Chapter 8

Interlinkages: Governance for Sustainability

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Main messages

The Earth functions as a system: atmosphere, land, water, biodiversity and human society are all linked in a complex web of interactions and feedbacks. Environment and development challenges are interlinked across thematic, institutional and geographic boundaries through social and environmental processes. The state of knowledge on these interlinkages and implications for human well-being are highlighted in the following messages:

Environmental change and development challenges are caused by the same sets of drivers. They include population change, economic processes, scientific and technological innovations, distribution patterns, and cultural, social, political and institutional processes. Since the report of the World Commission on Environment and Development (Brundtland Commission), these drivers have become more dominant. For instance, the world population has increased by 34 per cent and world trade has increased almost three times. During the past two decades it has resulted in a situation where:

- *human societies have become more interconnected* through globalization driven by increasing flows of goods, services, capital, people, technologies, information, ideas and labour;
- *development challenges have become more demanding* as evident in the efforts to meet the Millennium Development Goals (MDGs); and
- *pressures on the environment, and consequently the rate, extent, interconnectedness and magnitude of environmental change, have increased*, as have their impacts on human well-being.

The responsibility for the drivers that create the pressures on the environment is not equally distributed throughout the world. Economic processes are a good example. In 2004, the total annual income of the nearly 1 billion people in the richest countries was nearly 15 times greater than that of the 2.3 billion in the poorest countries. Also that year, the Annex 1 countries of the UN Framework Convention on Climate Change, contained 20 per cent share of the world population, produced 57 per cent of world GDP, based on purchasing power parity, and accounted for 46 per cent of greenhouse gas (GHG) emissions. Africa's share of the GHG emissions was 7.8 per cent.

One form of human activity can cause several reinforcing environmental effects and affect human well-being in many ways. Emissions of carbon dioxide, for example, contribute both to climate change and to acidification of oceans. In addition, land, water and atmosphere are linked in many ways, particularly through the carbon, nutrient and water cycles, so that one form of change leads to another. For example, changes in the structure and functioning of ecosystems caused in part by climate change will, in turn, affect the climate system, particularly through the carbon and nitrogen cycles. Human activities, such as agriculture, forestry, fisheries and industrial production, have increasingly altered ecosystems, and the ways in which they provide services in support of human well-being.

Social and biophysical systems are dynamic, and characterized by thresholds, time-lags and feedback loops. Thresholds – sometimes also referred to as tipping points – are common in the Earth system, and represent the point of sudden, abrupt, or accelerating and potentially irreversible change triggered by natural events or human activities. Examples of thresholds being crossed due to sustained human activities include: collapse of fisheries, eutrophication and deprivation of oxygen

(hypoxia) in aquatic systems, emergence of diseases and pests, introduction and loss of species, and regional climate change. Biophysical and social systems also have the tendency to continue to change, even if the forces that caused the initial change are removed. For example, even if atmospheric concentrations of greenhouse gases were to be stabilized today, increases in land and ocean temperatures due to these emissions would continue for decades, and sea levels would continue to rise for centuries, due to the time-lags associated with climate processes and feedbacks.

The complexity of human-ecological systems, and the limitations in our current state of knowledge of the dynamics of these systems, make it hard to predict precisely where critical thresholds lie. These are the points where an activity results in an unacceptable level of harm, for example in terms of ecological change, and requires a response. This uncertainty also makes it difficult to identify measures for pre-empting the crossing of critical thresholds. This is of significant concern for human well-being, as past examples such as in Mesopotamia and Easter Island show how crossing some thresholds can contribute to the catastrophic disruption of societies.

The complexity, magnitude and the interconnectedness of environmental change do not mean that decision-makers are faced with the stark choice of "doing everything at once in the name of integrated approaches or doing nothing in the face of complexity." Identifying interlinkages offers opportunities for more effective responses at the national, regional and global levels. It may facilitate the transition towards a more sustainable society. It provides the basis for applying measures where they are most effective, based on trade-offs among different interests in society, and in a complementary manner.

Consideration of interlinkages among environmental challenges can facilitate more effective treaty compliance, while respecting the legal autonomy of the treaties. This would highlight areas for cooperation and joint programming among the treaties, and for more effective enforcement and compliance at the national level, as well as for related capacity building and technology support. Considerations of the overall normative basis for environmental governance may help identify new opportunities for more effective institutional structures for international environmental cooperation.

Collaboration across existing governance regimes can strengthen the integration of environmental concerns into the wider development agenda. Significant opportunities in this respect are offered by the UN reform process, due to its particular focus on system-wide coherence in the area of environment, and the "One UN" approach at the country level. Approaches such as mitigation, including carbon storage, and adaptation to climate change that consider links with other environment and development challenges, may potentially address multiple environmental and development challenges simultaneously.

Governance approaches that are flexible, collaborative and learning-based may be *responsive* and *adaptive*, and better able to cope with the challenges of integrating environment and development. Such adaptive governance approaches are well placed to address complex interlinkages, and to manage uncertainty and periods of change. They are likely to result in incremental and cost-effective evolution of institutional structures, and reduce the need for more fundamental institutional restructuring. Tools for dealing with interlinkages, such as assessments, valuation techniques and integrated management approaches that link environment to development, provide a critical foundation for adaptive governance.

"Until recently, the planet was a large world in which human activities and their effects were neatly compartmentalized within nations, within sectors (energy, agriculture, trade), and within broad areas of concern (environment, economic, social). These compartments have begun to dissolve. This applies in particular to various global 'crises' that have seized public concern, particularly over the last decade. These are not separate crises: an environmental crisis, a development crisis, and energy crisis. They are all one."

Our Common Future
The Brundtland Commission report

INTRODUCTION

The World Commission on Environment and Development (Brundtland Commission) referred to the environmental, development and energy crises as "the interlocking crises" (WCED 1987). The interconnectedness of the environment and human society is emphasized throughout the Brundtland Commission report, and it is central to the concept of sustainable development (WCED 1987). It is also fundamental to the GEO conceptual framework, which focuses on the interaction between environment and society. Preceding chapters have assessed the linkages among and between drivers, pressures, environmental change, ecosystem services, human well-being and policy responses to the environmental challenges. They have also demonstrated how the patterns of the human-society interactions change with scale and time, how the environmental changes vary from one geographic region to another, and how different groups are vulnerable to various forms of environmental change.

Twenty years after the Brundtland Commission report was published, its findings are more pertinent than ever. The global pattern of the human-society interactions is changing. From a human perspective, the world is becoming smaller. For example, the amount of land per capita has been reduced to about one-quarter of what it was a century ago due to population growth (see Figure 8.1), and is expected to be further reduced to about one-fifth of the 1900 level by 2050 (GEO Data Portal, from UNPD 2007 and FAOSTAT 2006). Social change processes, in terms of population growth, scientific and technological innovation, economic growth, and consumption and production patterns, are increasingly seen as the major drivers of environmental change (Young 2006, Schellnhuber 1999, Vitousek and others 1997). Trends for some of these major drivers of change are also illustrated in Figure 8.1.

The world is witnessing a pattern of globalization characterized by increasing flows of goods, services, capital, technologies, information, ideas and labour at global level, driven by liberalization policies and technological change (Annan 2002). In particular, the rapid development of the Internet (see Figure 1.9 in Chapter 1) is revolutionizing the communication abilities and interconnectedness of people, and can be harnessed to level the playing field for nations and individuals (Friedman 2006).

With an increasingly interconnected global society ever more potently driving environmental change, there is a need to understand how and by whom the environmental challenges best can be addressed. The report, "*Protecting Our Planet – Securing Our Future*," (Watson and others 1998) and the *Millennium Ecosystem Assessment* (2005), demonstrated how environmental problems are often linked to one another. In drawing on the findings of previous chapters, this chapter further pursues

Gro Harlem Brundtland, then Prime Minister of Norway, addressing the UN General Assembly in 1987. The interconnectedness of the environment and human society is a common thread that runs throughout the Brundtland Commission report and the *GEO-4* assessment.

Credit: UN Photo

Understanding and addressing the human-environment interlinkages will strengthen the effectiveness of governance regimes at all levels.

Credit: Shehab Uddin/Still Pictures

the current understanding of human-environment interlinkages. It examines how the different drivers, human activities and environmental changes are interlinked through complex cause-and-effect relationships embedded in both biophysical and social processes. This part of the chapter also examines to what extent the increasingly complex set of human pressures on the environment may exceed critical thresholds, and result in potentially sudden, unexpected effects and irreversible changes.

Environmental governance regimes have evolved in response to the environmental changes, but these mechanisms have often lagged behind the problems they address. These mechanisms have thus faced major challenges in being effective (Schmidt 2004, Najam and others 2006). As previous chapters have shown, some environmental challenges, such as point source pollution, are characterized by linear cause-effect interactions, and are relatively easy to deal with. Others are characterized by complex, often nested sets of linkages that are more persistent and difficult to address. These linkages need to be addressed in a systematic, sustained, integrated and coherent manner across administrative borders at various scales. Sustainable development is contingent upon an environmental governance regime that adapts to the evolving environmental challenges of the Earth system.

This chapter discusses how understanding these interlinkages and applying a systems approach can strengthen the effectiveness and complementarity of the environmental governance regimes at national, regional and international levels. It considers how interventions within and among response regimes can be aligned through adaptive governance, supported by enhanced knowledge and information infrastructure. These considerations include the implications of such approaches for the enforcement and compliance regimes under the various multilateral environmental agreements.

HUMAN-ENVIRONMENT INTERLINKAGES

Previous chapters have assessed the state of knowledge with respect to key environmental challenges. They have demonstrated that there are interlinkages within and between changes such as climate change, ozone depletion, air pollution, biodiversity loss, land degradation, water degradation and chemical pollution. Environmental changes are linked across scales and between geographical regions through both biophysical and social processes. This section uses the GEO conceptual framework as a basis for an overarching and integrated analysis of these human-environment linkages (see the Reader's Guide). More specifically, this section provides an overview of how:

- human drivers of environmental change cause and link various forms of environmental change, and how the social and economic sectors shape the human-environment linkages;
- human activities and pressures create multiple environmental changes, and how various forms of environmental changes are connected through complex systems involving feedback loops and biophysical thresholds; and

- an increasingly complex set of environmental changes and potential system-wide changes can exceed biophysical thresholds, leading to sudden and unexpected effects on human well-being.

Drivers of change

Environmental change and human development are all driven by the same factors, such as demographics, economic processes, scientific and technological innovations, distribution patterns, and cultural, social, political and institutional processes. These processes are complex and vary, depending on social and ecological circumstances. The pressure on the environment and consequently the rate, extent and magnitude of environmental changes have grown larger. The development challenges have also become more demanding as evidenced, for example, in the efforts to meet the MDGs.

Population growth is creating an increasing pressure on the planet, as illustrated by the shrinking size of land per capita since 1900 as the population increased (see Figure 8.1). According to estimates used in this report, the world population is expected to rise to 9.2 billion by 2050 from about 6.7 billion in 2007. The population in less developed regions is expected to rise from 5.5 billion in 2007 to 8 billion in 2050. In contrast, the population of the more developed regions is expected to remain largely unchanged at 1.2 billion, and would have declined were it not for the expected migration from developing to developed countries (GEO Data Portal, from UNPD 2007). Programmes to address population issues need to be closely related to other policies, such as those for economic development, migration, maternal and reproductive health, and gender equality and empowerment of women (UN 1994).

The impacts of population growth on the environment are inextricably related to people's consumption patterns. Consumption, particularly in the richer nations, has been increasing at a faster rate than that of population growth. Technological innovation has been a critical driver of this trend (Watson and others 1998). Since 1987, the world population has increased by 34 per cent (GEO Data Portal, from UNPD 2007), and world trade has increased 2.6 times. As shown in Figure 8.1, global economic output has increased by 67 per cent, also increasing the average per capita income in the same period. However, changes in per capita income vary greatly among regions, from a decrease of more than 2 per cent in a few African countries to a doubling in some countries in Asia and the Pacific since 1987 (World Bank 2006a). The graphs in Figure 8.1 give an indication of such pressures and environmental changes from human activities.

