5 ECOSYSTEM SERVICES IN RURAL AREAS AND NATURAL RESOURCE MANAGEMENT

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Content of this chapter

Key Messages

- **Desire for change is not enough.** People and institutions may want to practice sustainable resource use but are impeded by poverty, ineffective governance and poorly designed incentive schemes.
- **It's easier to act if you can see what you're doing.** Valuation makes the impacts of changes in the flow of ecosystem services visible. This is useful in negotiations around the distribution of costs and benefits.
- **Integration is effective.** Placing value (monetary and otherwise) on ecosystem services can help make the case for integrated ecosystem management. Integrated approaches have already been developed and applied around the world.
- **Local officials play a key role** in implementing sustainable practices in forestry, fisheries, water management, agriculture and tourism. They can initiate capacity building, balance the needs of various sectors, promote locally-produced sustainable produce, run incentive schemes, and establish regulations and management-use zoning. They can also promote and explain the economic benefits of protected resources to their constituents.
- **Local governments can make disasters easier to manage** by maintaining and restoring ecosystems. The role of ecosystem services in disaster mitigation is gaining increasing attention. Healthy forests, mangroves, wetlands, floodplains, and reefs protect communities from natural disasters.

> "We need to start looking at having a way of managing the whole ecosystem, because you can't pick away at it piece by piece, you have to truly start being coordinated and managing our resources as a system. We haven't gotten to that point yet."
>
> Ted Danson

In this chapter we illustrate the relevance of an →*ecosystem service* perspective in increasing the potential for effective natural →*resource* management. We argue that such an approach is not only ecologically sound, but also holds economic benefits both for those directly dependent on them and for the national economy in terms of medium and long-term cost and benefits. **Well-managed natural →*ecosystems* provide citizens with vitally important goods and services**, including clear and plentiful supplies of water, high quality farm soils, genetic material for medicines and crop breeding, wild foods including fish, and buffering against extreme weather events and climate change. These, along with a range of cultural, spiritual and aesthetic →*values* that we derive from nature, are called ecosystem services.

An **ecosystem service perspective** can make a **substantial contribution to the effective management of natural resources** for improved agriculture (5.1), fisheries (5.2), forestry (5.3), tourism (5.4) and disaster mitigation (5.5). Many decisions on the use of natural resources are typically made by the individuals, families and companies engaged in these sectors, such as farmers, fishermen, logging companies and tourism operators. Local governments and other local actors (NGOs, local sector agencies) can play an essential role in realizing the economic potential of managing natural resources in a way that values the ecosystem services, by providing advice, creating economic incentives and playing a regulatory role.

Under conditions of climate change, good management of natural resources becomes even more important as **healthy ecosystems can significantly contribute to both mitigating climate change and providing good adaptation opportunities locally**. For example, natural disaster management particularly preventing damage from storms, avalanches or flooding, is a policy field where ecosystems can often provide very cost-effective protection.

Maintaining and managing ecosystem services can be challenging, either because benefits are far removed from the local ecosystem or because some problems only become visible after a certain time-lag, in both cases collective action may be necessary to address management. Carefully designed policies can ensure that the costs and benefits of ecosystem services are fairly distributed across space and time, but only if these are properly understood. Whilst the legal framework for such interactions is often worked out at a national level, the day-to-day negotiations – and some of the most innovative approaches to solving resource conflicts – usually take place at the local level. The final section of this chapter summarizes options for local policy to effectively enhance ecosystem services in natural resource management.

5.1 AGRICULTURE

Almost half of the world's population live in rural areas, with their livelihoods and security depending directly on the productivity of land and water resources (Engelman 2010). At the same time, rural areas provide resources for urban populations, ranging from food and fibre to water, minerals and energy. **Agriculture is the single most important sector in providing the basic necessities for human existence.** It accounts for about 37% of the world's labor force or about 1.2 billion people, even though this is well under 10% in most developed countries (CIA 2010).

For agriculture to be able to provide the service it does, it must rely on a set of complex interdependent and functional relationships between soil, crop production, animal husbandry, and often forestry and wetlands.

