928). Extensive knowledge of local ecosystems has led to many instances in which traditional knowledge and practices have formed the basis for developing agricultural and other products, and in which traditional remedies have given rise to the pharmacopoeia of modern medicines. An example from agriculture is an insecticide based on active ingredients of the neem plant, whose particular characteristics were discovered thousands of years previously by indigenous Indian farmers. In the area of traditional medical knowledge, quinine, now commonly contained in medi-

cation to prevent malaria, has long been used by Andean indigenous peoples to cure fever (Roht-Arriaza 1996, pp. 921–22).

Traditional practices are also an important source of knowledge for sustainable development. Having gone through processes of trial and error, traditional practices have adapted to local needs and local ecosystems. Numerous examples of traditional practices contributing to sustainable development have been recorded in agriculture (Brookfield et al 2003), water management, and other areas. Growing recognition of the value of traditional knowledge and the interest in it in the biotechnology, pharmaceutical, and human health care industries over the last two decades has resulted in a correspondingly greater acknowledgment of traditional knowledge in international environmental law and policy, thereby contributing to its legitimization.

Traditional knowledge was first addressed at the international level at the 1992 United Nations Conference on Environment and Development, which stated that traditional peoples are central to environmental management and development due to their knowledge and practices, and further stipulated that they be empowered (Rio Declaration, Principle 22; Agenda 21, Chapter 26, Para. 3(a)(iii)). Since then, a number of legally binding instruments concerning or including provisions on traditional knowledge have been adopted, and programs of work developed. The International Labor Organization's 1991 Convention 169 on Indigenous and Tribal Peoples in Independent Countries, for instance, highlights the contribution made by indigenous and tribal peoples to the "ecological harmony of humankind," and notes that traditional knowledge shall be incorporated into educational programs and services for the peoples concerned (ILO Convention 169, Preamble and Article 27(1)). The Convention on Biological Diversity provides that contracting parties shall, as far as possible and appropriate, and subject to their national legislation, respect, preserve, and maintain traditional knowledge relevant to the conservation and sustainable use of biodiversity, as well as to promote its wider application (CBD, Article 8(j)). The Convention to Combat Desertification stipulates that contracting parties shall, subject to their national legislation, exchange information on traditional knowledge and ensure its adequate protection (CCD Article 16(g), UNCCD 1992). Further, parties are to support research activities that protect, enhance, and validate traditional knowledge (CCD, Article 17(1)(c)). Other instruments contributing to the legitimization of traditional knowledge at the international level include the Declaration on Science and the Use of Scientific Knowledge adopted by the 1999 World Conference on Science (Declaration on Science, Preambular Paragraph 26) and the Draft United Nations Declaration on the Rights of Indigenous Peoples (Draft UN Declaration, Preambular Paragraph 9).

In addition to acknowledging traditional knowledge in international environmental treaties and declarations, some multilateral development banks have adopted policies that address the importance of traditional knowledge. This has been done largely as a consequence of criticism of the detrimental impact of MDB-funded projects on traditional peoples. For example, the Bayano hydroelectric dam in Panama led to the forced relocation of 2,000 Kuna and 500 Embera indigenous people from their traditional territories (World Commission on Dams 1999, p. 15). The World Bank adopted Operational Directive 4.20 in 1991, which provides policy guidance to ensure that development projects benefit indigenous peoples and avoid or minimize adverse effects. The Directive emphasizes participation of indigenous peoples in development projects, stating that traditional knowledge be incorporated into the project approach of any project affecting indigenous peoples (World Bank 1991, Paragraph 8). The Inter-

American Development Bank and the Asian Development Bank also refer to traditional knowledge (Inter-American Development Bank 1990, Guiding Principle C1(b); Asian Development Bank 1998, Paragraph 2(iii) Appendix).

An aspect central to legitimizing traditional knowledge is the recognition of its origins to traditional peoples as well as the recognition of its utility and relevance in an array of applications at broad levels. Possibly the main controversy surrounding the debate on granting intellectual property rights to traditional knowledge holders is the question whether the current international framework on intellectual property is an adequate forum for addressing the protection of traditional knowledge (Barsh 2001, p. 153). This question and the multitude of concerns arising out of it must be given close consideration in the future.

#### **2.2.6.2 Knowledge Acquisition (Scientific Research) and Acceptance (Legitimization)**

Scientific knowledge is pertinent to responding to ecosystem-related problems as it generates relevant information on the functioning of ecosystems, and identifies modes of application of this information, which can contribute to the protection of ecosystems and their components.

Scientific knowledge is commonly acquired through recorded observations of present events, through the analysis of information on past and future events, as well as through experimental studies. In order to respond to ecosystem-related problems based on scientific information, decision-makers both at the national and at the international level consult and are advised by a variety of bodies. A central role is played by scientific advisors working within governments, and by bodies specifically set up by governments to provide them with requested information and advice, such as the Center for Global Environmental Research, which conducts environmental research for the Japanese government, or TERI, which plays a similar role in India. National-level advisory bodies are complemented at the international level, advisory bodies established by intergovernmental processes, such as the Intergovernmental Panel on Climate Change, established in 1988 by UNEP and the World Meteorological Organization. Outside institutions providing scientific information include nongovernmental, inter-governmental, and industry organizations, research institutes, and universities.

Acquisition of scientific knowledge through government scientific advisors and advisory bodies is done by submitting information requests to the advisors and considering the information received. In addition to such mechanisms, outside bodies provide information during stakeholder meetings, through the dissemination of papers and by lobbying government representatives at conferences (Yamin 2001, p. 151; French 1996, p. 255–56). A key aspect in policy-makers' acquisition of scientific knowledge is the identification of the most relevant organizations and institutions. This is of particular importance in dealing with ecosystem degradation and protection due to the large variety of topics this encompasses, and consequently of organizations working on associated issues. Once identified, cooperation with the organizations and institutions must be ensured by, among other instruments, establishing effective and continuous communication. Communication between the IPCC and the decision-making body of the UNFCCC, for example, takes the form of both organizations attending and addressing each other's sessions, with the IPCC presenting its reports within a given time frame at meetings of the decision-making body. These reports are also sent to national governments, and meetings are held among senior officials, thus providing representatives of the decision-making body with an opportunity to submit requests for scientific information.

With the legitimization of scientific knowledge being achieved through its acceptance by policy-makers, it is of interest to consider those aspects that contribute to this acceptance. The two principal features are the credibility and policy relevance of the knowledge presented, which are advanced through a series of characteristics pertaining to the mandate, procedure, and membership of the body in question. *Policy relevance* is achieved, for example, through effective communication. Information is presented in nontechnical language in a manner understandable and relevant to policy-makers. Information requests submitted by policy-makers early in the scientific assessment process are responded to adequately (Levy 1993, p. 406; Meffe 1998, p. 742).