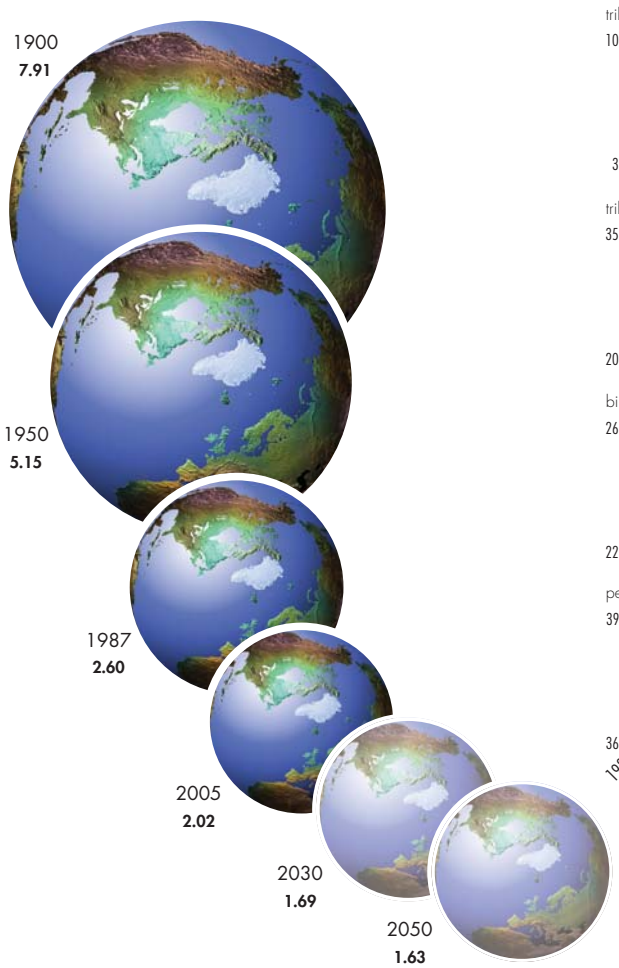
Resources are not equitably distributed around the world. The world's poorest countries – mainly in Africa, Asia and the Pacific and Latin America and the Caribbean – had, in 2004, an average annual per capita income of US$2 100. The richest regions and countries – Europe, North America, Australia and Japan respective – had an average annual per capita income of US$30 000. On average, the total annual income of the nearly 1.2 billion people in the richest countries, is nearly 15 times greater than that of the 2.3 billion people in the poorest countries (Dasgupta 2006). Also in 2004, the Annex 1 countries of the UN Framework Convention on Climate Change, had 20 per cent of the world population, produced 57 per cent of world GDP, based on purchasing power parity, and accounted for 46 per cent of greenhouse gas (GHG) emissions. Africa's share of the GHG emissions was 7.8 per cent, while it had 13 per cent of world population (IPCC 2007a).

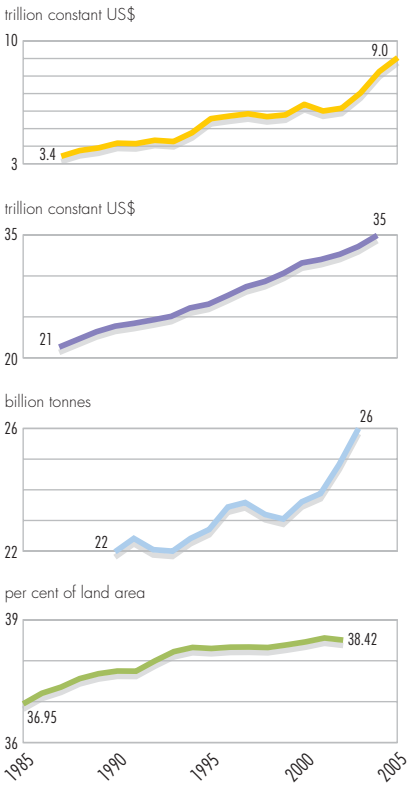
Increased consumption of raw materials and the related production of waste place tremendous pressure on the environment. Sixty per cent of the ecosystem services studied by the Millennium Ecosystem Assessment (MA) are being degraded or used unsustainably. Their degradation could grow significantly worse before 2050 due to rapidly growing demands for food, freshwater, timber, fibre and fuel, as well as from increasing pollution and climate change (MA 2005a).

Changes in the biosphere over the last few decades have contributed to substantial net gains in human well-being and economic development (MA 2005a). Formal and informal social and economic sectors have transformed natural resources (equated to natural capital) into forms that support development and human well-being.

In the poorest countries, natural resources are estimated to make up 26 per cent of the total wealth, forming the basis for subsistence and a

Figure 8.1 Our "shrinking" Earth





Notes: Numbers next to images of Earth reflect hectares of land per capita.

Graphs show changes in trade volume (1987–2005), GDP (1987–2004), CO_2 emissions (1990–2003) and agricultural land area (1987–2002).

Sources: FAOSTAT 2006, Chapter 9 population projection, WTO 2007, GEO Data Portal compiled from UNPD 2007-low estimate, World Bank 2006a, UNFCCC-CDIAC 2006 and FAOSTAT 2004

source of development finance (World Bank 2006b). Agriculture is the most important sector in low-income countries', responsible for 25–50 per cent of their gross domestic product (GDP) (CGIAR and GEF 2002). Agricultural growth is directly correlated to well-being, notably in terms of income and livelihood of farmers. For every dollar earned by farmers in low-income countries, there is a US$2.60 increment in incomes in the economy as a whole (CGIAR and GEF 2002). Therefore, an increase in crop yields has a significant impact on the upward mobility of those living on less than a dollar a day. The World Bank estimates that a 1 per cent increase in crop yields reduces the number of people living under US$1/day by 6.25 million. Natural capital can be transformed into forms of material capital, such as infrastructure and machines, as well as human capital, for example, knowledge and social capital, such as governance structures. These capitals determine the ability of individuals to exercise their freedoms of choice and to take actions to achieve their material needs.

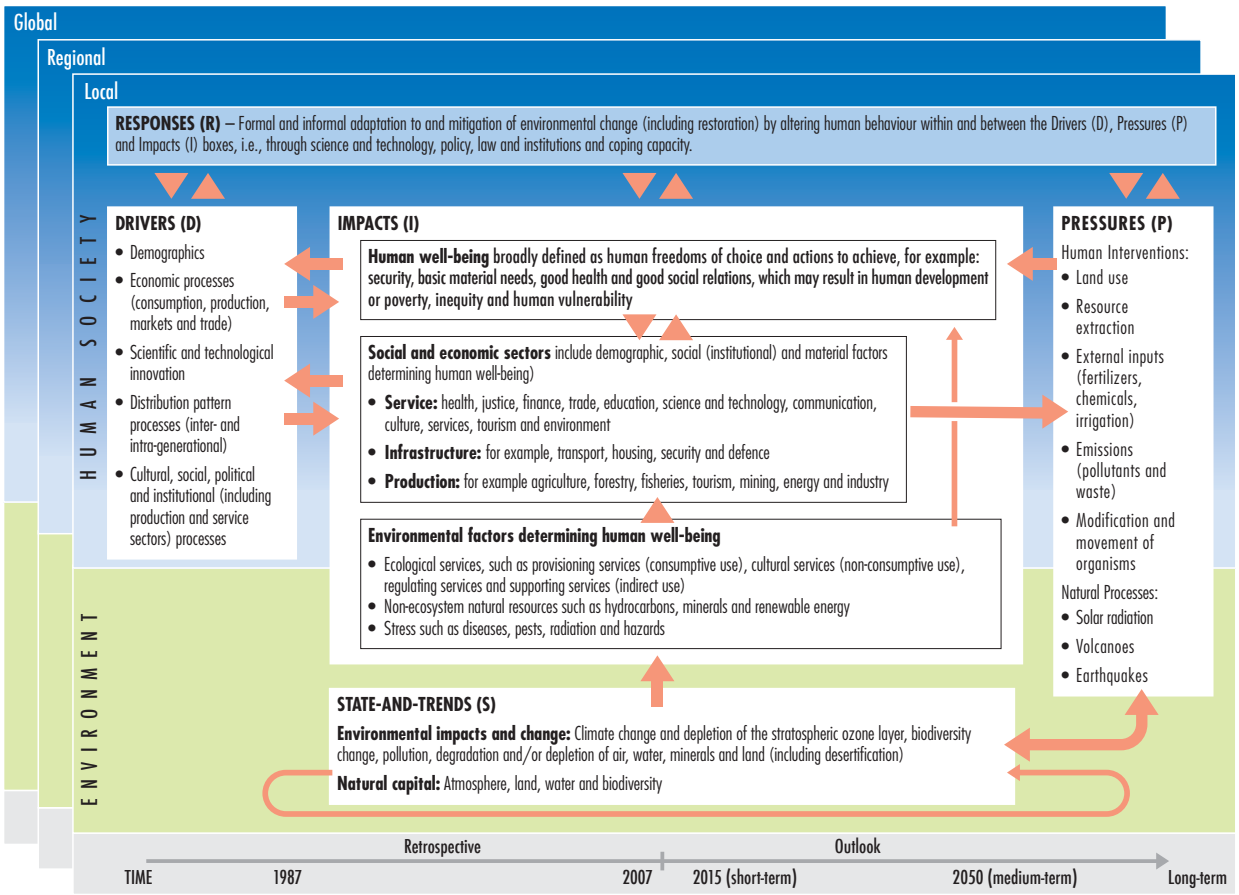
The observed net gains in human well-being facilitated by the social and economic sectors have, however, been at the cost of growing environmental changes, and the exacerbation of poverty for some groups of people (MA 2005a). Sustainable development relies on an effective integration of environmental concerns into development policies. A critical component of a strengthened international environmental governance regime is that it is able to support such integration (Berruga and Maurer 2006). Environmental impacts are, however, often not factored into operations of the social and economic sectors as a cost, and hence these impacts are referred to as externalities. The externalization of such costs does not allow for a true trade-off in terms of costs and benefits when development decisions are taken. These sectors are instrumental in utilizing

ecosystem services and natural resources. They also affect ecosystem services, and are affected by ecosystem change (see Figure 8.2).

The agricultural sector, for example, interlinks a number of environmental changes, including climate change, biodiversity loss, land degradation, and water degradation. Chemicals are also a factor in envirnmental change. Agriculture is, however, also highly dependent on ecosystem services, such as predictable climatic conditions, genetic resources, water regulation, soil formation, pest regulation, and primary productivity of land and water. These services must be secured if the sector is to meet the demand for food. Chapter 3 concludes that a doubling of global food production will be required to meet the MDG on hunger, given projections that the world's population will increase to more than 9.2 billion by 2050. In the four GEO-4 scenarios, the human population is projected to between 8 billion and 9.7 billion in 2050 (see Chapter 9).

Measures for responding to environmental changes will often be implemented by government authorities, the private sector, civil society, communities and individuals associated with social and economic sectors. Responses will, as outlined in Figure 8.2, be in the form of either mitigation of or adaptation to environmental change. Both mitigation and adaptation can take the form of informal and formal approaches to altering human behaviour as they relate not only to drivers, but also to pressures and impacts. Response strategies need to take into account that roles, rights and responsibilities of women and men are socially defined, culturally based, and are reflected in formal and informal power structures that influence how management decisions are taken (Faures and others 2007). Management of common resources and complex systems are particularly challenging, and may require a broad set of multi-scaled governance tools, and an adaptive approach (Dietz and others 2003). Responses are an integral part of the

Figure 8.2 A variation of the GEO-4 conceptual framework highlighting the dual role of the social and economic sectors



human-environment interlinkages. A response to one environmental change may, therefore, directly or indirectly affect other environmental changes, and in itself contribute to the interlinkages among them.

Impacts and consequences of human activities on biophysical processes

Efforts to integrate environmental concerns into development and to promote sustainable consumption and production patterns need to factor in the ways in which environmental challenges are linked through human activities (pressures) and biophysical processes. Human activities have multiple direct impacts on the environment, and thus on ecosystem services and human well-being. Emissions of carbon dioxide, for example, contribute both to climate change (see Chapter 2) and to acidification of oceans (see Chapter 4). Human activities, such as agriculture, forestry and fisheries, meet human needs, especially in the short-term and thus have a positive impact on human well-being (see next subsection). However, if such activities are not managed sustainably, they can have a negative impact on the environment.

Human activities result in multiple impacts on the environment because of biophysical interlinkages. Land, water and atmosphere are linked in many ways, but particularly through the carbon, nitrogen (see Chapter 3) and water cycles, which are fundamental to maintaining life on Earth. Feedbacks and thresholds affect the boundaries, composition and functioning of ecological systems. A classic case of feedback loops is seen in the interactions that influence the Arctic (see Box 8.1) (see Chapters 2 and 6).

Examining the interlinkages among multiple environmental challenges is similar to applying a systems approach by looking at the interlinkages within and between the wider global system or a sub-system. The biophysical interlinkages constitute an important characteristic of the environmental challenges themselves. System properties such as non-linear changes, thresholds, inertia and switches (see Box 8.2) are important characteristics. When developing management options, there is a need to consider the cause-effect chains, as these system properties (Camill and Clark 2000) are often cumulative in time and space.

A key example of how a human activity has resulted in multiple environmental impacts is the release of reactive nitrogen (Nr) from the burning of fossil fuels and use of fertilizers, discussed in more detail

Box 8.1 Feedback loops in the Arctic

Feedback

This describes a process by which the output of a system is used or allowed to modify its input, leading to either positive or negative results. In the climate system, a "feedback loop" has been described as a pattern of interaction where a change in one variable, through interaction with other variables in the system, either reinforces the original process (positive feedback) or suppresses the process (negative feedback). It is becoming apparent that there are major feedbacks in the Arctic systems associated with the rapid changes in the regional climate (see Chapters 2 and 6). It is clear that the Arctic system is very dynamic, and different sets of variables form feedbacks at different times, highlighting the complexity of feedbacks and interlinkages.

Temperature-albedo feedback

Rising temperatures increase melting of snow and sea ice, not only reducing surface reflectance, but also increasing solar absorption, raising temperatures further, and changing vegetation cover. The feedback loop can also work in reverse. For example, if temperatures were to cool, less snow and ice would melt in summer, raising the albedo and causing further cooling as more solar radiation is reflected rather than absorbed. The temperature-albedo feedback is positive because the initial temperature change is amplified.

Temperature-cloud cover-radiation feedbacks

Feedbacks among temperature, cloud cover, cloud types, cloud albedo and radiation play an important role in the regional climate. There is some indication that, except in summer, Arctic clouds seem to have a warming effect, because the blanket effect of clouds tends to dominate over reduction in shortwave radiation to the surface caused by the high cloud albedo. This appears to be different when compared with other regions of the world. The temperature-cloud cover-radiation feedback is negative as the initial temperature change is dampened. However, cloud cover also acts as a blanket to inhibit loss of long wave radiation from the Earth's atmosphere. By this process, an increase in temperature leading to an increase in cloud cover could lead to a further increase in temperature – a positive feedback.