The most essential components of a farming enterprise are the soil, crops, livestock, pasture, and household, but pollinators and natural predators are also important (Figure 5.1). The crops draw the nutrients from the soil to produce a harvest for subsistence and/or markets. By-products of the agricultural harvest enter the livestock system as fodder or bedding for animals which in turn produce meat, milk, eggs and fur, and in some cases, draught power. Animal waste may either be used to manure the soil, thus closing the nutrient cycle, or as fuel for cooking (dung cakes and biogas). Careful management, based on understanding local ecological conditions, can maintain or enhance productivity whilst reducing some harmful effects of intensive agriculture. In Japan, for example, rice farmers keep the Aigamo duck, which removes weeds and pests from the rice fields. The duck also fertilizes the rice, producing mulch around the rice plants (TEEBcase Fertilizing the fields with ducks, Japan).

Maintaining an agro-ecosystem in a productive state is a challenge. If a hill farm replaces all its trees with a monoculture crop, the subsequent rains will wash down substantial amounts of soil into the neighbor's low-lying fields and affect the soil fertility, for better or worse. Use of harmful pesticides on one farm may affect the neighboring farm through spray drift in the atmosphere or being transported in waterways or may facilitate migration of chemical resistant varieties of pest. Thus, explicitly **considering ecosystem services** and maintaining or restoring the system to a healthy state, is a valuable strategy **for securing or improving agricultural yields**. Hiware Bazaar (Box 5.1) has achieved this through improved water management.

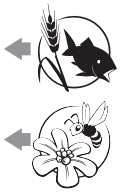
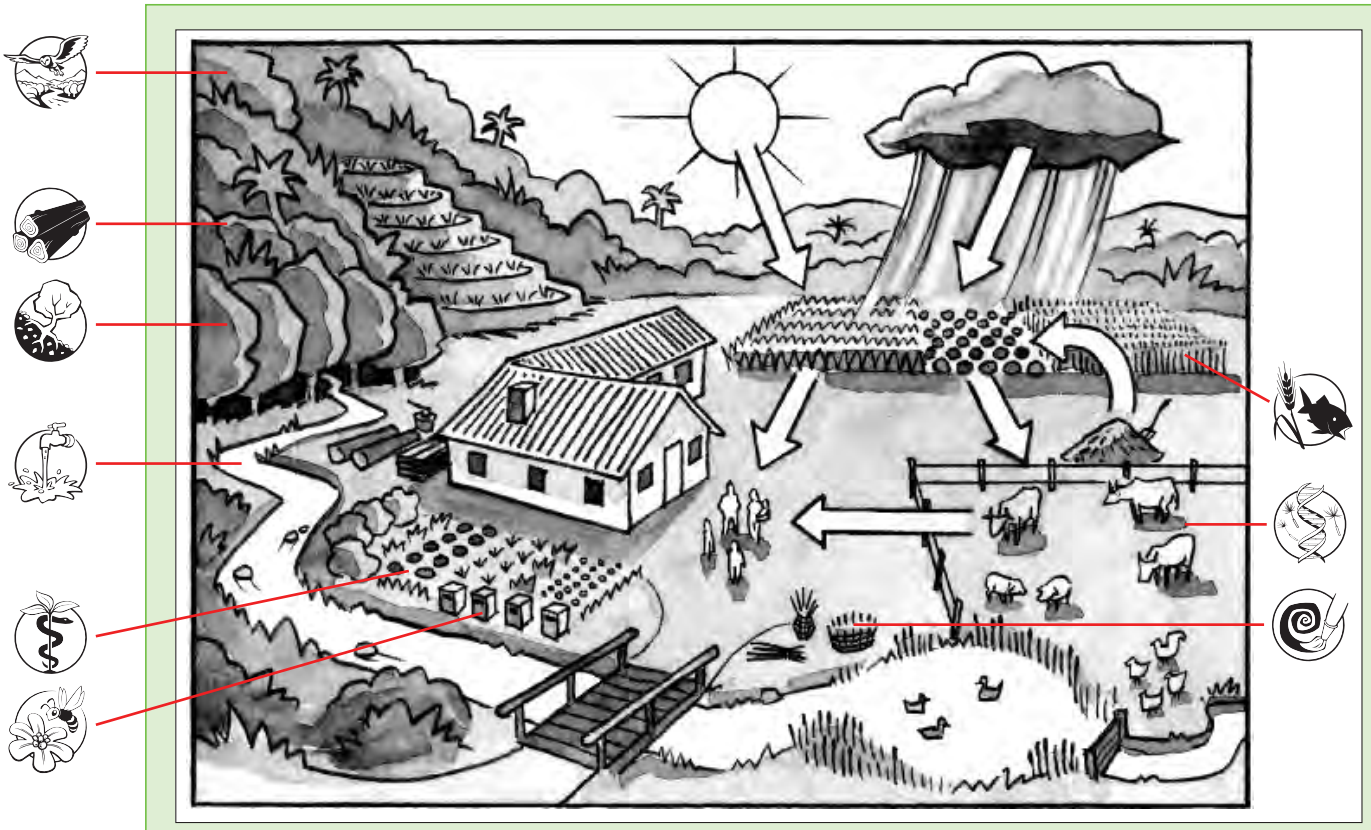