The *credibility* of the information presented is determined by its quality, the transparency of the scientific bodies' procedures, and policy-makers' buy-in into the information. The most widely used quality-assurance is to submit working papers to peer review prior to being published; the expertise of advisory body members is also key in contributing to the quality of the knowledge produced (Kimball 1996, pp. 100–01, 140, 144; Peterson 1998, pp. 429–30). Policy-makers' buy-in is in turn attained by including a government component in the body producing the scientific knowledge and, in the case of knowledge produced for international bodies, by ensuring geographic representation of the advisory body members (Agrawala 1998, p. 628). The Animal and Plants Committees established under CITES, for example, are each composed of ten regional representatives.

Finally, it must be noted that the legitimization of scientific knowledge is not a guarantee for being employed to address ecosystem-related problems, as governments may be unwilling to act on the basis of this knowledge if it stands in conflict with other concerns such as economic or political ones.

### 2.2.6.3 Summary: Cognitive Responses

This section described the role that the legitimization of traditional and scientific knowledge, as well as the acquisition of scientific knowledge, plays as a response on ecosystem-related problems. Traditional knowledge is relevant as it encompasses extensive understanding of local ecosystems and how they can be effectively managed and conserved. This knowledge is not always applied as widely as it might be as policy-makers are often unaware of its value. Scientific knowledge is also important as it responds to ecosystem-related problems by generating relevant information on the functioning of ecosystems, and it identifies modes of application of this information, which can contribute to decision-making and to the protection of ecosystems and its components.

### 2.2.7 Typology of Responses: Summary

Policy-makers have available an array of responses for sustainable management of ecosystems for ensuring human well-being. These responses are classified according to a typology of legal, economic, social and behavioral, technological and cognitive interventions. The chapter presents the typologies as one-dimensional and does not account for potentially complex interplay among many of the responses. Since the direct and indirect drivers of ecosystem change also interact in complex ways, choosing the most effective responses may depend on identifying interplay among the drivers. This is not the focus of this section. Instead, it offers a snapshot of the basic functional relationships between responses and how they work systemically together.

The responses are guided by an institutional framework that sets the rules of the game. The rules may be formal or informal. Legal responses serve a "command and control" function. Formal

laws govern much of the operationalization of many of the other responses. At the international level, law tends to be weaker but is an area increasing in scope and function. Even when strong international legal responses do exist and are applied, effectiveness is highly dependent upon enforcement systems and the nature and degree of national-level acceptance. Conversely, domestic laws are usually backed up by strong enforcement systems. In general, ecosystem-related legislation, whether domestic or international, has tended to be weaker than economic and social legislation. With growing recognition of the dangers of environmental degradation and the need to protect ecosystems for intra- and inter-generational well-being, legal responses would gain strength. All legal responses, no matter what the scale, usually remain static without implementation, compliance, and enforcement in respective jurisdictions.

Economic and financial interventions are an effective policy tool to regulate the use and overuse of ecosystem goods and services. These response options are based on the premise that human beings are driven to maximize their economic welfare. Thus market mechanisms framed within the context of legal rules provide powerful incentives for people to moderate their behavior. Manipulating economic and financial factors can powerfully alter how ecosystems goods and services are valued and traded. The various types of economic interventions are combined in many cases to achieve an effective regulatory regime. The effectiveness of the economic intervention mechanism, however, is moderated by the fact that socioeconomic conditions vary from society to society.

Fundamentally the objective of legal and economic responses is to change human behavior by changing incentives. But human behavior can also change according to changing norms and values driven by cognitive factors. For example, by empowering people in the political realm, harm to ecosystems because of the corruption of a few can be mitigated. Women, civil society, local communities, and youth tend to demonstrate a strong aptitude for ecosystem stewardship because they are more directly dependent on ecosystem services for sustenance. Through the conferral of rights, liberties, and responsibilities, and through education and information dissemination, disempowered people gain advantages so as to protect their ecological patrimony. Participation and inclusiveness are important for instilling attitudes of stewardship.

Technological responses allow humans to mitigate their effects on ecosystems by allowing less dependence on them, by lowering anthropogenic impact, or by helping to restore degraded ecosystems. Technology, however, carries with it risks that cannot be fully accounted for in practice. Moreover, the right technology is often times unavailable in an equitable manner. The risk of side effects and unintended consequences of technological fixes make it imperative that proper evaluation and risk assessment be carried out before resorting to this response.

Knowledge underlies all types of responses. Institutional change is sometimes necessary in order to adapt to changes in the social and physical world. Such change is often instructed by new knowledge. Legal instruments must reflect new knowledge so that law is not illegitimate, leading to non-conformity and revolt. Knowledge and learning are also important factors in determining how market conditions change and thereby altering existing relationships of humans with nature. Knowledge is fundamental to belief systems, attitudes, values, and norms. Given the role that knowledge plays in forging cognitive processes, creating knowledge, applying it to concrete problems, and disseminating it are also important options for policy response.

## 2.3 Responses by Impact on Drivers

The MA conceptual framework (MA 2003) identifies the numerous and diverse events and processes affecting ecosystems as drivers. A driver is defined as any natural or human-induced factor that directly or indirectly causes a change in an ecosystem. These factors are structured into two broad categories: direct drivers and indirect drivers. *Direct drivers* are factors that unequivocally influence ecosystem processes and therefore can be identified and measured to differing degrees of accuracy. Direct drivers can be of anthropogenic or natural origin. In contrast, *indirect drivers* operate more diffusely, from a distance, and often by altering one or more direct drivers. Accordingly, an indirect driver can seldom be identified through direct observation of the ecosystem; its influence is established by understanding its effect on a direct driver.

This section assesses the main categories of responses defined above with respect to their impacts on the direct and indirect drivers of ecosystems change. The assessment is organized around two matrices in which response options and drivers represent the two axes. Each cell contains a pair of entries. The first entry indicates the effectiveness of the response in influencing the driver: to what extent can the given response be expected to modify the driver. On a scale of 1 to 5, higher marks indicate the higher expected effectiveness of the response. It is important to note that effectiveness in the following discussion is an assessment of the expectation that the given intervention is capable of bringing about the desired change in individual and/or social behavior. It is not to be confused with economic efficiency (cost-effectiveness) that measures the costs of an intervention. The second part of each entry shows the proximity of the response option to the targeted driver: how long is the chain of the cause-effect mechanisms from the response to the driver. The smaller the number of transmission steps in the response process is, the higher the mark assigned to the response option. The entries denote general assessments that represent the average performance of interventions across a diversity of ecosystems and social conditions. Ecosystem-specific assessments in chapters in Part II of this volume fluctuate around these values accordingly; the broad appraisal below provides a useful background to the more detailed discussions in Part II.

It is important to point out that entries in these tables, especially those concerning the effectiveness marks, represent estimated average values under “normal” socioeconomic conditions: rule of law and order, void of war and chronic corruption. Even under such conditions, the actual effectiveness may well vary somewhat depending on the prevailing sociocultural circumstances. Nevertheless, the tables broadly reflect current thinking about the possibilities of having an impact on different kinds of direct and indirect drivers of ecosystems change.