Melting of permafrost and methane emissions

Permafrost areas of the Arctic, in particular tundra bogs, contain methane trapped since the last glaciation, about 10 000–11 000 years ago. Climate change is resulting in melting of the permafrost, and the gradual release of methane, a gas with warming potential more than 20 times as great as CO_2 (see Chapter 2 and 3). This is a positive feedback, which could lead to significant acceleration of climate change.

Sources: ACIA 2004, Stern and others 2006, UNEP 2007a

in Chapter 3. Nr creation has increased tenfold since 1860 (UNEP 2004). The benefits from use of fertilizers have been increased food production to support a growing population and increasing per capita food consumption. Many factors influence how much nitrogen is applied and used, including soil moisture, timing of fertilizer application, labour availability, inherent soil quality and type, farming systems, and major macro-nutrient availability (N-P-K) (see Chapter 3). It is recognized that to increase food production in Africa, there is a need for improved soil quality and fertility, with some improvements coming from the addition of inorganic fertilizers (Poluton and others 2006). However, in other regions, excess nitrogen is being lost to the environment, partly due to inefficient farming practices related to the quantity and timing of fertilizer application. Reactive nitrogen adversely affects many components of terrestrial and aquatic ecosystems and the atmosphere, as illustrated in Figure 8.3. For example, nitrogen released to the atmosphere from fossil fuel combustion and fertilizer use can, in sequence, increase tropospheric ozone concentration, decrease atmospheric visibility and increase precipitation acidity. Following deposition it can increase soil acidity, decrease biodiversity, pollute groundwater and cause coastal eutrophication. Once emitted back to the atmosphere it can contribute to climate change and decreased stratospheric ozone (UNEP 2004). The impacts continue as long as the nitrogen remains active in the environment, and it ceases only when Nr is stored for a very long time, or is converted back to non-reactive forms. Policy options aimed at addressing only a single impact and thus only one substance can lead to pollutant swapping. This illustrates the need for an approach that considers the multiple and linked impacts, and prevents the creation of reactive nitrogen.

Another example of multiple impacts from human activity is climate change. The links between climate

Box 8.2 System properties: thresholds, switches, tipping points and inertia

Identification and assessment of key human-environment interlinkages needs to take into account that most social and biophysical systems are characterized by dynamic system properties. These properties include thresholds, switches, inertia and time-lags, as well as feedback loops, illustrated in Box 8.1

Thresholds are sometimes referred to as tipping points. They are common in the Earth system, and represent the point of sudden, abrupt, or accelerating and potentially irreversible change switched on by natural events or human activities. For example, there is evidence to show that a decrease in vegetation cover in the Sahara several thousand years ago was linked to a decrease in rainfall, promoting further loss of vegetation cover, leading to the current dry Sahara. Examples of thresholds being crossed due to sustained human activities include the collapse of fisheries, eutrophication and deprivation of oxygen (hypoxia) in aquatic systems, emergence of diseases and pests, the introduction and loss of species, and regional climatic change.

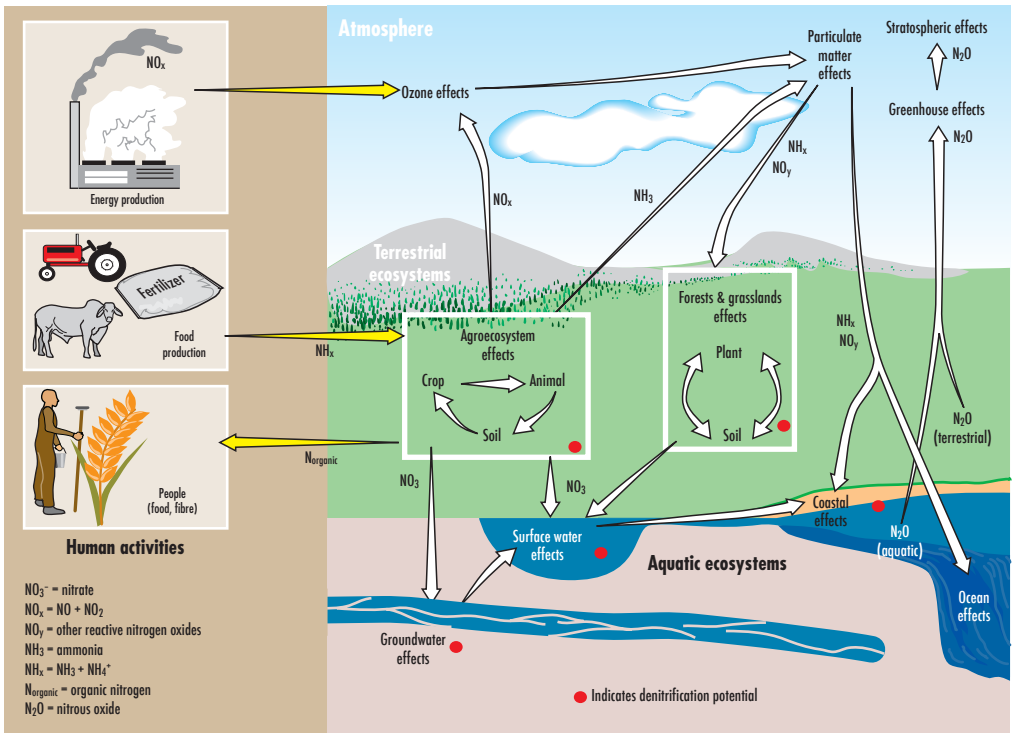
Another example of switches or thresholds and interlinkages in environmental change is illustrated by the change from grass dominance to shrubland. Changes in the grazing and fire regime associated with land management practices during the past century are thought to have increased the woody plant density over significant areas of Australia and Southern Africa. Large-scale ecosystem changes (such as savannah to grassland, forest to savannah, shrubland to grassland) clearly occurred in the past (such as during the climatic changes associated with glacial and interglacial periods in Africa). Because these changes took place over thousands of years, diversity losses were ameliorated, since species and ecosystems had time to undergo geographical shifts. Changes in disturbance regimes and climate over the coming decades are likely to produce equivalent threshold effects in some areas, but over a much shorter time frame.

Biogeochemical and social systems have time lags and inertia, the tendency to continue to change even if the forces that cause the change are relieved. For example, even if greenhouse gas concentrations in the atmosphere were to be stabilized today, increases in land and ocean temperatures due to these emissions will continue for decades, and sea levels will rise for centuries, due to time scales associated with climate processes and feedbacks (see Chapter 2). Time lags associated with human societies include the time between development of technologies, their adoption and behavioural changes needed, for example, for climate change mitigation.

Critical thresholds are the points where activities result in unacceptable levels of harm, for example, in terms of ecological change, and require responses. The complexity of the coupled human-ecological systems and our current state of knowledge of the dynamics of the system makes it hard to predict precisely where such thresholds lie. It also makes it challenging to identify measures to pre-empt the crossing of such thresholds. Consequently, society is often left coping with harmful environmental changes through mitigation, and if mitigation proves difficult, through adaptation to the change. With the unprecedented and increasing socio-economic impacts of humanity on ecological systems, there is concern that these systems may be nearing or have exceeded some critical thresholds, and as a result, it is increasingly likely that they will experience large, rapid and non-linear changes. The crossing of such thresholds is of significant concern for human well-being, as in the past they have led to the catastrophic disruption of societies.

Sources: Australian Government 2003, Diamond 2005, IPCC 2001a, IPCC 2001b, IPCC 2007b, Linden 2006, MA 2005a

Figure 8.3 The nitrogen cascade and associated environmental impacts



Source: Adapted from Galloway and others 2003 and redrawn by Robert Smith, Charlottesville, VA

change and biodiversity – both aquatic and terrestrial – are illustrative of the links between land, water and atmosphere (see Figure 8.4). Biodiversity is, in many instances, under multiple pressures. These can include land degradation, land and water pollution, and invasive alien species. Changes in climate exert additional pressures, which have affected biodiversity (see Chapter 5). These include the timing of reproduction of animals and plants and/or migration of animals, the length of the growing season, species distribution and population size, especially the poleward and upward shifts in ranges in plant and animal species, and the frequency of pest and disease outbreaks. Bleaching of coral reefs in many parts of the world has been associated with increased seasonal sea surface temperatures. Changes in regional temperatures have contributed to changes in stream-flow, and the frequency and intensity of extreme climatic events, such as floods, droughts and heat waves. These changes have affected biodiversity and ecosystem services (IPCC 2002, IPCC 2007b, CBD 2003, Root and others 2003, Parmesan and Yohe 2003). In high-latitude ecosystems in the northern hemisphere, there have been changes in species composition and even ecosystem types. For example, some boreal forests in central Alaska have been transformed into extensive wetlands during the last few decades of the 20th century. The area of boreal forest burned annually in western North America has doubled in the last 20 years, in parallel with the warming trend in the region. Large fluctuations in the abundance of marine birds and mammals across parts of the Pacific and western Arctic may be related to climate variability and extreme events (CBD 2006). Species and ecosystems appear to be changing and/or adapting at differing rates, which may also disrupt species relationships and ecosystem services.

The case of ongoing environmental change in the Arctic, discussed in detail in Chapter 6, also illustrates the land-water-climate change links. Some of the feedbacks and linkages are highlighted in Box 8.1. Ongoing changes in the Arctic include the effect of regional climate change on land cover, permafrost, biodiversity, sea ice formation and thickness, and meltwater intrusion into ice sheets, which increases the speed of their disintegration on the seaward edge. Feedbacks can result in further changes, with adverse impacts on human well-being, both in the Arctic and around the world.

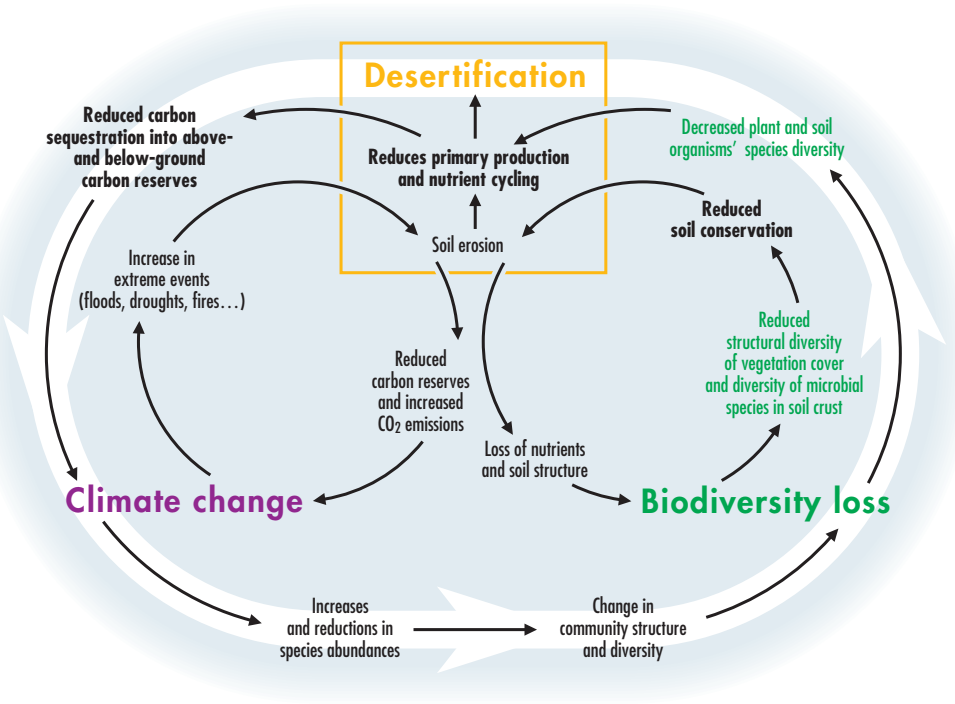
A major interlinkage that occurs is due to changes in land use, particularly land cover. Changes in

Figure 8.4 Linkages and feedback loops among desertification, global climate change and biodiversity loss

Notes: Green text: major components of biodiversity involved in the linkages.

Bold text: major services impacted by biodiversity losses.

The major components of biodiversity loss (in green) directly affect major dryland services (in bold). The inner loops connect desertification to biodiversity loss and climate change through soil erosion. The outer loop interrelates biodiversity loss and climate change. On the top section of the outer loop, reduced primary production and microbial activity reduce carbon sequestration and contribute to global warning. On the bottom section of the outer loop, global warming increases evapotranspiration, adversely affecting biodiversity; changes in community structure and diversity are also expected because different species will react differently to the elevated CO_2 concentrations.



Source: MA 2005a

land use and/or land cover, such as deforestation and conversion to agriculture, affect biodiversity and waterbodies and contribute to land degradation (see Chapters 2–5). These activities not only change the biodiversity at the species level, but also result in habitat loss, fragmentation and alteration of ecosystems, as well as contribute to climate change by altering the local energy balance, reducing plant cover and loss of soil carbon. However, some changes in land use, such as afforestation and reforestation, can also result in an increase in biodiversity and increased local energy balance.