Figure 5.1 Agriculture interacts with the wider ecosystem and its services



Box 5.1 A village with 54 millionaires: Agricultural revolution in an Indian village

Hiware Bazaar, an agrarian village in an arid district in the state of Maharashtra, has turned from abject →*poverty* to become home to more than 50 millionaires (in Rupees) and boasts one of the highest average rural incomes in India. In the 1970s, problems from low rainfall (400 mm annually) were exacerbated by increasing run-off during monsoons, leading to a decline in water levels and acute water shortages. The cause was deforestation and vegetation loss in the surrounding catchment. By 1989 barely 12% of the arable land could be farmed and this crisis had already triggered a trend of out-migration.

Village elders and leaders realised that the way out of this vicious poverty cycle was better management of water and forests. They drew up and implemented an integrated natural resource management plan which was helped by the emergence of the Indian government's Employment Guarantee Scheme (EGS) in the mid-1990s. With additional resources, and good coordination between government departments supporting the EGS, the village members regenerated 70 ha of degraded forests and built 40,000 contour bunds around the hills to conserve rainwater and recharge groundwater.

The number of active wells doubled, the area under irrigation expanded from 120 to 260 ha between 1999 and 2006, while grass production went up from 100 to 6,000 tonnes. Consequently, livestock increased dramatically, as did milk production from 150 litres to 4,000 litres per day. Income from agriculture alone amounted to 25 million Rupees (US$ 550,000) in 2005. In less than a decade, poverty reduced by 73% and there was an overall increase in the quality of life with people returning to the village. Hiware Bazaar is a striking example of an integrated approach to natural resource management.

Source: Enhancing agriculture by ecosystem management, India. TEEBcase mainly based on Neha Sakhuja (see TEEBweb.org)

THE IMPACTS OF AGRICULTURE ON ECOSYSTEMS

The demand for agricultural products is constantly increasing due to population growth, new food preferences and an increase in purchasing power with economic growth (Pretty et al. 2006). Although crop and livestock production systems have been vastly enhanced over the last 50 years, **both the intensity of production and the growth in area cultivated are increasingly affecting ecosystem services** (MA 2005).

A major **side-effect of agricultural intensification is soil degradation and deterioration in water quality**. Animal effluent and run-off from agricultural fields that includes fertilizers, pesticides, hormones, and high levels of nitrates may pollute ground water and nearby aquatic systems. Emissions from livestock stables and feedlots can additionally affect air quality. The negative impact of intensive agricultural production systems not only affects human →*well-being* directly, but also reduces populations of bees and other beneficial insects that pollinate food crops or provide biological control of pests. Agricultural intensification is one of the main threats to →*biodiversity* (EEA 2006). Agro-bio-diversity, the variety of different plants cultivated and animals produced, typically also declines in intensive agricultural systems.

The most **common →*externalities*** with respect to the expansion of agricultural area **are changes in land-use at the expense of forests and other ecosystems, land degradation and nutrient depletion**. At the same time this accelerates climate change, especially deforestation of tropical forests, which is a significant source of green house gas emissions.

The **challenge today** is therefore **to secure and increase yields while** at the same time **maintaining or enhancing other vital ecosystem services** including water quality and quantity, maintaining soil fertility and biological control. Fortunately, many successful examples of sustainable approaches to agriculture already exist around the world.

THE ROLE OF BIODIVERSITY FOR AGRICULTURE

Many wild animal and plant species play a role in agriculture; some damage crops and livestock (see Box 5.8); others control pests through predation and competition or provide essential services such as pollination. Such agro-ecosystems build populations of valuable soil micro-organisms and use natural vegetation in field margins and on slopes to stabilize soil and retain moisture.