### 2.3.1 Direct Drivers

The list of direct drivers defined by the MA includes land use and land cover, species introduction and removal, technology adoption and use, external inputs, harvest and consumption, climate change, and natural physical and biological drivers. Table 2.1 presents the estimated effectiveness and the length of the causal chain of the various legal, economic, social, technological, and cognitive responses in influencing these direct drivers. Natural drivers are not included in this table because they by definition cannot be affected by response options.

*Land use and land cover* as direct drivers of ecosystems change can be most effectively controlled by domestic regulatory law and command-and-control interventions. These measures typically take the form of land zoning and of establishing natural parks or

nature reserve areas. Empowering communities so that they can take the responsibility for their own lands can also be an effective option, especially if this is coupled with arrangements to legitimize traditional knowledge. In some cases, international treaties (like the CCD and the Ramsar Convention) provide the broader framework and additional motivation for domestic regulation but their effectiveness remains relatively low compared to domestic, national, and local interventions.

International agreements are also part of the response strategies in preventing *species introduction and removal* as well as external inputs, but domestic arrangements are more powerful in these cases as well. Domestic regulation and command-and-control type interventions at the national and local levels are most effective legal and economic responses. Empowerment of communities and the legitimization of traditional knowledge appear to be especially promising responses to control species introduction/removal and external inputs at the local level.

Similar to the cases of the previous two direct drivers, the *adoption and use of specific technologies* are most effectively controlled through domestic legal, economic, and social responses. Outright ban of ecologically harmful technologies and promotion of environmentally benign technologies by financial and monetary measures usually work. When empowered to manage their own resources, communities are also expected to make their technological choices by considering protection requirements. International trade policies, nevertheless, are likely to have increasing effects on technology adoption and use in appropriating ecosystems goods and services for international markets.

*Harvest and consumption* represent a mixed driver category. While harvest decisions are mostly made locally, part of the demand for ecosystems products can be triggered by remote consumption preferences. Domestic regulatory law and command-and-control interventions are conceived to be effective instruments to control harvesting technologies and the amount allowed to be harvested. Empowered communities are often capable of harmonizing harvest and protection concerns.

*Climate change* as a driver of ecosystems change represents a distinct case. An international legal framework is required to put the corresponding domestic regulatory mechanisms in place. Command-and-control as well as incentive-based instruments can be helpful in the implementation. International trade policies can usefully complement both international legal and domestic economic responses. Incentives for innovation and technological R&D are considered to be very effective response options, especially over the long term. In contrast, social responses, especially community-oriented measures, seem to be less important here.

### 2.3.2 Indirect Drivers

The MA identifies a broad set of indirect drivers that play a role in ecosystems changes. The list comprises demographic, economic, sociopolitical factors, science and technology, as well as values, culture, and religion. Table 2.2 shows the effectiveness of the response options in influencing these drivers and their proximity to the drivers.

*Demographic drivers* can mainly be influenced by domestic interventions, primarily by constitutional and regulatory law and explicit population policies and public education; economic command-and-control regimes, incentive-based, and financial measures can also play some role. The influence of international law on demographic drivers is limited to their implications for international migration flows (magnitude, direction).

Several response options in each main response category can effectively influence *economic drivers* of ecosystems change. Inter-

**Table 2.1. The Relationship between Response Options and Direct Drivers of Ecosystem Change.** The first number indicates the potential effectiveness of the response options to influence the driver. The second number shows the proximity of the response option to the driver.

Responses	Direct Drivers					
	Land Use, Land Cover	Species Introduction and Removal	Technology Adoption and Use	External Inputs	Harvest and Consumption	Climate Change
<b>Legal</b>						
International treaties	2/1	3/1	2/1	1/1	1/1	5/4
International soft law	1/1	1/1	1/1	1/1	1/1	3/4
International customary law	1/1	1/1	1/1	1/1	1/1	3/4
International agreements outside the environmental sector	2/1	2/1	2/1	2/1	2/1	2/3
Domestic environmental regulations	5/5	5/5	5/5	5/5	5/5	5/5
Domestic administrative law	4/4	3/3	3/3	3/3	3/3	3/3
Domestic constitutional law	5/2	1/2	1/2	1/2	1/2	2/1
Domestic legislation outside the environmental sector	3/4	3/4	3/4	3/4	3/4	3/4
<b>Economic</b>						
Command-and-control interventions	5/5	5/5	5/5	5/5	5/5	5/5
Incentive-based	4/5	3/4	5/5	5/5	5/5	4/3
Voluntarism-based	3/5	2/3	2/4	3/3	4/3	2/3
Financial/monetary measures	4/5	3/4	5/5	2/3	3/3	3/3
International trade policies	4/4	4/4	3/2	1/2	4/3	4/4
<b>Social and Behavioral</b>						
Population policies	3/3	3/3	2/2	3/2	3/3	3/3
Public education and awareness	3/5	3/5	3/5	3/5	3/5	3/5
Empowering communities	4/5	4/5	4/5	4/5	4/5	3/4
Empowering women	4/5	4/5	4/5	4/5	4/5	3/4
Empowering youth	3/4	3/4	3/4	3/4	3/4	3/4
Civil society protest and disobedience	2/5	1/5	1/5	1/5	1/5	1/3
<b>Technological</b>						
Incentives for innovation and R&D	3/3	2/2	3/5	2/2	4/5	5/3
<b>Cognitive</b>						
Legitimization of traditional knowledge	3/5	3/5	1/5	1/5	3/5	1/5
Knowledge acquisition and acceptances	3/5	3/5	3/5	3/5	3/5	3/5

national environmental treaties, customary law, and non-environmental agreements influence the ways in which ecosystems goods and services are harvested, used, and traded beyond national borders. Domestic environmental regulation and non-environmental legislation are the key domestic legal instruments to alter economic drivers. Obviously, the full arsenal of incentive-based, financial and monetary, and command-and-control interventions

can be used rather effectively to induce changes in the economic drivers of ecosystem change. Some social responses are also available in the form of public education and awareness, and community empowerment.

The *sociopolitical drivers* are more closely tied to the local and national social and political conditions, but an increasing number of international arrangements, especially international customary

**Table 2.2. The Relationship between Response Options and Indirect Drivers of Ecosystem Change.** The first number indicates the potential effectiveness of the response options to influence the driver. The second number shows the proximity of the response option to the driver. Blank cells mean the response is not applicable to the driver.