Land degradation can lead to the loss of genetic and species diversity, including the ancestors of many cultivated and domesticated species. This means losing potential sources of medicinal, commercial and industrial products. In addition, change from forest to agricultural or degraded lands affects biophysical and biogeochemical processes, particularly the hydrological cycle. The reduced water holding capacity of cleared land results in increased flooding, erosion and loss of the more fertile topsoil, resulting in less water and organic matter retained in the soil.

Consequently the siltation results in the degradation of waterbodies, such as rivers and lakes, by soil. In freshwater and coastal systems, land degradation affects sediment mobilization and transport. This, in turn, can affect biodiversity (Taylor and others 2007), such as that of coral reefs, mangroves and sea grasses, in adjacent coastal and shelf environments. In some cases, these effects are exacerbated by particle-reactive contaminants, including persistent organic pollutants (POPs), which are adsorbed onto soil particles.

Water resource management affects terrestrial, freshwater, coastal and nearshore (marine) systems. For example, water withdrawals and the rerouting of inflows, affect biodiversity, terrestrial and aquatic ecosystem functioning, and land cover. Chapters 3, 4 and 5 provide details on how pollution, siltation, canalization and water withdrawals adversely affect biodiversity (terrestrial, near coastal and aquatic), and change ecosystem functioning and composition upstream and downstream. They can also result in land degradation, especially salinization, and an increase in invasive alien species.

Increased levels of UV-B radiation are reaching the Earth's surface due to the depletion of the ozone layer by ozone-depleting substances. This has had a number of impacts on the biosphere. UV-B radiation affects the physiology and development of plants, influencing plant growth, form and biomass, although the actual responses vary significantly among species and cultivars. Increased UV-B radiation will probably affect biodiversity through changes in species composition, as well as affecting ecosystems through changes in competitive balance, herbivore composition, plant pathogens and biogeochemical cycles. Increased UV-B radiation reduces the production of marine phytoplankton, which is the foundation for aquatic food webs, and a major sink for atmospheric CO_2. It has also been found to cause damage to fish, shrimp, crabs, amphibians and other marine fauna during early development (see Chapters 2 and 6).

Environmental changes and human well-being

Environmental changes are not only interlinked through various human activities and biophysical processes, but also through how they affect human well-being. The different constituents of human well-being, including basic material needs (food, clean air and water), health and security, can all be influenced by single or multiple environmental changes through the alteration of ecosystem services (MA 2005a). Well-being exists on a continuum with poverty, which has been defined as "pronounced deprivation in well-being." Linked with these are concepts of natural, human, social, financial and physical capital and the issue of substitution among these capitals (MA 2003).

Socio-economic sectors that are highly dependent on ecosystem services, such as agriculture, forestry and fisheries, have contributed to substantial net gains in human well-being, especially through provisioning services (such as food and timber) (MA 2005a). However, this has been at the cost of increased poverty for some groups, and environmental changes, such as land degradation and climate change. It is therefore important to consider the trade-offs and synergies that can arise between and among ecosystem services and human well-being when developing management options. More detailed analysis of the numerous impacts of environmental changes on human well-being is found in Chapters 2–5.

As seen in Chapter 7, the degree to which some groups are vulnerable to such changes depends on both their coping capacity and the state of land and water. For example, environmental changes, such as land degradation, have enhanced the destructive potential of extreme climatic events, such as floods, droughts, heat waves and storm surges. The increase in the frequency and intensity of extreme climate-related disasters in the last four decades provides evidence of this trend (Munich Re Group 2006). About 2 billion people were affected by such disasters in the 1990s:

Poor land-use policies contribute to land degradation which adversely affects human health, security and limits livelihood options.

Credit: Ngoma Photos

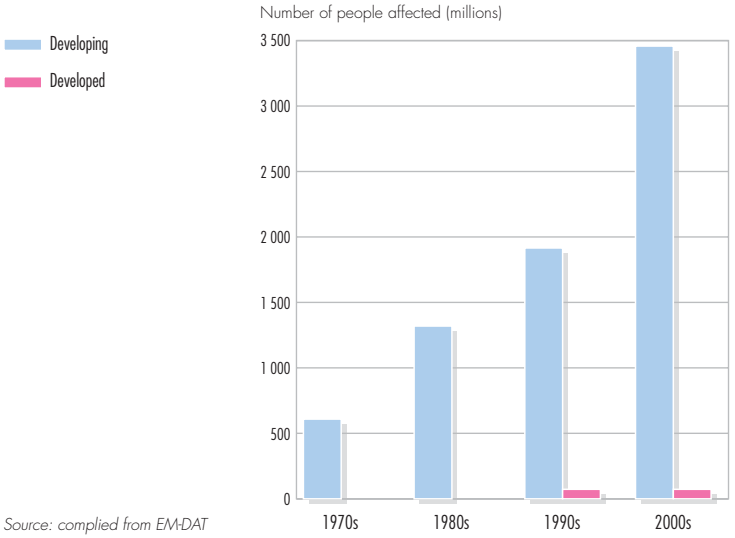
40 per cent of the population in developing countries, compared to a few per cent in developed countries (see Figure 8.5). A combination of the observed and projected figures for the first decade of the 21st century shows more than 3.5 billion people or 80 per cent of the population in developing countries affected by such disasters, while still only a few per cent are affected in developed countries (see Figure 8.5). The variation between developing and developed countries is a reflection of the multiple environmental changes that the different populations face, the socio-economic status of the countries, and the fact they are located in areas that are sensitive to climate variability and change, water scarcity, and, in some cases, conflict. Some of the increase is due to more people living on marginal (such as semi-arid and arid) land, and in coastal zones prone to disasters, such as storm surges (IPCC 2001b). Part of this increase in the number affected is attributed to the accelerated rate and magnitude of climate change and variability, land degradation and the scarcity of clean water in many parts of the world (UN 2004).

Environmental changes may affect human well-being in more than one way (see Figure 8.6). For example, land degradation not only threatens food production and contributes to water shortages, but may also have impacts across spatial and temporal scales and boundaries which means that human well-being in one locality may be influenced by drivers, pressures and changes caused outside the locality. Human well-being may also be affected by drivers and human impacts stemming from many different sectors.

There are increasing and cumulative human pressures on the Earth system, creating a variety of interacting forms of environmental change. The amount of change taking place begs the question as to whether there are biophysical thresholds and limits within which humanity must stay to avoid significant disruption to the planet's life support systems (Upton and Vitalis 2002). The history of past societies may provide insight into such thresholds and limits. Environmental degradation has been deduced to have played a key role in the decline and even collapse of whole societies. This includes societies in Mesopotamia 7 000 years ago (Watson and others 1998), as well as the Easter Island society and the Norse society in Greenland within the last millennium. For the Maya in Central America, there are multiple hypotheses, including one of periodic droughts acting as added stress on top of other environmental changes, especially deforestation and overgrazing (Diamond 2005, Linden 2006, Gallet and Genevey 2007). The studies of those societal declines suggest that the environment-society interaction may have gone beyond a point of no return, whereby society did not have the capacity to reverse the ecological degradation that eventually undermined its existence (Diamond 2005). However, it must be understood that the scale of contemporary environmental changes is far greater than that which led to the localized collapse of the spatially limited societies mentioned here.

A key challenge in sustainable development is to avoid a development path that could lead society to such points of no return (Diamond 2005). Such efforts could be facilitated by enhancing the understanding of how environmental changes interact within the coupled human-environment system. A strengthened knowledge base should include information on the risk of exceeding thresholds and undermining life-supporting processes, how crossing thresholds may lead to degradation of ecosystem services, and how this would have impacts on development paths in terms of expanding or limiting people's capabilities to be and achieve what they value. Such knowledge would underpin the choices and trade-offs with respect to distribution of access to environmental services and exposure to environmental stress among different groups of people. The knowledge

Figure 8.5 Number of people affected by climate-related disasters in developing and developed countries



Source: complied from EM-DAT

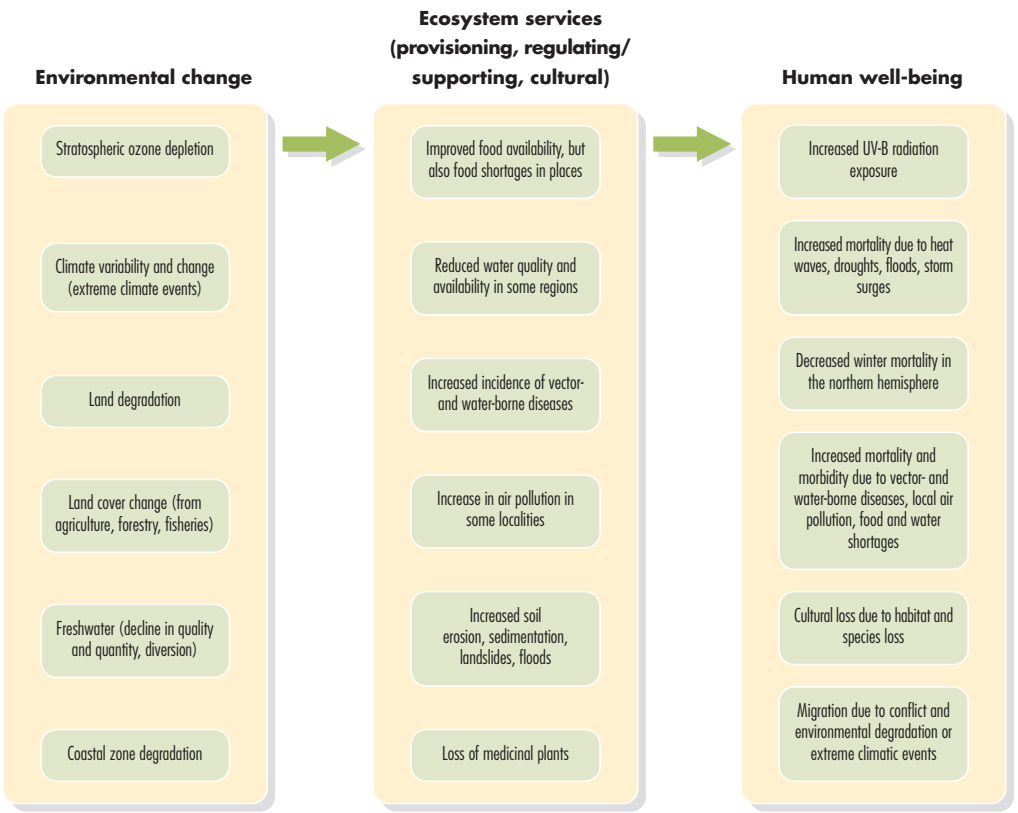
base would be part of the continued evolution of adaptive environmental governance, which incorporates ideas of environmental management, and the integration of environment into development policies (see last section of this chapter).

INTERLINKAGES AND ENVIRONMENTAL GOVERNANCE

Governance systems can be considered as institutional filters, mediating between human actions and biophysical processes (Kotchen and Young 2006). Interlinked environment-development challenges require effective, linked and coherent governance and policy responses within the framework of sustainable development. Governance for sustainable development requires effective administrative executive bodies, and enabling legal and regulatory frameworks. Progress in this area over the last 20 years is mixed, with limited success. However, there are encouraging developments at international, regional and national levels, including the private sector and civil society, which provide valuable lessons and directions for managing interlinked environment-development challenges. This includes the emergence of flexible, more adaptive governance entities.

Governance regimes have undergone a significant evolution in response to different environment and development challenges since the Brundtland Commission. Milestones include the UN Conference on Environment and Development and its achievements, including Agenda 21; the Millennium Summit and Declaration; and the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg and the Johannesburg Plan of Implementation (UNEP 2002a, Najam and others 2006). An examination of the landscape of environmental governance over the last 20 years shows that states have created a growing number of institutions, authorities, treaties, laws and action plans to conserve and safeguard the environment, and more recently, to respond to new understanding of the extent and implications of global environmental change. Through summits, states have set common goals and outlined key definitions. Many of the responses that have been

Figure 8.6 Multiple environmental changes and their effects on human well-being constituents and determinants



Source: based on WHO 2003

The past 20 years have seen many developments in environmental governance at national, regional and international levels, in response to environmental changes. Governments now regularly raise the environmental flag at international conferences.

Credit: (FREELENS Pool) Tack/ Still Pictures

put in place nationally, regionally and internationally are not necessarily well matched, and there is often a "problem of fit" between the institutions created, and the ecological and development concerns being addressed (Young 2002, Cash and others 2006).

Commonly cited areas of concern regarding international environmental governance (IEG) include (Najam and others 2007):

- proliferation of multilateral environmental agreements (MEAs), and fragmentation of IEG;
- lack of cooperation and coordination among international organizations;
- lack of implementation, enforcement and effectiveness of IEG;
- inefficient use of resources;
- the challenge of extending IEG outside the traditional environmental arena; and
- involvement of non-state actors in a state-centric system.

Informal consultations by the UN General Assembly on the institutional framework for the United Nations' environmental activities identified similar areas of concern among governments.

While the large number of bodies involved with environmental work has allowed specific issues to be addressed effectively and successfully, it has also increased fragmentation, and resulted in uncoordinated approaches in both policy development and implementation. It has further placed a heavy burden on countries in terms of participation in multilateral environmental processes, compliance with and effective implementation of legal instruments, reporting requirements and national-level coordination. Whereas a large body of policy work has been developed and continues to expand, a growing gap remains between normative and analytical work and the operational level. The focus of attention and action is shifting from the development of norms and policies to their implementation in all countries. In that respect, capacity building at all levels, especially in developing countries, is of key importance (Berruga and Maurer 2006).