In addition, **crop genetic diversity** – both cultivated plants and the wild plants from which our crops originate, are important resources **for food security and economic stability**. This diversity provides crops well-adapted to local ecological and climatic conditions and contributes valuable source material for crop breeding. Estimates of the global value associated with the use of plant genetic resources for crop breeding vary from hundreds of millions to tens of billions of US dollars per year (Stolton et al. 2006). Wild coffee, for example, with its associated potential genetic resources for agriculture, is only maintained in the understorey of Ethiopian highland forests, which are rapidly disappearing (Gatzweiler 2007). Hein and Gatzweiler (2006) estimated the economic value (net present value) of these genetic resources at US$ 1,458 million (over 30 years, 5% →*discount rate*).

Whilst seed collections are useful and necessary, it is also important to maintain healthy wild populations in the field – whether in protected areas or otherwise conserved. Yet many of the places that are richest in economically important crop wild relatives have low protected area coverage and many important species and varieties remain at risk of extinction (Stolton et al. 2008a). Conserving local crop varieties, and supporting farmers in improving them, can help secure local livelihoods in the short-term and provide important options for the future (Box 5.2).

TAKING ECOSYSTEM SERVICES INTO ACCOUNT IN AGRICULTURE

Agriculture goes beyond the provisioning of essentials such as food and fibre; it also incorporates biodiversity and genetic resources, biological control mechanisms, soil microorganisms and habitats that

Box 5.2 Benefits of genetic diversity for rice farmers in the Philippines

A SEARICE-led initiative aims to empower local farmers and decision makers to conserve genetic diversity. The project started with efforts to conserve different local varieties jointly with Philippine farmers. Rather than just conserving varieties in their present state, farmers wanted to improve them further, in order to increase food security and yields. Provided with the necessary know-how they were able to develop locally well-adapted traditional varieties at a cost of ~US$ 1,200 per site for an annual breeding program; considerably lower than those of formal crop breeding (~US$ 6,000 per year per site). Rice farmers benefit from the genetic diversity conserved as the availability of good quality seeds increases, input and production costs decrease and dependence on conventional plant breeding companies is reduced. Hence, decision makers and farmers with knowledge about their regional genetic diversity gain immediate benefit (SEARICE 2007).

provide a range of other ecosystem services. Policy makers have the power and capacity to bring an integrated ecosystems perspective to agriculture. For example, if looking to enhance productivity through technology, it is important to avoid deterioration of other ecosystem services in the process.

Agricultural development requires a whole **system approach** and needs to be tailored to the particular opportunities and requirements of the ecosystem. In Muraviovka Park in Russia organic agriculture was introduced at a local level, along with a wetland conservation strategy. The use of traditional varieties, and a strategy of crop rotations with fallow, has allowed the elimination of agrochemicals. Yields obtained with these practices exceed those of the local conventional methods with only half of the production costs. Many farmers around the park followed the example (TEEBcase Organic farming in private protected area, Russia). With the resulting increase in wetlands and water quality, the biodiversity of the region improved with the number of cranes and storks increasing threefold. In Ecuador, for example, the Quichua community has successfully shown that reintroducing traditional crops and medicinal plants led to a dramatic increase in agricultural productivity, food security and income levels (Equator Intitiative Award 2008).

Box 5.3 Traditional water management delivers multiple benefits, Sri Lanka

The early Sri Lankan society developed a system of irrigation tanks that retain river runoff mainly for the purpose of irrigation agriculture. Besides the production of rice, the tanks provide goods such as fish, lotus flowers and roots that diversify household income.

Since the 1970's the demand for water in upstream areas for modern, large-scale agriculture and hydropower has risen and traditional management practices have been lost. This led to increased sediment load and siltation with negative consequences for the livelihood of downstream users. Recently, local authorities took over management of the tanks and raised the spill in order to rapidly restore their capacity for water storage. This, however, did not solve the problem of siltation.

IUCN together with the local authorities conducted an →*economic valuation* of the goods and services that the traditional tank system is providing for the livelihood of local communities in the Kala Oya river basin. The analysis considers four different scenarios and shows two things: First, the ecosystem services perspective revealed that only 16% of households obtain benefits from paddy rice cultivation, the most prominent purpose of the tank, while 93% benefit from access to domestic water. Secondly, the analysis suggests that rehabilitating tanks and continue 'traditional management' is the scenario with the highest economic return for local communities with a net present value (NPV) of US$ 57,900 per tank (over 30 years, 6% discount rate) as a broad range of services can be secured. Since the communities would directly benefit from the rehabilitation of the tank system, they were positive about participating and taking over the restoration work.