Response	Indirect Drivers				
	Demographic	Economic	Sociopolitical	Scientific and Technological	Cultural and Religious
<b>Legal</b>					
International treaties		4/4	3/4	2/4	
International soft law	1/3	1/4	2/4	3/4	2/4
International customary law	1/1	5/5	5/5		2/4
International agreements outside the environmental sector	2/1	3/4	3/3	2/3	2/2
Domestic environmental regulations	5/5	5/5	5/5	4/4	5/5
Domestic administrative law	2/3	2/3	2/3	2/3	2/3
Domestic constitutional law	4/5	3/4	5/5	5/5	
Domestic legislation outside the environmental sector	5/5	5/5	5/5	4/4	5/5
<b>Economic</b>					
Command-and-control interventions	5/5	5/5	4/5	4/5	5/5
Incentive-based	3/5	5/5	4/4	4/4	3/4
Voluntarism-based	2/4	2/4	2/3	4/4	4/5
Financial/monetary measures	3/5	5/5	3/4	4/5	3/4
International trade policies		4/5	4/5	4/5	3/4
<b>Social and Behavioral</b>					
Population policies	5/5	1/3			
Public education and awareness	4/5	4/5	4/5	4/5	4/5
Empowering communities	3/4	4/4	5/5	3/4	4/5
Empowering women	3/4	4/4	5/5	3/4	4/5
Empowering youth	2/3	3/3	4/4	2/3	3/4
Civil society protest and disobedience	1/5	1/5	1/5	1/5	1/5
<b>Technological</b>					
Incentives for innovation and R&D		4/4	3/3	5/5	
<b>Cognitive</b>					
Legitimization of traditional knowledge	2/5	2/5	2/5		3/5
Knowledge acquisition and acceptances	2/5	2/5	2/5	2/5	2/5

law, might affect them. Nonetheless, domestic environmental and non-environmental regulations remain the main instruments to sway sociopolitical drivers in the legal realm. Not surprisingly, the social response options are likely to play the key role when such drivers of ecosystems change need to be addressed with education and empowerment of communities as the most promising ones.

*Scientific and technological drivers* appear to be more difficult to influence. The various economic responses and domestic legal regulation are the most promising avenues but public education and awareness raising about the ecological impacts of the technologies may also be effective responses in some cases.

Possibly the most controversial drivers and also the most difficult to control are the *cultural and religious drivers*. Two possible strategies are apparent from Table 2.2. The first one is blunt prohibition or prescription in the form of domestic constitutional or

regulatory laws or by economic command-and-control interventions. The second avenue is to influence cultural and religious drivers through public education and awareness raising.

### 2.3.3 Responses and Drivers: Summary

It is important to recall that the effectiveness marks in Tables 2.1 and 2.2 indicate the prospects for success to achieve a given ecological, technological, or biophysical target. These values say nothing about the social costs of implementing the given response, let alone the economic efficiency (cost effectiveness) of the response option. These issues are discussed in Chapter 3. The economic efficiency of any response option crucially depends on the socioeconomic and institutional context in which, and on the resource/ecosystem problem to which, it is applied and thus it is

impossible to assess at the general level of discussion in this chapter. Chapters in Part II of this volume provide more detailed discussion of the relative merits of applying different response options to different ecosystems goods and services.

Two clusters of response options emerge as potentially effective in altering direct drivers. Considering the effect of indirect drivers of ecosystems change on direct drivers, it seems to be difficult to override those effects and use responses other than prescriptive regulatory measures like domestic legal regulation or command-and-control instruments, although in some cases incentive-based economic responses may work as well. Land zoning, the prohibition of introducing or removing species, or the ban of certain technologies or inputs are hard and blunt tools to achieve clearly defined ecological objectives. The economic efficiency of such responses can nonetheless be improved by using incentive-based instruments (like tradable permits) in the implementation phase.

The second cluster of promising responses to affect direct drivers can be found in the social domain. Empowering communities and social groups close to and crucially depending on the ecosystem or resource base can be effective in mitigating ecosystems problems when communities establish generally accepted rules of access to, and harvest or use of, ecosystems goods and services.

Indirect drivers are the ultimate causes of ecosystems problems but they involve a broad range of demographic, economic, social, and technological factors. In a globalizing world, there is an increasing influence on indirect drivers from international legal and economic agreements. Nevertheless, the domestic regulatory responses and the domestic legislation outside the environment sector including them stand out as the most effective options. They are usefully complemented by economic responses, especially those based on incentives or involving command-and-control measures.

In the domestic realm, the pattern is rather obvious: economic responses, especially command-and-control, incentive-based, and financial and monetary responses dominate the options to affect economic driving forces. Social responses, primarily empowering communities, are most effective in influencing sociopolitical as well as cultural and religious drivers. Incentives for innovation and research and development are the most direct and most effective ways to sway scientific and technological drivers but economic responses, especially incentive-based ones, are also valuable.

## 2.4 Responses by Actors

### 2.4.1 Key Responses Available to the Government Sector

Governments at all levels, through laws, regulations, and other policy decisions, are key actors in the protection of ecosystems. Their actions can be direct or indirect.

Direct actions by governments to protect ecosystems by limiting or prohibiting commercial exploitation are the most easily understood and analyzed. Protection of land as parks, wilderness areas, etc., is the most obvious and visible of such actions. Such protection is often accompanied by efforts to counteract previous ecosystem degradation. There are also many other approaches, which, while stopping short of full protection, promote sustainable development and use of ecosystems, for example, community-based natural resource management (Viet et al. 2001).

At both the national and international levels, governments also act to protect species, habitats, and specific land types with policies that do not fully protect land. These policies either limit the types of activities that can occur on the land or promote activities that will limit or reverse ecological damage. CITES ([www.cites.org](http://www.cites.org)) is an example of an international policy to protect species; the U.S. Endangered Species Act ([www.endangered.fws.gov](http://www.endangered.fws.gov)) and India's National Policy and Action Plan on Biodiversity, 2000 (Indian Government 2001) are examples of policies at the national level. The Convention to Combat Desertification ([www.unccd.int](http://www.unccd.int)), with its requirement for national, sub-regional, and regional action plans to limit and reverse the spread of desertification, is an example of a policy at both the national and international levels, that is aimed at protecting both habitats and land types. U.S. regulations on the protection of wetlands (Clean Water Act, Section 404; [www.epa.gov/owow/wetlands/regs/sec404.html](http://www.epa.gov/owow/wetlands/regs/sec404.html)) and the Central American Forest Convention (Aguilar and Gonzalez 1999) are examples of such policies at national and regional levels.

Many government policies implemented for other reasons affect ecosystems. Some of these policies have negative impacts on ecosystems, and their removal can be a response option. Examples of policies that can have a negative impact on ecosystems include:

- building of roads, dams, and other civic infrastructure that directly destroy habitats or open areas to more intensive settlement;
- agricultural policies, including subsidies and unsustainable irrigation, that promote the cultivation of marginal land or overuse of existing farmland; and
- economic development policies that promote urbanization and strain water supply and other resources.

While these negative outcomes are often considered “unintended consequences,” analyzing policies from a sustainable development perspective will often warn of potential negative outcomes. Environmental impact assessments are a useful tool in conducting the environmental portion of such an analysis.