This section summarizes developments in environmental governance at national, regional and international levels, in the context of how institutions respond to a situation characterized by

environmental changes that are interacting across themes, as well as across spatial and temporal scales and boundaries. The following section looks at some of the opportunities to change, adapt or reorient this current governance regime towards a system that could more effectively address the human and biophysical interlinkages.

National level

The national environmental governance landscape evolved in a largely linear, sectoral fashion to provide specific services over a short- or medium-time scale, often related to electoral cycles. Such arrangements are not always well suited to respond to more complex, cross-sectoral challenges posed by sustainable development, which has a longer-term intergenerational time horizon, requiring sustained commitment going beyond the typical 4–5 year electoral cycles. With its need for a "triple bottom line" focus on environment, economy and society, sustainable development contradicts the way policies have traditionally been formulated and developed (OECD 2002).

Effective environmental governance depends on a well-functioning executive, legislature and judiciary, as well as participation by all stakeholders, including the electorate, civil society and the private sector. This can result in conflicting interests, and there is a need for well-defined mechanisms and processes to involve the various groups in collective decision making and in finding solutions (OECD 2002). The electorate has become a key stakeholder in the management of the environment, supporting legislative changes, and protecting environmental resources and the rights of communities (Earthjustice 2005). Business and industry are increasingly engaging in responsible corporate citizenship, making efforts to improve and report on their environmental and social performance, particularly related to climate change, and in high-impact industries that face criticism from stakeholders and public institutions (UNEP 2006a).

The effective implementation of environmental policies, particularly in the case of binding international commitments, such as MEAs, involves a simultaneous and interconnected process at the

Box 8.3 Examples of national-level mechanisms that bridge environmental governance challenges

Coordinating mechanisms in the prime minister's or president's office including inter-cabinet or inter-ministerial committees, such as the National Environmental Board in Thailand, chaired by the prime minister. **Sustainable development committees**, often established after the UN Conference on Environment and Development, coordinate national and/or international policy related to sustainable development at interdepartmental and interagency levels.

Judicial institutions and mechanisms are central to promoting the goals of sustainable development, interpreting and ensuring effective implementation of legislation, integrating emerging principles of law, handling diverse sectoral laws, and providing an opportunity for society to ensure protection of fundamental rights such as the right to a clean and healthy environment. An important area of activity dealing with interlinked environmental challenges has been the strengthening of national laws and institutional frameworks, both through the development of framework environmental legislation, and the development of integrated sectoral legislation. This seeks to improve the implementation of several MEAs related to one issue, such as biodiversity or chemicals .

National Focal Points (NFPs) or lead agencies are designated for the coordination of the implementation of binding international commitments such as MEAs and for national reporting to CSD, sometimes supported by **national committees**.

National Sustainable Development Strategies (NSDS) that "should build upon and harmonize the various sectoral economic, social and environmental policies and plans that are operating in the country" were called for in Agenda 21. The WSSD urged states to not only formulate NSDSs, but also to begin implementation by 2005, while integrating the principles of sustainable development into country policies and programmes. This is one of the targets of the Millennium Declaration. There have been mixed results regarding governance structures for NSDSs. Nevertheless NSDSs and associated planning processes provide unique opportunities to address interlinkages, such as those involving local and national development, environmental issues and global environmental threats, through links to the MEAs.

Planning and development bodies and mechanisms, such as commissions and authorities, are crucial macroeconomic institutions that take a long-term view of development issues, and can promote a cross-sectoral, integrated and interlinked approach between economic, social and environmental issues. In developing and middle-income countries, initiatives such as UN Development Assistance Frameworks (UNDAFs), and national planning processes, such as poverty reduction strategies (PRS), include the environment as a key factor to be considered in the context of development, poverty reduction and achieving other aspects of human well-being, such as health, food and security.

Other innovative mechanisms include the creation of a **Commissioner of the Environment and Sustainable Development (CESD)** within the Office of the Auditor-General of Canada to monitor and report on the federal government's performance in environmental and sustainable development areas. Fact-based, independent reports from the commissioner help Parliament to hold the government accountable for its performance in these areas.

Sources: OAG 2007, UNEP 2005, UNEP 2006b, UNESCAP 2000

domestic and intergovernmental levels of policy making to follow up on agreements. A number of obstacles to coordination of interlinkages arise at the national level. They may be horizontal in nature, surfacing across government ministries and agencies, such as between MEAs and national focal points for negotiation and policy implementation, or between the environment ministries or agencies and development planning authorities. Institutional constraints may also arise vertically, across different levels of governmental administration, for example, where initiatives at the provincial, district or village level may not support, or may even be contradictory to national policies or programmes (DANCED 2000).

A major impediment faced by many countries is the lack of capacity at national and sub-national (federal, provincial, state and local government) levels. In addition, there may be inadequate financial resources to implement policies and agreements (UNDP 1999, UNESCAP 2000). The proliferation of MEAs, sometimes cited as an indicator of the increased recognition of and response to environmental challenges at the international level, has shown a trend towards greater complexity over time, and placed a huge demand on national-level capacity to implement their requirements (Raustiala 2001). For example, in Thailand the National Environmental Board (NEB) has 42 sub-committees created to oversee the implementation of MEAs and other environmental policies (UNU 2002). With increasing recognition of this burden, there are efforts to streamline and harmonize implementation among the MEAs in order to reduce the burden at national level, as well as to maximize the synergies and interlinkages (UNU 1999, UNEP 2002b). This has included developing coordinating mechanisms, such as national committees, streamlining legislation and reporting, and capacity building (see Box 8.3).

Regional level

The regional level presents an important middle ground for environmental governance. Regions (bioregions or institutional entities) provide a bounded context within which policies and programmes can be devised and implemented, that are relevant and responsive to local and interlinked conditions and priorities. Though rule making for better environmental governance is primarily a function of the national, international and global levels, the regional level has emerged as an important intermediate link for action and implementation. The pressures of environmental changes come to bear on particular localities, and more often than not cross national boundaries and intersect with development concerns. Responses to environmental challenges are encapsulated by a number of regional institutions and mechanisms that are important for addressing and coordinating such environment-development challenges and interlinkages (see Box 8.4).

Box 8.4 Regional institutions and mechanisms

Regional integration agreements can harmonize standards among member countries (such as the European Union's new Sustainable Development Strategy 2007), and implement programmes that foster regional cooperation in, for example, fisheries, chemicals and hazardous waste management (such as NEPAD's Action Plan of the Environment Initiative).

Regional MEAs or implementation mechanisms can bridge international and national levels (such as Africa's Bamako Convention in response to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal). They can reinforce and translate international commitments (such as the Andean Community's Regional Biodiversity Strategy to implement the Convention on Biological Diversity).

Regional ministerial arrangements, such as the African Ministerial Conference on the Environment (AMCEN) and the Tripartite Environment Ministers' Meetings (TEMM) between China, Korea and Japan, are high-level political fora that can set regional priorities and agendas, and raise awareness of regional concerns.

Mechanisms attached to regional trade agreements, such as NAFTA's Commission for Environmental Cooperation (CEC) and the ASEAN Agreement on Transboundary Haze Pollution, can address cross-border environmental issues through intergovernmental cooperation.

Regional or sub-regional environment and development organizations, such as the UN regional economic commissions, regional development banks, and the Central American Commission on Environment and Development (CCAD), can play an important role in data collection and analysis, capacity building, and resource allocation and management.

Transboundary or bioregion-based plans and programmes, such as the Mekong River Commission, the Pacific Regional Environment Programme (SPREP) and UNEP's Regional Seas Programme, are important for data collection, analysis and dissemination, sectoral and resource assessment, policy development, capacity development and monitoring.

Regional approaches tend to work partly because of established mechanisms for collective experimenting, and the learning and sharing of experiences. Geographical proximity provides a basis for the rapid diffusion of practices, and reduces the time needed to adapt to new conditions. In addition, actions implemented at the regional level can benefit from the continuous emergence of implementation opportunities provided by other complementary initiatives (Juma 2002). Nevertheless, there are still many challenges to making regional mechanisms work and fulfil their functions or mandates, particularly for developing regions. There are challenges in terms of financial resources, and the human capacity for implementation and institutional interplay for coherence and effectiveness.

International level environmental governance

At the international level, the key actors with respect to governance and management regimes relevant to environment, development and their interlinkages are the United Nations, the MEAs, and regimes dealing with development, trade, finance and related fields. The private sector, research and scientific bodies, civil society, trade unions and other stakeholders are also key players, and their individual and collective actions have been central to mainstreaming the environment into development. The need for institutional coordination and cooperation has become an increasing imperative, due to the heavily fragmented structure of international environmental governance, and similar issues in development governance (UNEP 2002c, Gehring and Oberthur 2006, Najam and others 2007, UN 2006).

The international governance landscape has multiple organizations that were established to address environment and human interactions. Within this landscape there are several distinguishable regimes for environment, development, trade and sustainable development (the latter is the most loosely connected, as it brings the environment and socio-economic components together). Cooperation and coordination under each of the regimes generally takes place through lead organizations (such as UNEP for environment, WTO for trade, UNDP and the World Bank for development, and CSD for sustainable development).

The development of multilateral environmental agreements (MEAs) over the last decades has been remarkable (see Figure 1.1 in Chapter 1). There are now more than 500 international treaties and other agreements related to the environment, of which 323 are regional and 302 date from the period between 1972 and the early 2000s (UNEP 2001a).

The largest cluster of MEAs is related to the marine environment, accounting for over 40 per cent of the total. Biodiversity-related conventions form a second important but smaller cluster, including most of the key global conventions, such as the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the 1992 Convention on Biological Diversity. CITES and the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal are two of a few MEAs that regulate trade. They also highlight some of the interlinkages between environment and trade. One of the challenges faced in enforcement is the growth of illegal trade in both wildlife and hazardous waste. Box 8.5 and Figure 8.7 highlight some of the issues.

Most of these institutions and treaties have independent governing bodies with independent mandates and objectives. The interlinkages among these bodies are complex (see Figure 8.8), and the systems have been described as fragmented and overlapping (UN 1999). With the growth of the number and diversity of actors and organizations, interagency mechanisms, such as the Environmental Management Group (EMG), UN Development Group and the liaison groups between MEA secretariats, have been created to bridge independent agencies and promote greater cooperation. The UN Economic and Social Council and the UN General Assembly play major roles in coordination, and they have created fora for promoting cooperation with other institutions, such as the WTO and Bretton Woods institution that are outside of the UN system.

At the international level, business and industry have played increasingly important roles in connecting the environment, development and trade regimes through direct interaction with global institutions. For example, organizations such the World Business Council for Sustainable Development and processes such as the Global Compact are bridging international action with that of business actions (WBCSD 2007, UN Global Compact 2006). The power of markets has equally played an important role in bridging the interlinkages between environmental change (such

as climate change and the carbon markets) and development (such as through the Clean Development Mechanism). The international system of investment and finance fuels global development, and investment decisions – from where to build a dam to which type of automobile to develop – and all have direct impacts on the environment. However, investors are beginning to understand the powerful implications of global environmental change, particularly climate change, on portfolio performances across sectors, and are seeking out various business models to manage environmental risk. The Principles for Responsible Investment (PRI) are a major commitment by signatory institutional investors and asset managers to integrate environmental and social issues into their decision making processes, and provide a significant platform for their inclusion in mainstream investment practices (UNEP 2006d and UNEP 2006e).

Box 8.5 Eco-crime exploits loopholes of legal regimes

Few of the MEAs actually regulate trade. Two exceptions are CITES and the Basel Convention. While enforcement to regulate trade is a key element for the implementation of both conventions, effectiveness of both MEAs is being undermined by illegal trade, highlighting the interlinked challenges of trade and environment, particularly in relation to thriving black markets across the globe.

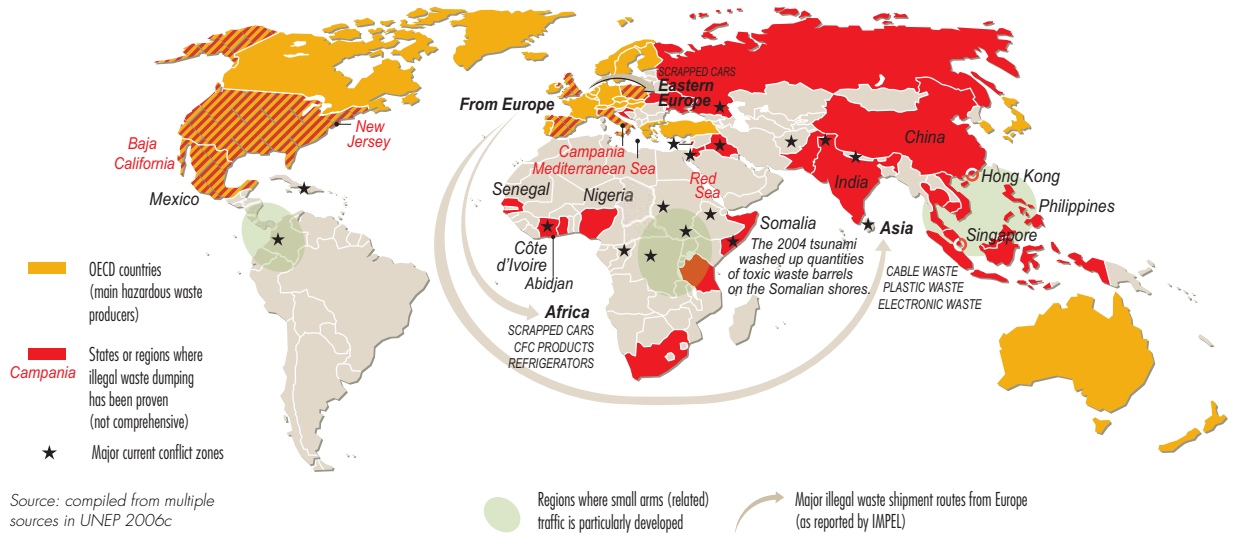
The basic criteria required to fulfil the mandate of the Basel Convention (Secretariat of the Basel Convention undated) include the existence of a regulatory infrastructure that ensures compliance with applicable regulations, as well as enforcement personnel (competent authorities, police, customs officers, port and airport authorities, and coast guards) trained in technical areas, including procedures and identification of hazardous wastes. However, the lack of human resources, training and equipment are some of the barriers to effective implementation. Others include inadequate industry response to treat, recycle, re-use and dispose of wastes at source and an inadequate information network and alert systems to assist with detection of illegal traffic in hazardous wastes. In an effort to try and address some of these gaps, the Basel Convention parties have developed an illegal traffic guidance manual, while a guide for legal officials is under development and training is provided to developing countries through the Basel Convention Regional Centres.