Source: Water tank rehabilitation benefits rural development, Sri Lanka. TEEBcase based on Vidanage et al. (see TEEBweb.org)

In many areas of the world people have developed and maintained sustainable production systems over a long time. These **traditional landscapes** often fare well from an ecosystem perspective as they **provide multiple benefits**. These systems are now increasingly threatened, due to urbanization, new technologies, or population migration. While not all traditional systems are more productive or more equitable, analyzing them from an ecosystem perspective can help to uncover benefits that often go unrecognized, as the example of traditional water management system in Box 5.3 illustrates. Measures are urgently needed to recover the sustainable practices and knowledge involved to improve agricultural technologies. The Ministry of the Environment of Japan and the United Nations University Institute of Advanced Studies jointly initiated the Satoyama Initiative to conserve these sustainable types of human-influenced natural environments, and the many species that depend on them. (TEEBcase Conserving cultural landscapes, Satoyama Initiative, Japan). Practical experience with sustainable practices is increasing rapidly (Box 5.4).

HOW CAN LOCAL POLICY SUPPORT SUSTAINABLE AGRICULTURE?

Local governments, local sector agencies, non-governmental organizations, and other actors at the local level have many opportunities to encourage sustainable practices by:

Providing advisory services: Farmers may not be aware of land-use alternatives even if they make economic sense. This is often the case for enhancing services through improved soil fertility, water retention, pollination and biological control. Agricultural extension services can help create awareness and access to alternatives.

Supporting long-term investments: The deterioration of ecosystem services becomes visible only after a certain time lag. Equally the benefits from investing in improvements such as agro-forestry or contour trenches to combat erosion are slow to be seen. Therefore, even though the benefits often outweigh the costs, poor farmers are usually unable to make significant investments upfront so that credit schemes or subsidies on investments can be decisive.

Creating incentives for maintaining ecosystem services across scales: This is particularly important where benefits are mostly public or accrue to others. Examples include water supply, which may be dependent on a watershed system hundreds of miles away; carbon sequestration, which is not only locally significant but serves to regulate the global climate, and maintaining habitat for species that are valued globally. Where public benefits are local, as for local climate regulation, recreation and health, there is a rationale for local governments to invest in providing these services. Where the benefits occur elsewhere, local policy makers have a role to play as intermediaries by

Box 5.4 Sustainable agricultural methods and technology raises yields and improves ecosystem services

A study of 286 interventions in 57 developing countries assessed the impact of various sustainability-enhancing agricultural practices: integrated pest management; integrated nutrient management; use of conservation tillage; agroforestry; aquaculture; water harvesting and integration of livestock in farming systems. A net crop productivity increase of 79% and an improvement in critical environmental services was found over the 12.6 million farms that were studied.

Projects dealing with adequate use of pesticides reported a 71% decline in their use, while increasing yields by 42%. The overall water use efficiency increased considerably by enhancing soil fertility and reducing evaporation, using low-tillage techniques, improved varieties and inducing microclimatic changes to reduce crop water requirements. Annual gains of 0.35t C per hectare in carbon sequestration potential offered new opportunities for households to generate income from carbon trading schemes. Within a period of four years, there was a dramatic increase in the number of farms (56%) and area (45%) that adopted sustainable technologies and methods, with poor households benefiting substantially.

Source: Pretty et al. (2006)

supporting farmers in negotiations with distant beneficiaries. Integrating payment for ecosystem service schemes across levels are an instrument to do this (see Chapter 8 for examples).

Enhancing coordination: Improving ecosystem services often requires collective action. For example, habitat conservation for biodiversity in intensely used landscapes requires careful coordination between land users. Farmers can support biodiversity conservation by limiting agricultural land use or providing wildlife corridors. Europe has implemented payment schemes based on keeping land in 'good agricultural and environmental condition' (EEA 2006). Similar schemes exist in Canada (Robinson 2006), USA (Lenihan and Brasier 2010), New Zealand (Rosin 2008) and Japan (Hiroki 2005). State and district authorities can define local desirable practices in agri-environmental schemes.

5.2 FISHERIES AND WETLANDS

Marine and freshwater wetlands supply many values (Box 5.5) including fish, but attitudes to wetlands remain ambiguous and management is patchy. Some fisheries are relatively well managed and management techniques are understood; here the challenge is to extend techniques to other areas. Wetlands, however, particularly freshwaters and estuarine habitats, are still quite neglected and there is a major challenge in changing perceptions and practices.