### 2.4.2 Key Responses Available to the Private Sector

The private sector, that is, business and industry, is often portrayed simply as an exploiter of ecosystem goods and services. However, as a major user of ecosystem goods and services, the private sector can play an important role in the protection of ecosystems. The private sector acts at three levels: in partnership with governments, in partnership with other stakeholders, and on its own.

Partnerships between the private sector and government occur both formally and informally. An example of a formal arrangement was the partnership between TotalFinaElf and the Bolivian National Oil Company, YPFB, to minimize the ecological impacts of oil exploration in Bolivia's Madidi National Park ([www.ipieca.org/downloads/biodiversity/sens\\_envir\\_case\\_studies/TotalFinaElf\\_bolivia.pdf](http://www.ipieca.org/downloads/biodiversity/sens_envir_case_studies/TotalFinaElf_bolivia.pdf)).

Informal partnerships can develop in a number of ways. In 1970, S.C. Johnson began purchasing pyrethrum, a natural insecticide, for use in its products from the Pyrethrum Board of Kenya, the agency that controls and operates the pyrethrum business in Kenya. Over the years this relationship grew from a simple supplier-purchaser interaction into a collaborative effort with a strong degree of knowledge and technology exchange. Promotion of pyrethrum cultivation is beneficial to ecosystems in two ways: pyrethrum requires little fertilizer or pesticide input and it produces a natural product that can be used to reduce insecticide usage for other applications ([www.wbcsd.org/web/publications/technology-cooperation2.pdf](http://www.wbcsd.org/web/publications/technology-cooperation2.pdf), pp. 39–46).



Partnerships between the private sector and other stakeholders can be very effective in encouraging more sustainable use of ecosystems. This was the case when Bayer CropScience conducted a pilot program of its integrated crop management program in Brazil. The goals of this program were to use the full range of weed and pest control techniques to reduce dependence on chemical agents and lessen potential impacts on ecosystems. Other stakeholders included local government authorities and farmers' associations (see [www.wbcsd.org/web/publications/technology-cooperation2.pdf](http://www.wbcsd.org/web/publications/technology-cooperation2.pdf), pp. 9–17). The pilot was successful and was used as a basis for a larger program in Guatemala.

Finally, private sector companies often act on their own in undertaking efforts to preserve and enhance the ecosystems in which they are working. Since environmental law and regulation is now comprehensive in most parts of the world, these efforts usually entail going beyond specific legal requirements. Rio Tinto has done this in Madagascar where it has put in place a team of Malagasy environmental professionals to carry out research and to monitor the progress on restoration of a biodiverse area in which the company is mining ilmenite. The goal is restoration of the forests and wetlands that are important not only as habitats but for the economic well-being of the local community ([www.wbcsd.org](http://www.wbcsd.org), see case studies).

#### 2.4.3 Key Responses Available to the Local Community

The importance of traditional and local managers in stewarding ecological resources is obvious. They are the actors who have to implement many government policies and their commitment, or lack thereof, to these policies can determine their success or failure. For example, many anti-desertification policies tried in the Sahel in 1970s and 1980s failed because they did not take local socioeconomic factors into account (OCEE 1996). Conversely, the Kikori Integrated Conservation and Development Project, a partnership between ChevronTexaco and the World Wildlife Fund in Papua New Guinea, which protected some of the world's rarest wildlife and promoted the sustainable development of local communities, was a success because it involved local communities in project planning and execution. The World Bank called this project "a model for other resource developers operating in ecologically sensitive areas" ([www.ipieca.org/downloads/biodiversity/sens\\_envir\\_case\\_studies/ChevTex\\_PNG.pdf](http://www.ipieca.org/downloads/biodiversity/sens_envir_case_studies/ChevTex_PNG.pdf)).

The knowledge that traditional and local managers bring as part of an informed public participation process can be invaluable in defining the ecological risks and ways of avoiding them.

#### 2.4.4 Key Responses Available to NGOs

Advocacy groups, traditional environmental groups as well as social justice groups, play an important role in education and awareness-raising. They are often the first to call attention to the potential ecological impacts of proposed developments, and often play an important role in developing detailed information about the magnitude and extent of potential impacts.

Advocacy groups can play an important role in empowering local communities and other stakeholders. The benefits of public participation can be achieved only when the public has sufficient information about an issue to make an informed decision. For example, the economic benefits of development are usually well advertised, but their ecological costs may be hidden. Advocacy groups can provide information on those ecological costs, allowing local communities and other stakeholders to make informed choices.

Advocacy groups also play a critical role in mobilizing stakeholders at the national and international level. Again, education and public awareness are the key factors. Successful campaigns to save baby harp seals and raise the level of concern about endangered species could not have occurred without the international education and public awareness campaigns undertaken by environmental advocacy groups. Advocacy groups also develop and promote innovative approaches to ecosystem protection, for example debt-for-nature swaps which have been promoted by WWF and Conservation International ([www.fao.org/docrep/w3247e/w3247e06.htm](http://www.fao.org/docrep/w3247e/w3247e06.htm)).

While advocacy groups often assume an adversarial posture, they also work in partnership with governments and the private sector to achieve mutual goals. An example is the partnership between the government of Bolivia, Fundacion Amigos de la Naturaleza, the Nature Conservancy, and three U.S. energy companies to protect over 60,000 hectares of the Noel Kempff Mercado National Park, one of the most biological diverse areas in the world (<http://nature.org/initiatives/climatechange/work/art4253.html>).

Finally, advocacy groups can act on their own to protect ecosystems. For example, the Nature Conservancy ([www.nature.org](http://www.nature.org)) has bought or otherwise protected over 40 million hectares of threatened ecosystem.

#### 2.4.5 Responses and Actors: Summary

Table 2.3 shows the relationship between responses and actors. Across the top of the table are the actors that range from governments to civil society groups. Down the rows are the various responses, from legal to cognitive responses. There are two numbers in each cell; the first number is the availability of the response to the actor. The numerical range is from one to five; a higher number indicates that the response is readily available to the actor while a lower number actor indicates that the response is either not available or seldom used. The second number in the cell shows the effectiveness that the actor has in using the corresponding response. A high number shows that the actor could effectively use the response and a lower number shows that the actor would have little effective result from using the response.

The tallies indicate some clear patterns of availability and effectiveness. Governments predominately have the widest range of responses available to them compared to other actors. Legal responses are only available to governments though other actors may be able to challenge legal responses through dispute settlement and judicial action or through influencing law-making negotiations through education and lobbying. The predominance that the government has over legal response options results from its control of the authority to make laws and the economic power to implement decisions. The effectiveness of these responses may vary and, though the response may indeed have the potential to change behavior, the implementation may be subject to socioeconomic factors that result in outcomes that are less than effective.