UNEP estimated the annual revenue from the international illegal wildlife trade to be US$5–8 billion. While enforcement in the trade of wildlife (especially through the use of permits, licences and quotas) has proved effective in many cases, illegal trade (and the subsequent creation of "black markets") will continue as long as consumer demand is high, profits remain enormous and risks remain low. As with many environmental concerns, the characterization of the wildlife trade as a mere "environmental" consequence tends to reduce its importance on national policy making agendas, vis-à-vis security and economic issues, resulting in fewer resources and less attention being committed to it. Another major problem is that CITES itself contains several loopholes which are extensively exploited by black marketers. Such loopholes include trading with non-parties, and exemptions for sports hunting of the captive-breeding programme.

Other MEAs also relate to trade and the environment, but have been undermined by "eco-crimes." Stronger international regulations, effective governance structures for enforcement at all levels and a national commitment to sustainable development can help align developmental and environmental needs.

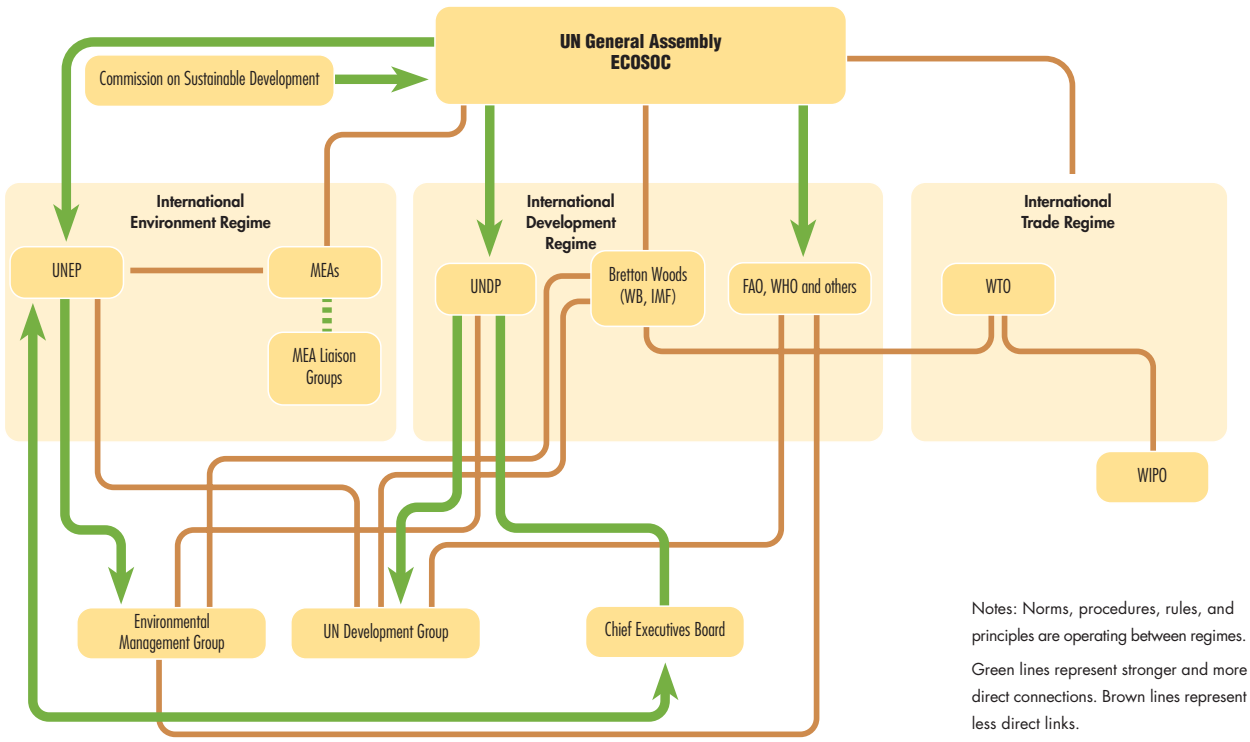
Sources: Lin 2005, Secretariat of the Basel Convention 1994, Secretariat of the Basel Convention undated, UNEP 1998, UNEP 2006c, YCELP undated

Figure 8.7 Waste trafficking



Source: compiled from multiple sources in UNEP 2006c

Figure 8.8 International governance-environment-development-trade interlinkages



Notes: Norms, procedures, rules, and principles are operating between regimes.

Green lines represent stronger and more direct connections. Brown lines represent less direct links.

In the last 20 years, there has been a significant rise of international plurality. Civil society has a major role under the international environmental, development and trade regimes, and plays an essential role in providing analysis, advocacy, and awareness raising to these regimes. The vertical interlinkages between national and international levels have been especially well developed in this period, and now many national and local civil society actors (such as NGOs and indigenous groups) play major roles in international decision making, either as observers or as members of national delegations, by providing commentary and analysis, or through protest and civil action. Horizontally, the interlinkages between civil societies are developing, and many have formed umbrella groups (such as the Climate Action Network), and cooperate on common and overlapping issues and interests. Civil society has not, however, adequately developed the issue of interlinkages (among drivers, environmental changes and impacts) as a subject area for its attention. Most civil society groups remain focused on single-issue areas, such as climate change, wildlife conservation, poverty reduction or human rights, and have not recognized the need to address the interlinkages among these issues.

OPPORTUNITIES FOR MORE EFFECTIVE ENVIRONMENTAL GOVERNANCE

The previous section has demonstrated that the environmental governance system is multi-scaled, diverse and extends into development governance regimes. The boundaries separating institutional systems, like those of ecosystems, are often indistinct. Consideration of the interactions between these international arrangements are important in understanding and strengthening their effectiveness in addressing interlinkages between environmental changes, which are interacting across spatial and temporal scales and boundaries (Young 2002). Not only does environmental governance involve many institutional regimes, but it also involves trade-offs and transaction costs that are critical to adaptation to and mitigation of environmental changes, and the improvement of human well-being.

The magnitude of the interconnectedness of environmental changes does not mean, however, that policy-makers are only faced with the choice of "doing everything at once in the name of integrated approaches or doing nothing in the face of complexity" (OECD 1995). Interlinkages offer opportunities for more effective responses at the national, regional

and global levels. Sometimes, responses need to be integrated, and occur as a chain of actions to match the complexity of the situation; sometimes more restricted and targeted responses are called for (Malayang and others 2005). Understanding the nature of interlinkages, their interplay, and identifying which linkages need to be acted on at which scale, offers opportunities for more effective responses at the national, regional and global levels.

The complexity and the magnitude of the interlinkages among the environmental changes requires that policy-makers prioritize which interlinkages require immediate attention. Appropriate policies and measures can then be adopted nationally to mitigate the negative impacts, and to maximize the effectiveness of existing policies. Such understanding can also guide parties to MEAs to decide which types of collaboration and which types of joint work programmes could be prioritized and strengthened. A scientific understanding of the key interlinkages among the environmental changes (and between environmental and socio-economic changes) is still not fully developed nor widely understood, and will require future assessments and research in order to guide such policy making. However, it is clear that one of the major interlinkages is driven by climate change, seen in its roles in land and water degradation.

An adaptive approach to environmental governance (see later sections) may address the call for enhanced coordination, and improved policy advice and guidance. Development of a long-term strategic approach for enhancing the infrastructure and capacities for keeping the environmental situation under review may help in identifying key interlinkages at and between both the national and international levels. There is broad agreement on the need for better treaty compliance, while respecting the legal autonomy of the treaties. A process that considers interlinkages may help identify areas for cooperation among the treaties, and for more effective enforcement and compliance at national level as well as for related capacity building and technology transfer.

Considerations on the overall normative basis for environmental governance may help identify more effective institutional structures. Better integration of environmental activities in the broader sustainable development framework at the operational level, including through capacity building, requires an in-depth understanding of interlinkages. Current gaps and needs relating to existing national and international infrastructure and capacities for integrating environment into development could be identified, and a long-term approach for addressing such needs could be explored. The subsequent section assesses the opportunities in the context of interlinkages.

UN reform and system-wide coherence on the environment

Efforts to enhance governance and system-wide coherence have been a recurrent feature of the United Nations (Najam and others 2007). Recent processes within the United Nations itself have acknowledged that it has not been as effective as it could be. The UN Secretary-General's High-Level Panel on UN System-wide Coherence in the Areas of Development, Humanitarian Assistance and the Environment (the Coherence Panel) states for instance that: "The UN has outgrown its original structure. We have seen how weak and disjointed governance and inadequate and unpredictable funding have contributed to policy incoherence, duplicating functions and operational ineffectiveness across the system" (UN 2006).

The importance of UN system-wide coherence in order to address environmental change has also been a recurring theme, particularly over the last decade (Najam and others 2007). Table 8.1 provides a summary of the recommendations of three recent processes. One was a review of the requirements for a greatly strengthened institutional structure for international environmental governance (IEG) in 2000, and adoption of an IEG package (UNEP 2002b). The second was the outcome of the 2005 World Summit, which called for stronger system-wide coherence within and between the policy and operational activities of the United Nations, in particular in the areas of humanitarian affairs, development and environment. The third was the Coherence Panel. The panel's mission has been to explore how the United Nations can be better structured to help countries achieve the MDGs and other internationally agreed development goals, and how the United Nations can better respond to major global challenges such as environmental degradation (UN 2006).

Table 8.1 Recommendations from some recent UN environmental governance reform processes

	The International Environmental Governance (IEG) Initiative (UNEP 2002c)	The 2005 World Summit Outcome (UN 2005)	Selected recommendations of the Secretary-General's High-level Panel on UN System-wide Coherence (UN 2006)
UNEP and the environment in the UN	A Strengthened UNEP through: ■ improved coherence in international environmental policy making – the role and structure of the Governing Council/ Global Ministerial Environment Forum; ■ strengthening the role and financing of UNEP; and ■ strengthening the scientific capacity of UNEP.	More efficient UN environmental activities through: ■ enhanced coordination and improved policy advice and guidance; and ■ strengthened scientific knowledge, assessment and cooperation.	■ strengthen and improve IEG coherence by upgrading UNEP with a renewed mandate and improved funding; and ■ UNEP's technical and scientific capacity should be strengthened for monitoring, assessing and reporting on the state of the global environment.
UN system-wide coherence	■ enhanced coordination across the UN system – the role of the Environmental Management Group.	■ stronger system-wide coherence within and between the policy and operational activities of the United Nations, in particular in the areas of humanitarian affairs, development and environment; and ■ agreement to explore the possibility of a more coherent institutional framework. including a more integrated structure.	■ UN Development Policy Operations Group within the Chief Executives Board for Coordination framework bringing together heads of all UN organizations working on development; ■ more effective cooperation among UN agencies, programmes and funds working in different thematic areas of the environment; and ■ an independent assessment of the current UN system of IEG should be commissioned.
MEAs	■ improved coordination among and effectiveness of multilateral environmental agreements (MEAs).	■ better treaty compliance, while respecting the legal autonomy of the treaties.	■ more efficient and substantive coordination to support effective implementation of the major MEAs.
Country-level operations	■ capacity-building, technology transfer and country-level coordination for the environmental pillar of sustainable development.	■ better integration of environmental activities in the broader sustainable development framework at the operational level, including through capacity building.	■ One UN Country Programme to deliver as one at the country level; ■ UNEP to provide substantive leadership and guidance at the country level, including building capacity and mainstreaming environmental costs and benefits into policy making; and ■ UN Sustainable Development Board, reporting to ECOSOC, to oversee the performance of the One UN at country level.

There are clear commonalities in the outcomes and recommendations of these three processes, which relate to UNEP and environment in the UN system, UN system-wide coherence, implementation of the MEAs, and country-level operations.

Calls for a UN or World Environment Organization (UNEO or WEO) have been made since the early 1970s (Charnovitz 2005). There is still much debate about whether there is a need for such an organization, and what form it might take in order to address the shortcomings of the present international environmental governance system (Charnovitz 2005, Speth and Haas 2006). Suggested functions include planning, data gathering and assessment, information dissemination, scientific research, standards and policy setting, market facilitation, crisis response, compliance review, dispute settlement and evaluation (Speth and Haas 2006, Charnovitz 2005).

A number of studies have observed that, despite significant achievements, the current governance regimes are inadequate and unable to deal effectively with the complexity of the interlinked human-biophysical or the social-ecological systems (Najam and others 2007, Kotchen and Young 2006, Olsson and others 2006). The current reform processes and debates offer a significant opportunity for addressing many of the interlinkages within and between environmental change and environmental governance at all scales, because much of what occurs or is agreed at the global level has to be addressed or implemented at the national and sub-national levels.

Better treaty compliance and implementation

The informal consultations by the UN General Assembly on the institutional framework for the United Nations' environment-related activities identified a range of views among member states on how to ensure better treaty compliance. Despite some value in specificity, there was widespread support for a much more coherent system dealing with the multitude of environmental issues currently under discussion. Issues raised included the material limitations to attend and participate meaningfully in a multitude of meetings, as well as the administrative costs and heavy reporting burden. This burden also extended to capacities required to implement legal agreements, affecting the legitimacy of such instruments and thus reinforcing the argument that enhanced capacity building is essential, especially for developing countries. On compliance, there were different perspectives. Some were in favour of improved monitoring and compliance mechanisms, like the establishment of a voluntary peer-review mechanism on compliance, while others supported capacity building (Berruga and Maurer 2006).

One challenge is that thematic responsibilities often fall under several different MEAs, such as biodiversity which falls under the CBD, CITES, Ramsar, CCD, CMS and the World Heritage Convention. Also, one MEA can contribute to the objectives of other MEAs. For instance, ozone-depleting substances (ODS), which are also greenhouse gases, are regulated under the Montreal Protocol. By 2004, emissions of these gasses were about 20 per cent of their 1990 levels (IPCC 2007a). The fact that the major environmental changes are interlinked offers opportunities for cooperation among the MEAs at many levels.

Some voluntary cooperative mechanisms now act as bridges among secretariats of conventions. There is the Joint Liaison Group on the conventions on climate, biodiversity and desertification, and the Biodiversity Liaison Group, which involves five biodiversity-related conventions. Potential avenues

Biodiversity issues, at all levels – genes, species and ecosystems – are covered by several MEAs such as CBD, CITES, RAMSAR, CCD, CMS and WHC.

Credit: Ferrero J.P./Labat J.M./ Still Pictures

for improved cooperation among MEAs and between MEAs and UNEP have been explored through informal consultations.

While compliance with and enforcement of a treaty is first and foremost the responsibility of the parties to the conventions, the parties frequently call on support from other institutions, individually and collectively. The Global Environment Facility (GEF) is the funding mechanism for multiple MEAs, and therefore has a major influence on the operational activities and priorities of the participants, namely the implementing and executing agencies, and the national or regional institutions involved in implementation. The GEF is therefore well placed to focus activities on interlinkages and exploiting synergies between the focal areas (biodiversity, climate change, international waters, land degradation and persistent organic pollutants (POPs)), and between the respective MEAs. In addition, the GEF finances multifocal area projects to promote sustainable transport, conservation and sustainable use of biodiversity. These are important to agriculture, sustainable land management, adaptation to climate change, and national capacity assessment and development. Other initiatives in support of better treaty compliance include the third Montevideo Programme for the Development and Periodic Review of Environmental Law for the first Decade of the Twenty-first Century (UNEP 2001b), and guidelines on compliance with and enforcement of multilateral environmental agreements, which are complemented by a manual on compliance with and enforcement of MEAs (UNEP 2002c, UNEP 2006b).

Future opportunities for strengthening compliance with and implementation of MEAs at the national level may include greater focus on the creation of integrated or umbrella legislation for MEAs that are related or which overlap. With the growing number of MEAs, and the shift from negotiations to implementation (Bruch 2006), this option is increasingly attractive for countries that have passed the relevant legislation but do not implement it. Benefits of such an umbrella approach could include more coherent national legal frameworks, promotion of institutional coordination, or even cost effectiveness (Bruch and Mrema 2006). Umbrella approaches are relatively new, but there are some good examples of national legislation implementing biodiversity-related and chemical-related MEAs (Bruch and Mrema 2006).

An umbrella format at the international level was already proposed by the Brundtland Commission in 1987. It recommended that "the General Assembly commit itself to preparing a universal Declaration and later a Convention on environmental protection and sustainable development." It stressed the need, in building on existing declarations, conventions and resolutions, to consolidate and extend relevant legal principles on environmental protection and sustainable development (WCED 1987). While the first element of the recommendation from the Brundtland Commission was implemented through the Rio Declaration on Environment and Development, the idea of a universal convention has so far not been pursued by UN member states. The idea was, however, visited by stakeholders, led by the World Conservation Union (IUCN), in the form of a Draft Covenant on Environment and Development. This was launched in 1995 at the United Nations' Congress on Public International Law (IUCN 2004).

The interlinked nature of the environment and development challenges, and the diverse landscape of environmental governance may warrant regular reviews of the overall normative basis for international environmental cooperation. Ideally, the multilateral governance structures would flow from an agreed normative basis relating to the overarching purpose and scope of environmental cooperation and its contribution to development. They would deal with key principles for such cooperation, general rights and obligations of states, and key structures needed to support such intergovernmental cooperation, including capacity building. Considerations on the overall normative basis for environmental governance at both national and international level may help identify more effective institutional structures.

Integrating environment into development

The integration of environmental activities into the broader development framework is at the heart of MDG 7 on achieving environmental sustainability (UN 2000). Recognition of the need for integration of environmental concerns into public and private social and economic sector institutions, which was greatly enhanced by the vision put forward by the Brundtland Commission, has increased tremendously over the last decade at both national and international levels.

A key approach to integration of environment into development is achieving more sustainable

patterns of consumption and production (SCP), as facilitated through the Marrakech Process (see Box 8.6). The overarching objective is to decouple economic growth from environmental damage, in both developed and developing countries, through the active engagement of both the public and private sectors. This relates to all stages in the life cycle of goods-and-services, and requires a range of tools and strategies, including awareness raising, capacity building, design of policy frameworks, market-based and voluntary instruments, and consumer information tools.

SCP is becoming a priority for countries worldwide, and there are many initiatives and programmes in addition to the Marrakech Process. Unsustainable patterns of consumption and lifestyles in developed countries have so far proved a particularly intractable problem. These forms of consumption result in, by far, the majority of negative environmental impacts associated with production and consumption of goods-and-services. It is necessary to look at innovative measures to meet (material) needs, and develop new innovative product and service systems. This is especially important when considering the new emerging "global consumer class," with large groups of middle-class consumers showing increasingly similar consumption patterns in rapidly-developing countries, such as Brazil, China and India (Sonnemann and others 2006).

One of the main messages in developing policies for sustainable consumption and production is that one single instrument will not fix the problem; it is necessary to design a package of different instruments, including regulatory frameworks, voluntary measures and economic instruments. Likewise, it is important to actively involve all stakeholders: government,

Box 8.6 Sustainable consumption and production: the Marrakech Process

Sustainable consumption involves the choices consumers make, and the design, development and use of products and services that are safe, and energy and resource-efficient. It considers the full life-cycle impacts, including the recycling of waste and use of recycled products. It is the responsibility of all members of society, and includes informed consumers, government, business, labour, consumer and environmental organizations. Instruments to promote sustainable consumption include sustainable or green procurement, economic and fiscal instruments to internalize environmental costs, and use of environmentally sound products, services and technologies.

Sustainable and cleaner production is "the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner production can be applied to the processes used in any industry, to products themselves and to various services provided in society." This broad term encompasses such concepts as eco-efficiency, waste minimization, pollution prevention, green productivity and industrial ecology. Cleaner production is not anti-economic growth, but is pro-ecologically sustainable growth. It is also a "win-win" strategy that aims to protect the environment, the consumer and the worker while improving industrial efficiency, profitability and competitiveness.

Central to such efforts is the global, multistakeholder Marrakech Process, which supports regional and national initiatives to promote the shift towards sustainable consumption and production (SCP) patterns. The process responds to the call of the WSSD Johannesburg Plan of Implementation to develop a 10-Year Framework of Programmes on Sustainable Consumption and Production (10YFP). UNEP and UNDESA are the leading agencies of this global process, with the active participation of national governments, development agencies, the private sector, civil society and other stakeholders. The Commission on Sustainable Development (CSD) will review the theme of SCP during its 2010–2011 two-year cycle.

Activities under the Marrakech Process are undertaken through voluntary task forces led by governments, with the participation of experts from developing and developed countries. Through a Cooperation Dialogue with other partners, they commit themselves to carrying out a set of concrete activities at national or regional level that promote a shift to SCP patterns. The task forces are carrying out activities such as:

- an eco-labelling project in Africa;
- national action plans on SCP;
- developing tools and supporting capacity building to promote sustainable public procurement;
- projects and networks on product policy to encourage more innovation on product eco-design and performance;
- projects on sustainable buildings focusing on energy efficiency;
- the promotion of sustainable lifestyles and education through demonstration projects; and
- developing policy tools and strategies for sustainable tourism.

Another important mechanism for implementing SCP is collaboration with development agencies and regional banks. The Cooperation Dialogue aims to highlight the contribution of SCP policies and tools to poverty reduction and sustainable development, including the MDGs, and better integration of SCP objectives in development plans. A key priority is to contribute to poverty reduction through the promotion of sustainable consumption and production, which is especially relevant for developing countries.

Sources: UNEP 2006f, UNEP 2007b, UNEP 2007c

industry, business, advertising, academia, consumer associations, environmental NGOs, trade unions and the general public. In addition, there is a need for sectoral approaches in order to modify the unsustainable systems of consumption and production (Sonnemann and others 2006).

Integration of environment into development also needs to be addressed at a macro-economic level. Wealth as an index of well-being (Dasgupta 2001), and the idea that an economy's wealth should not decline over time, or should ideally increase, have recently been put forth as powerful concepts serving the cause of sustainable development (Dasgupta 2001, World Bank 2006b). This is based on the idea that a decline in wealth (or assets) signifies an unsustainable path. In accounting terms, it means that depreciation or loss of assets should be recorded as negative. Furthermore, the idea of wealth creation brings with it the twin notions of investment and saving.

A portfolio approach assumes that assets are managed in a way that minimizes risks through, for instance, distribution of assets across a broad range of investment schemes, that profit (rent) is realized, and that there is sustained growth of the various portfolios, which will permit saving and reinvestment (see Box 8.7).

In previous sections, the importance of natural capital, including ecosystem services, was highlighted as being critical in the development of nations. Yet depletion of energy resources, forests, agricultural lands and watersheds, and damage from air and water pollutants are not recorded in the national accounts as depreciation. However, all these sectors through their respective activities create unwanted negative impacts (externalities). An impact analysis and evaluation calls for an assessment of the trade-offs (the pluses and minuses) caused by economic activities and development projects that are necessary for development. In the case of these sectors, the productive base is the natural capital, which provides great sources of well-being.

Evaluation of activities related to these sectors involves assessing the benefits versus the costs that development projects will have on the individual and society in general. The social worth (Dasgupta 2001) of such projects not only looks at the monetary return, but also assesses how the quality of life of communities is affected. If the projects or portfolio has negative externalities on the productive base (in this case, natural resources), its social worth might be negative and therefore should be rejected.

It is important for policy and decision making to move accounting of natural resources from satellite accounts to the main accounts, as they provide critical information in the planning and budgetary processes. Use of instruments such as genuine savings is an effort in this direction. Indeed, genuine savings measures the true level of saving in a country after recording depreciation of produced capital (goods), investment in human capital (expenditures on education) and depletion of natural resources (World Bank 2006b). These types of assets accounts are helpful in measuring and monitoring how sustainable or unsustainable countries' activities are.

Accounting for the depletion in stocks provides countries with a picture of how balanced or unbalanced their portfolio of stocks is. For instance, countries and regions, such as Malaysia, Canada, Chile, the European Union and Indonesia, have constructed accounts for forests. Work by Norway

Box 8.7 Portfolio management: analysis of impacts

A portfolio approach to sustainable development takes into account not only the value (both tangible and intangible) of the assets at hand, but also the necessary institutions that go hand in hand with the development process. This ultimately leads to an environmental and social optimum between and across generations.

A portfolio approach to sustainable development presupposes the optimal and long-term management of natural resources. The socially optimal allocation of these stocks, and how to mainstream these resources into the main economy and development process is where the challenges lie. This is also where policies that emerged as a response to the recommendations made in the 1987 Brundtland Commission report have for the most part failed.

Additionally, governmental institutions, mostly those responsible for the management of natural resources, have been for the most part unable to sensitize finance and treasury ministries to the importance of natural resources, both for the development process as well as for human well-being. At the same time, ministries of finance have mostly ignored the analysis of natural resource issues.

Exploring the interlinkages between environment and development, and more specifically the roles and impacts of sectors on the environment and human well-being calls for an impact analysis and evaluation of policies and projects. It requires close scrutiny of the important role played by institutions and governance, and of the instruments and tools available in order to provide the required information for decision making.

Sources: Dasgupta 2001, Dasgupta and Maler 1999, World Bank 2006b

(1998), the Philippines (1999) and Botswana (2000) (see Box 8.8) in resource rent to calculate the value of assets, has illuminated policy decisions with regard to economic efficiency in the management of resources, as well as to the sustainability of the decisions.

In terms of accounting for natural resources, some of the challenges are (World Bank 2006b):

- lack of data in some countries;
- no market for many of these resources;
- some of the intangible services provided by these resources (such as cultural and spiritual services) are difficult or impossible to value;
- few countries have comprehensive environmental accounts; and
- there are difficulties in undertaking international comparisons, because of differences in approaches, coverage and methodologies.