Social, economic, technological, and cognitive responses are generally only available to nonstate actors. The private sector tends to exercise control over financially based responses where it can create incentives for technological change, such as research and development, or where it has the financial power to implement the response. Incentive-based research and development is an important response for the private sector and one, in which it exercises considerable control; if used for the development of new products to protect and conserve ecosystems, it can be an effective response. Volunteer-based responses also tend to be an effective response, as business and industry prefer self-regulation and the

**Table 2.3. The Relationship between the Responses and the Actors.** The first number in a cell is the availability of the response to the actor. The second number shows the effectiveness the actor has in using the response. Blank cells mean the response is not applicable to the actor.

Response	Actors			
	Government	Private Sector	Local Communities	NGOs
<b>Legal</b>				
Treaties	5/5			
International soft law	2/5			
International customary law	3/5			
International agreement; legislation outside environment sector	3/5			
Domestic environmental regulations	5/5			
Domestic administrative law	3/5			
Domestic constitutional law	4/5			
Domestic legislation outside the environmental sector	4/5			
<b>Economic</b>				
Command-and-control interventions	5/5			
Incentive-based	5/5	5/5	2/3	2/4
Voluntarism-based	3/5	4/5	4/5	4/4
Financial/monetary measures	5/5	5/4	3/3	3/3
International trade policies	4/5			
<b>Social and Behavioral</b>				
Population policies	5/4	3/4	4/3	3/4
Public education and awareness	5/3	4/5	4/5	4/5
Empowering youth	3/5	4/5	4/5	4/5
Empowering communities	3/5	4/3	5/5	5/5
Empowering women	3/5	4/3	5/5	5/5
Civil society protest and disobedience			1/5	1/5
<b>Technological</b>				
Incentives for innovation R&D	5/4	5/5	5/4	5/4
<b>Cognitive</b>				
Legitimization of traditional knowledge	5/2		5/5	5/5
Knowledge acquisition and acceptances	5/3	4/3	3/2	4/4

flexibility to choose their own response instead of having these responses imposed by government. Education and awareness raising can also be effectively used by the private sector, though often these types of responses are not employed for the betterment of ecosystems but for marketing and sales.

Local communities and NGOs tend to have at their disposal social policies that educate, empower, or provide information and knowledge to change values, perceptions, and attitudes. Civil disobedience and protest may also be readily available to these actors, but the effectiveness of these responses is normally very low compared to other responses. Local communities and NGOs also play an important role in the legitimization and use of traditional knowledge, which is critical for understanding the complex systematic relationships between humankind and nature—a relationship that is not always understood by modern or scientific knowledge.

Innovation incentives for research and development are available to all actors, but in very different aspects. Whereas government and the private sector play important roles in providing the

means for innovations, NGOs and local communities can set agendas either by defining the necessity for new technology and the need for practical applications of technology or by promoting greener ecosystem technologies through education, dissemination, and lobbying.

In discussing the various actors and the key responses available to them, this section has shown the limitations of responses available to nonstate actors compared with those available to governmental actors. Nevertheless each actor plays an important role in implementation and propagation of behavioral and ecosystem change.

## 2.5 Response Options by Scale of Operation of Decision-maker

Ecosystem related problems require policy responses that correlate to the scale of the problem. In the natural sciences, scale has tradi-

tionally been a prominent issue; but only recently has this issue come to the fore in discussion of policy responses to environmental problems. This section examines the different response options according to their scale and discusses appropriate pairing of the scale of the environmental problems and responses. Response options are determined by their jurisdictional reach, or by the decision-makers' authority to craft such a response. Thus the section examines the scale of various state-sanctioned response options, as well as the physical and political considerations that affect them.

### 2.5.1 Global/Universal Responses

Global responses to ecosystem problems are warranted when those problems are universal in nature—potentially affecting all people and ecosystems of the planet. Although there are numerous problems of this nature, there are few truly universal response options. Customary international law, defined above as, “a general practice accepted as law,” is the main response option that is universal, for customary law is binding on all states, irrespective of their accession status to a particular treaty. The majority of global environmental problems, however, are addressed through multilateral solutions.

### 2.5.2 Multilateral Agreements

In contrast to customary international law, multilateral treaties are binding only on those parties that sign and ratify them. Much of the body of international environmental law has arisen through multilateral treaty-making. Examples range from the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal to the Convention on International Trade and Endangered Species of Wild Fauna and Flora.

Climate change, often cited as one of the most complex environmental challenges facing society, demonstrates the need for multilateral response options. The Intergovernmental Panel on Climate Change noted in its Third Assessment Report that changes to atmospheric composition will have consequences for future levels of mean temperature, precipitation, sea level, and the occurrence of extreme events (IPCC 2001). Because climate change has the potential to affect all human beings, the policy response has been to draft multilateral legal instruments. The UNFCCC and the Kyoto Protocol rely on Hardin's model of “mutual coercion, mutually agreed upon,” whereby parties mutually agree to limit their emissions of carbon dioxide. Other multilateral responses that ascribe to mutual coercion and preserve open access to resources include the Montreal Protocol, the CBD, and the Antarctic Treaty.

Most often, multilateral response options are appropriate for common pool resource problems, when the resource in question is both rival (one person's consumption will diminish another person's) and non-excludable (under current policy arrangements, no one can be barred from consuming said resource). Multilateral responses can include Hardin's model of mutual coercion, though the effectiveness may diminish with complex ecosystems or numerous actors. Restricting the transboundary movement of hazardous waste, for example, provides an incentive to reduce the production of this waste and to ensure its safe disposal, either within a party's borders or with the explicit prior informed consent of the recipient party.

However, this model of cooperation under anarchy presents a number of problems (Oye 1986). The greater the number of actors involved, the more difficult cooperation becomes. In addition, lengthy time horizons, as with the issue of climate change, often provide a disincentive for cooperation. However, actors

who are forced to negotiate with each other over time, and across a number of issues, are more likely to cooperate, and less likely to free-ride.

### 2.5.3 Plurilateral Agreements

Plurilateral agreements address regional problems, often transboundary in nature. These issues require the participation of those parties affected by the problem, but need not involve states beyond the area of that ecosystem. For example, the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, creates a framework and specific guidelines for regional and sub-regional management of migratory fish stocks. It builds upon an existing multilateral treaty, the U.N. Convention on the Law of the Sea, but adds much stronger incentives for compliance. Vessels found to be in violation may be banned from fishing the area covered by the regional agreement.

The Regional Seas Programme, run by UNEP, is another example of a set of plurilateral agreements. Of the seventeen separate bodies of water covered by the various programs, twelve have corresponding conventions and, in most cases, one or more protocols. These have been enacted to tailor policy responses to the environmental characteristics of and threats to each specific body of water. Each program includes the participation of all nations surrounding a given sea and takes measures to protect it against threats, including pollution, overexploitation, invasive species, and global change.