Efforts are needed by a broad range of partners to address these challenges in a coherent and systematic manner.

Coping with interlinkages among environmental changes, which are increasing in rate and magnitude, will become a major challenge for development. The case of climate change is an example of where this is becoming evident. As the impacts of climate change are becoming more obvious, the importance of adaptation to climate change is gaining attention on international and national agendas. It is also clear that climate variability and change do not act in isolation (IPCC 2002, CBD 2003) (see earlier sections). The status of the natural resources, the other environmental changes (such as land degradation and water stress), and human, social, financial and physical capital can determine the coping capacity of the people and the adaptive capacity of ecosystems (IPCC 2001). In addition, many developing countries cannot cope with the present climatic extremes, and climate change is seen to be a risk to development (Stern and others 2006, World Bank 2007). Thus, adaptation is a necessity (IPCC 2001). A climate risk management approach is being adopted by funding agencies (such as the World Bank and the UK Department for International Development), which takes account of the threats and opportunities arising from both current and future climate variability and change, and the interlinkages among the environmental changes. This approach also necessitates the consideration of interlinkages between and among the environmental changes, ecosystem services and human well-being.

The recent focus on these interlinkages, and not just climate change alone, represents an opportunity for addressing current environment-development challenges more coherently. Mitigation of climate change in terms of carbon storage measures may potentially also address multiple environment and development challenges simultaneously. Such measures need to be supported in the context of development assistance frameworks, and take account of the fact that those groups of people most vulnerable to environmental changes are often different from those causing such changes.

Although achievements have been made in the area of integrating environment into development and internalizing the human-environment interlinkages into social and economic sectors, they have not kept pace with accelerating environmental degradation. Integration of environmental concerns into the wider development agenda requires collaborative efforts across existing governance regimes. Significant opportunities are offered by the UN reform process, due to its particular focus on strengthening system-wide coherence in the area of environment and the "One UN" approach at country level.

Environmental integration remains a formidable challenge for all sectors, but in particular for the environmental institutions, both at national and international levels. It requires a systematic and sustained effort by these institutions, comparable

Box 8.8 Reinvesting resource rent: the case of Botswana

Since its independence in 1966, Botswana, originally one of the world's poorest countries, has shown remarkable economic progress. Botswana has used its mineral wealth to transform the economy, joining the World Bank's category of upper-middle-income countries in the 1990s. The country came up with its own rule of thumb for reinvestment of mineral revenues to account for and offset natural resource depletion. The use of the Sustainable Budget Index in its accounting system requires that all mineral revenues be reinvested. Some of Botswana's achievements include improvements in infrastructure, human capital, and the basic services supplied to its population, for example:

- paved roads: 23 km in 1970, increased to 2 311 km by 1990;
- improved drinking water: 29 per cent of the population in 1970, increased to 90 per cent by 1990;
- telephones: 5 000 connections in 1970, increased to 136 000 by 2001; and
- female literacy: 77 per cent by 1997.

Sources: World Bank 2006b

Environmental integration requires bridging gaps, to strengthen scientific knowledge, assessment, and cooperation and improve decision making for sustainable development.

Credit: ullstein-Hiss/Mueller/ Still Pictures

to those of more established coordinating sectors, such as finance and planning. Current gaps and needs relating to existing national and international infrastructure and capacities for integrating environment into development could be identified. A long-term approach for addressing such needs could also be explored. It could draw on lessons learned from integration of environment into development at the macro-economic level. This could be done through portfolio management, promotion of sustainable production and consumption patterns to decouple economic growth from environmental damage, and approaches for reviews of environmental effectiveness in sectors based on, for example, agreed targets and indicators of achievements.

Strengthened scientific knowledge, assessment and cooperation

The Brundtland Commission report and subsequent environmental policy documents continue to emphasize reliable data and sound scientific information as being key components of sustainable development. Development efforts, including poverty reduction, and humanitarian assistance, need to take full account of knowledge about the contribution of the environment and ecosystem services to the enhancement of human well-being. Investing in infrastructure and capacities for environmental knowledge and information is, therefore, also an investment in sustainable development.

There is a wide range of collaborative processes for monitoring, observing, networking, managing data, developing indicators, carrying out assessments and providing early warnings of emerging environmental threats at international, regional and national levels. Notable achievements include the ozone and climate assessments. Many national and international institutions, including scientific and UN bodies, are active in the field of environmental assessments, monitoring and observing systems, information networks, and research programmes. At the global level, these include the global observing systems and the newly established Group on Earth Observations, with its implementation plan for a Global Earth Observation System of Systems (GEOSS). Efforts also include international scientific programmes, such as those operated by academic institutions around the world and under the International Council for Science (ICSU).

Most MEAs have their own subsidiary scientific advisory bodies, which to varying degrees, analyse scientific information. The UN Framework Convention on Climate Change is, in addition to its

subsidiary scientific advisory body, also supported by a corresponding assessment mechanism, the Intergovernmental Panel on Climate Change (IPCC), for which WMO and UNEP jointly provide the secretariat. Calls have been made for a similar assessment mechanism based on the achievements of the Millennium Ecosystem Assessment to support the ecosystem-related MEAs. The usefulness of such a mechanism is still being debated among governments and experts. In addition, the GEF has its own Scientific and Technical Advisory Panel (STAP).

Many countries in different regions have either national legislative or other provisions for undertaking state of the environment assessments, environmental impact assessments and strategic environmental assessments (SEA). Such assessments offer opportunities for identifying and addressing interlinkages, and promoting coherence, integration of environment into development, and improved management of national environmental endowments. European Union member states, for example, adopted the European Directive (2001/42/EC) on the Assessment of the Effects of Certain Plans and Programmes on the Environment (the SEA Directive), which became effective in 2004 (European Commission 2007). On a pan-European level, countries have agreed on a Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context, which opened for signature in 2003. In Canada, a cabinet-level directive provides for an administrative requirement to conduct a SEA on all policies, plans and programmes. In South Africa, some sectoral and planning regulations identify SEA as an approach for integrated environmental management. In the Dominican Republic, legislation refers to SEA or strategic environmental evaluation. Existing environmental impact assessment legislation in other countries requires a SEA-type approach to be applied either to plans (for example, in China), programmes (Belize) or to both policies and programmes (Ethiopia) (OECD 2006).

Box 8.9 Types of governance disjunctures

Spatial disjuncture
Governance does not match the spatial scales of ecosystem processes. For example, local institutions for management of sea urchins are unable to cope with the development of global markets and highly mobile "roving bandits."

Temporal disjuncture
Governance does not match the temporal scales of ecosystem processes. For example, in the 1950s and 1960s, governments in the West African Sahel promoted agricultural and population development in areas with only temporary productivity due to above-average rainfall. As the areas returned to a low-productivity state, erosion, migration and livelihood collapse resulted.

Threshold behaviour
Governance does not recognize or is unable to avoid, abrupt shifts in social-ecological systems. Application of "maximum sustainable yields" trigger fish stock collapse, due to overharvesting of key functional species.

Cascading effects
Governance is unable to buffer, or amplifies cascading effects between domains. For example, in Western Australia abrupt shifts from sufficient soil humidity to saline soil, and from freshwater to saline ecosystems, might make agriculture a non-viable activity at a regional scale, and trigger migration, unemployment and the weakening of social capital.

Sources: Adapted from Galaz and others 2006

Adaptive governance as an opportunity for addressing interlinkages

Ideal conditions for governance of human-environment systems are rare. As the preceding pages have shown, more often than not decision-makers are faced with challenges:

- **Problems of complexity.** These include the intricate nature of ecosystems, the differing spatial reach and temporal implications of biophysical processes, thresholds and feedback loops, and the human dimensions shaping ecosystem dynamics.
- **Problems of uncertainty and change.** Science is incomplete on aspects of environmental change, some understanding of biophysical processes and ecosystem dynamics are likely to be wrong, some changes are not predicted and provided for, and existing knowledge is not fully integrated.
- **Problems of fragmentation.** Much of the governance regime is not sufficiently linked or coordinated, resulting in inconsistent or conflicting policy proposals, authorities and mandates of institutions. Administrative structures overlap, decision making is divided, important users and constituents are outside the process, and centralization and decentralization of governance is often not appropriately balanced.

From a governance perspective, the problems of complexity, uncertainty and change, and fragmentation easily result in governance disjunctures (see Box 8.9) (Galaz and others 2006). Moreover, opportunities to shift underperforming existing governance processes and structures to more responsive interlinked ones are rare. Policy-makers

and implementers hardly ever have the luxury of starting from a clean slate; rather they have to work with and within existing interests and structures.

To address complex interactions and interlinkages, and to manage uncertainty and periods of change, adaptive governance approaches have much to offer (Gunderson and Holling 2002, Folke and others 2005, Olsson and others 2006). Adaptive governance emerges from many actors in the state-society complex, and can be institutionalized, though usually in a structure more akin to network governance. Adaptive governance relies on polycentric institutional arrangements that are nested and quasi-autonomous decision making units operating at multiple scales (Olsson and others 2006). The emphasis in adaptive governance is on management and responsibility sharing; it is governance through networks that link individuals, organizations and agencies at multiple levels. A core characteristic of this type of governance is collaborative, flexible and learning-based issue management (Olsson and others 2006).

Adaptive approaches are advocated as more realistic and promising ways to deal with human-ecosystem complexity than, for example, management for optimal use and control of resources (Folke and others 2005). A key strength of adaptive governance approaches is that they start with existing organizations, and seek to link with other relevant entities and stakeholders. Besides the democratic appeal of including all stakeholders, this type of inclusive governance also broadens the knowledge base significantly, and so brings together a range of different experiences and expertise (MA 2005a). With its emphasis on social coordination through networks, rather than the formation of new (often self-contained) institutions, adaptive governance inherently promotes more flexible management arrangements, and is likely to be more responsive to changes in the given human-environment system. It also allows decision-makers to more easily take on board new insights and knowledge to evoke change where necessary, survive change where needed and/or nurture sources of reorganization following change.

Given its diffuse and multi-actor nature, two elements critical for effective adaptive governance are leadership and bridging organizations (see Box 8.10). Leaders are imperative for trust building, managing conflicts, linking key individuals, initiating partnerships among relevant actors, compiling and generating knowledge, developing and communicating vision, recognizing and creating windows of opportunity, mobilizing broad support for change across levels, and gaining and maintaining momentum needed to institutionalize new approaches. Bridging organizations facilitate

Box 8.10 Leadership and bridging organizations: bottom-up and top-down collaboration

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

Laguna Lake Basin, Philippines, illustrates successful collaboration through a top-down initiative. The Laguna Lake Development Authority (LLDA) responded to declining water quality by forming River Rehabilitation Councils (RRCs) to address pollution coming from the lake's 22 tributaries. Until then, governance of the basin had been compartmentalized and was non-participatory. The RRCs on the other hand are composed of people's organizations, environmental groups, industry representatives and local government units, with the LLDA acting as the facilitating institution. The involvement of civil society has proven to be crucial to resolving major conflicts (for example, industry versus community, fishery versus industry, agriculture versus conversion of land to other uses). The multisectoral nature of the RRCs has resulted in a sustained clean-up of some tributaries, reducing pollution in the lake. In this way, the RRCs became crucial bridging organizations to build agreement around a new approach, and to include relevant stakeholders.

Sources: MA 2005b, MA 2005c, Malayang and others 2005

collaboration among different actors and entities. They are often at the interface of scientific knowledge and policy, or of local experience and research and policy. They reduce the cost of collaboration significantly, and often perform important conflict resolution functions (Folke and others 2005).

Adaptive governance approaches are a promising avenue for future efforts to address key interlinkages in a way that complements ongoing processes. Key to building adaptive capacity into governance responses is to prioritize the following three principles in the governance structures (Dietz and others 2003):

- Analytical deliberation: involves dialogue among interested parties, officials and scientists.
- Nesting: involves complex, layered and connected institutions. Nesting refers to solution-oriented processes that are embedded in several layers of governance, so that accountability exists from the local up to the national or even the international level, and includes the temporal and spatial scales of the environmental changes.
- Institutional variety: a mix of institutional types that facilitate experimentation, learning and change.

A range of tools and approaches are available to help in developing and implementing more adaptive policies and actions to address interlinkages, especially at national, sub-national and local levels. These are at project or programme level, and can be applied at several stages of project and programme development. These include, but are not limited to, environmental impact assessments (EIAs), strategic environmental assessments (SEAs), decision analytical frameworks, valuation techniques, criteria and indicators and integrated management approaches. At the national level, many of the approaches can be put into a national policy framework and thus covered by legislation. There are other tools and approaches that can help in the trade-offs between environment and development, including economic valuation of ecosystem services (MA 2003). Green accounting can help in the inclusion of ecosystem services and natural capital in national accounts. There is still a clear need for testing these tools and approaches in specific regions and where there are different combinations of environmental changes and development challenges. Lessons from these can help in further development of these tools and approaches.

CONCLUSION

This chapter has illustrated how human-environment interactions and the resulting environmental challenges are interlinked through complex, dynamic biophysical and social processes. Recognizing and addressing these interlinkages offers an opportunity for more effective responses at all levels of decision making. It may facilitate a transition towards a more sustainable society with a low-carbon economy. Such an approach requires collaboration across the existing governance regimes, which, in turn, have to become more flexible and adaptive.

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