### 2.5.4 Bilateral Agreements

Bilateral agreements, like plurilateral agreements, are often established to respond to transboundary problems. One of the older examples is the International Joint Commission, established in 1909 by the United States and Canada to manage shared water bodies. Years later, in 1972, the two countries created the Great Lakes Water Quality Agreement, to manage the transboundary freshwater Great Lakes. This formal bilateral agreement, amended in 1978 and 1987 to set more stringent goals for ecosystem management, lay the foundation for an extensive network of actors to cooperate in joint management efforts (Karkkainen 2004). Similar bilateral agreements have been established in southern Africa to create joint water commissions for the management of shared watercourses; on the whole, these demonstrate a clear political commitment by the states involved, to create frameworks to facilitate joint management of watercourses water projects (Giordano and Wolf 2003).

### 2.5.5 National Policies

Though multilateral agreements involve the consensus of a group of nations, such instruments often fall to the national level for implementation. For example, the frequent amendments of the Montreal Protocol kept pressure on parties to phase out chlorofluorocarbons and other ozone-depleting substances, which in turn increased the effectiveness of the agreement. However, national policies need not always be in response to an international mandate. They are more often the product of public opinion or policy priorities of law-makers of that nation. For example, though the Kyoto Protocol has yet to enter into force, a number of nations have taken extensive measures to attempt to meet the negotiated reductions within the timetable of the first commitment period.

### 2.5.6 State/Province-Level Responses

Similarly, states or provinces can take actions on the basis of a national mandate or simply implement policies autonomously. In

the United States, the state of California, for example, has adopted a number of its own policies to curb greenhouse gas emissions, despite the fact that the United States has stated that it will not accede to the Kyoto Protocol. Thus California is not legally required to take these measures, but rather chooses to do so of its own accord. Nonetheless, in the past two years, California has established a greenhouse gas registry, and will require car manufacturers to meet certain fleet standards from 2009 onward.

### 2.5.7 Local Responses

Like state and national response options, local responses to environmental problems can be in response to a mandate from a larger jurisdiction, or can be autonomous, taken to resolve issues specific to that area. An effort between communities and localities to jointly manage forest tracts in India is such an example (Sarin 1995); localities responded to a very specific need of residents in surrounding communities to reap greater benefits from their natural resource bases. On the local scale, voluntarism-based responses have emerged to address climate change. Many cities, for example, have conducted assessments of their greenhouse-gas emissions and implemented steps to try to reduce them—even in the absence of federally mandated regulation. To provide sufficient incentive, responsibility to manage these resources was partially devolved to residents themselves.

### 2.5.8 Challenges and Issues

Response options to ecosystem management problems have a considerable range—from the largest most complex ecosystems involving many actors to local or municipal ecosystems involving relatively few actors. The scale of the intervention varies with the ecosystem and with drivers of change, both direct and indirect. The challenge is not only to match the response option to the scale of the problem and drivers, but also to ensure that those problems with multiple responses do not conflict with each other.

Table 2.4 presents some of the challenges and issues discussed in this section; it differs slightly from the preceding tables. Since the objective of this table is to identify the scales at which response options are available, it does not assess proximity of the response option to its target. The absence of a number indicates that the response is not available at that scale.

The first section of the table indicates the appropriateness of specific types of legal responses at different scales. A “5” denotes an available response. The table shows that applicable responses cluster in two areas. Unsurprisingly, international legal responses are appropriate at the supra-national level—including multilateral, plurilateral, and bilateral responses. Domestic legal responses, including regulatory, administrative, and constitutional responses, are available at the national and sub-national level.

The section on legal responses, while indicating the available responses at different scales, does not distinguish among them in terms of effectiveness; for this reason, they are all assigned the same effectiveness value of 5. Without specifying the driver of change, it is difficult to identify the appropriate scale of response. For example, though a multilateral treaty may be most effective for a global commons problem such as protection of the world’s oceans, it would not be an effective response to manage a river basin shared by two nations. Thus there are nuances to the effectiveness of legal response options not captured by the table.

The second section of the table indicates that economic responses are available at all scales; the numbers indicate the perceived effectiveness relative to the other economic responses. At the supra-national level, command-and-control interventions are likely to be used by the private sector, to standardize practices

throughout large multinational corporations, and possibly, by international organizations such as the International Organization for Standardization.

On the national and sub-national levels, command and control will likely be a response option most used by governments. Incentive and voluntarism-based interventions are flexible response options available at all levels to a variety of actors. Financial and monetary measures are likely to be the purview of governments and the private sector, available to them at all levels of scale. Finally, international trade policies are available to governments, only at the supra-national scale.

The third portion of the table illustrates that social policies are likely to increase in effectiveness as the response approaches the local level. Since social response options are directed at individuals’ beliefs and behaviors, targeted interventions are more likely to be effective; thus effectiveness of almost all social responses increases as the scale moves toward the local. Population policies are one exception to this pattern. Because population policies are politically sensitive, and often controversial, it follows that such decisions would be taken at the national level; political compromise in the context of a supra-national response is not likely. Thus there are no response options available at the supra-national level.

Both technological and cognitive response options are available at all scales, and may be equally effective at the supra-national, national, and sub-national levels.

In general, the scale of the response option is determined in part by the interaction between domestic and international interests. This two-level game, satisfying the political requirements on both the national and international levels, can become quite complex with many actors and competing national interests. The result is a smaller number of acceptable outcomes that satisfy all players involved (Putnam 1988). Thus the range of response options acceptable to all parties involved is smaller than it would be with fewer actors, or fewer pressures from the domestic level.

Another important consideration in scaling response options is the need for similar or complementary policies elsewhere in the hierarchy of response options. For example, multilateral agreements must be implemented by national, and sometimes sub-national policies. If the bureaucratic, political, legal, or economic infrastructures are insufficiently developed, that nation may not be capable of carrying out its obligations under the multilateral agreement. Sub-national responses, such as those on the local or municipal level, also need support from further up the hierarchy. For example, many failures of sustainable forestry management by communities have been attributed to the lack of property rights in the region or nation (Church 1996; Ruitenbeek 1998). It is also important to consider the use of multiple types of actors at different scales, as appropriate, to help surmount these difficulties. Conversely, sub-national responses may need to be harmonized with responses at national and supra-national levels. Thus there is an added challenge of “scaling up” these responses, so that they do not conflict with (and, at best, are in harmony with) larger-scale interventions (Ostrom et al. 1999).

### 2.5.9 Response Options by Scale: Summary

This section has discussed the different scales at which response options can be implemented, and the appropriateness of these scales for different types of responses. It has also outlined some of the challenges involved in determining and implementing response options at the appropriate scale. First, in some cases—such as when responding with legal instruments—knowledge of the drivers of change may be a necessary prerequisite for evaluating the relative effectiveness of different response options. Second,

**Table 2.4. Challenges and Issues.** Since scale is the focus, this table does not assess proximity of the response option to its target. Blank cells indicate that the response option is not available at that scale.

Response	Scale					
	Multilateral	Plurilateral	Bilateral	National	State/Province	Local
<b>Legal</b>						
International treaties	5	5	5			
International soft law	5	5	5			
International customary law	5	5	5			
International agreements; legislation outside environment sector	5	5	5			
Domestic environmental regulations				5	5	5
Domestic administrative law				5	5	5
Domestic constitutional law				5	5	5
Domestic legislation outside environmental sector				5	5	5
<b>Economic</b>						
Command-and-control interventions	5	5	5	5	5	5
Incentive-based	4	4	4	4	4	4
Voluntarism-based	3	3	3	3	3	3
Financial/monetary measures	4	4	4	4	4	4
International trade policies	4	4	5			
<b>Social and Behavioral</b>						
Population policies				4	4	4
Public education and awareness	2	2	3	3	3	4
Empowering communities	2	2	3	3	3	4
Empowering women	2	2	3	3	3	4
Empowering youth	1	1	2	2	2	3
Civil society protest and disobedience	2	1	1	3	3	3
<b>Technological</b>						
Incentives for innovation and R&D	4	4	4	4	4	4
<b>Cognitive</b>						
Legitimization of traditional knowledge	2	2	2	2	2	2
Knowledge acquisition and acceptances	2	2	2	2	2	2

the interaction between political interests at the domestic and international levels may help determine the array of responses available. Third, response options on different scales at a minimum must not conflict with each other and ideally should be complementary.

## 2.6 Synthesis

Considering the immense variety of ecosystems, the problems and challenges emerging in using their goods and services to improve human well-being, and the vast diversity of socioeconomic conditions under which they must be managed, it is an almost hopeless attempt to derive generally valid observations concerning the most promising responses. Running the double risk of being far too general yet still being wrong because under special circumstances counterexamples could be cited, this section presents some general patterns concerning the most promising responses available to the four main actor groups (government, private sector,

NGOs, local communities) to induce changes in the direct and indirect drivers in response to feared, emerging, or prevailing problems with ecosystems.

Table 2.5 provides a synthesis of earlier tables in this chapter by compiling those responses that appear to be most effective in the hands of given actors to achieve desired changes in a driver of ecosystem change.

National governments play a central role in devising and implementing responses for several reasons. First, they control the domestic legal instruments ranging from constitutional to regulatory and administrative legislation. Second, they provide the context for other domestic responses. Third, they must utilize domestic legal instruments to implement most responses. Fourth, they provide the bridge from the international environmental and other agreements affecting the use of ecosystems goods and services to the national actors targeted by those agreements. National governments also control most economic responses, of which incentive-based and command-and-control measures are the most

**Table 2.5. The Most Effective Response Options Available to Four Main Actor Groups to Influence Direct and Indirect Driving Forces**

<b>Actors</b>	<b>Government</b>	<b>Private Sector</b>	<b>NGOs</b>	<b>Local Community</b>
<b>Direct Drivers</b>				
Land use, land cover	command-and-control regulatory incentive-based	voluntarism-based	education knowledge acquisition and acceptance	empowerment education legitimization of traditional knowledge
Species introduction and removal	command-and-control regulatory international treaty	voluntarism-base	deducation knowledge acquisition and acceptance	education empowerment legitimization of traditional knowledge
Technology adoption and use	command-and-control regulatory incentive-based financial/monetary international trade	financial/monetary incentive-based technology R&D	voluntarism-based education knowledge acquisition and acceptance	empowerment education legitimization of traditional knowledge
External inputs	command-and-control regulatory	incentive-based voluntarism-based	education knowledge acquisition and acceptance	education empowerment
Harvest	command-and-control regulatory	incentive-based technology R&D	education	legitimization of traditional knowledge empowerment
Climate change	international treaty command-and-control regulatory	voluntarism-based	education	voluntary-based empowerment
<b>Indirect Drivers</b>				
Demographic	domestic regulations domestic constitutional law		education empowerment	empowerment education
Economic	international trade policies incentive-based command-and-control financial/monetary	financial/monetary	voluntarism-based	voluntarism-based
Sociopolitical	international customary law domestic constitutional law domestic environmental regulations	voluntarism-based	voluntarism-based education	empowerment education
Scientific and technological	international soft law domestic environmental regulations incentives for innovation and R&D public education	incentives for innovation and R&D	education	traditional knowledge empowerment education
Cultural and religious	domestic constitutional law domestic regulatory law public education command-and-control	education empowerment	traditional knowledge education	empowerment traditional knowledge education

effective ones. Governments initiate national research and technological development programs and operate the basic education systems.

Therefore, national-level decision-making has a special role in several respects. First, even the best-designed local or regional actions are likely to be ineffective in the absence of proper coordination (for example, a stringent and enforced protective measure in one region may simply shift the harmful activity to another region). Second, the key legislative power is anchored at the national level (although the distribution between the federal and state levels varies in federal states). Finally, nation states are the recognized parties in the increasing number of international negotiations and agreements (from bilateral to global) concerned with ecosystem and biodiversity management.

At the other end of the spectrum, local communities are increasingly seen as the most appropriate guardians of their own ecosystems and resources. The empowerment of communities at large or special groups like women or youth emerges as a potentially effective response option from our assessment in the preceding sections. Their effectiveness can be further strengthened by education and information provision on the one hand and by the legitimization of traditional knowledge on the other.

NGOs can do a lot to help communities both at the production/harvest end and at the consumption end of ecosystems use. NGOs' contribution depends on an open and participatory process, the level of democratization in a country; and political comfort in engaging in an open dialogue and receptiveness to criticism. Their most effective response options are education, knowledge acquisition and acceptance, and encouraging voluntarism-based actions in the local communities and among consumers. On the production/harvest side, these activities help resource operators in making informed choices about land use, the introduction or removal of species, and the application of technologies. On the consumer side, it is mostly awareness raising about the implications of certain consumption patterns. NGOs can also target the private sector with these instruments.

When the national government gives the proper and clear signals and provides an operational framework, the private sector can rely on powerful response options to influence both direct and indirect drivers. Incentive-based instruments and voluntary measures can be used to have an effect on land use and land cover change or the application of external inputs. Financial and monetary instruments as well as incentives for innovation, research, and development can be used to shape harvesting practices and the adoption and use of technologies.

Another general pattern emerging from Table 2.5 is that the greatest potential for responses by NGOs and communities are related to the direct drivers. Except for climate change, these are decisions about local and regional resources and they are made locally. In contrast, the larger-scale responses concerning demographic, economic, political, and science/technology drivers are shaped by governments and, to some extent, by the private sector. The instruments available to NGOs to influence indirect drivers are fewer and relatively weaker.

Any typology involves some degree of (over)simplification. The typologies presented in this chapter are no exceptions. But it is important to point out that none of the response options presented and discussed here comes in a sterile or stand-alone form. The tools available to different actors complement each other and constitute a set of measures the final outcome of which will eventually guide the choices and decisions of consumers, the resource operators, and the intermediaries between them. The internal consistency of such packages is crucial. Therefore it is necessary to understand the effect mechanisms and the outcomes the various

response measures may trigger, especially their potential unintended consequences, whether technological or social nature. Chapters in Part II explore the responses in detail but it is important to keep in mind their interactions.

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