According to the Food and Agricultural Organisation, 250 million people in developing countries are dependent on small-scale fisheries for food and income (Béné et al. 2007). In 2004 the annual value of global marine catch was US$ 85 billion. However, **due to overfishing 75 percent of fish stocks were underperforming**. This is causing an annual loss of US$ 50 billion compared to the catch that would be possible if fish stocks were managed sustainably and not overfished (World Bank and FAO 2009). There are similar findings at the national level (Box 5.6).

Fisheries are declining globally (Pauly et al. 2005) due to damaging fishing practices and climate change will make this situation even worse. Coastal and nearshore fisheries are further impacted by agricultural run-off, deforestation, coastal tourism and destruction of mangroves and salt marshes. Many coastal communities are at risk because large-scale fishing operations have over-fished their traditional stocks, creating a social problem alongside the ecological losses. Aquaculture operations, while promoted as being more sustainable, often rely on wild caught fish for feed (Naylor et al. 2000). In some countries aquaculture has replaced mangroves where wild fish spawn, thus further reducing populations. The Millennium Ecosystem Assessment highlights the problem, **"The use of two ecosystem services – capture fisheries and freshwater – is now well beyond levels that can be sustained even at current demands"** (MA 2005:6). While the problems usually require national or even international regulation and management, local and regional policy makers can often influence coastal and inland fisheries as well as local aquaculture.

There is now ample evidence that **protected areas can rapidly rebuild fish numbers** and act as reservoirs for replenishing stocks beyond their borders. Thus local ecosystem management can quickly repay investment, particularly through the use of both temporary and permanent no-fishing areas (Box 5.7).

A review of 112 studies in 80 marine protected areas (MPAs) found that fish population densities were on average 91% higher, biomass 192% higher and organism size and diversity 20–30% higher than in surrounding waters, usually after just 1-3 years and even in small reserves (Halpern 2003). As fish increase in MPAs they 'spill-over' to surrounding waters, increasing catch; the net gain usually outweighs the lost fishing area (Pérez Ruzafa et al. 2008). Promoting and demonstrating the value of no-take zones can be a key role for local governments or NGOs interested in stabilising both marine environment and food supplies.

Box 5.5 Wetlands supply multiple values to society

Wetlands are under-valued, misunderstood and often viewed as unproductive waste areas that spread disease and serve as rubbish dumps. But the Millennium Ecosystem Assessment estimated that wetlands provided services worth US$ 15 trillion worldwide (MA 2005a), including:

Food: protein from fish and animals; plants used as food and fertiliser; mangroves are also important as fish nurseries. Cambodia's inland fisheries alone are worth up to US$ 500 million/year with 60% coming from Tonle Sap Lake (ICEM 2003).

Water: for irrigation, industry and domestic use. Wetlands can be highly effective in reducing pollution (Jeng and Hong 2005); the East Kolkata wetlands clean at least a third of the sewage from Kolkata in India (Ramsar 2008, Raychaudhuri et al. 2008). Some water plants concentrate toxic materials in their tissues, thus purifying surrounding water. In Florida's cypress swamps, 98% nitrogen and 97% phosphorus from waste water entering wetlands were removed before the water entered groundwater reservoirs (Abtew et al. 1995).

Protection: by allowing space for floods and sea surges to dissipate their energy, including in river flood-plains and coastal marshes. Wetlands have been shown to be very cost-effective ways to provide storm protection services (see section on Disasters). Conversely, loss of protection from coastal marshes was estimated to have been a major contributory factor in the US$ 75 billion damage caused by Hurricane Katrina in the southern US (Stolton et al. 2008b).

Stabilisation: of climate change by storing and capturing carbon, particularly in peat, which although it only covers 3% of the world's land surface is estimated to be the largest carbon store, storing 550 gigatonnes of carbon worldwide (Parish et al. 2008; Sabine et al. 2004). In 2008, however, emissions from degraded peat were estimated at 1,298 Mt, with over 400 Mt from peat fires, increasing the need for sound management (Joosten 2009).

Cultural values and recreation: for many people, particular wetlands also have important cultural values as places with high aesthetic quality, for sports and recreation, and also as sacred sites. These values often have direct economic benefits. Economic valuation by the World Resources Institute estimated the value of reef-related tourism and fisheries from just one area, Glover's Reef Marine Reserve, contributed around US$ 4.9-7.3 million a year to the national economy of Belize (Cooper et al. 2009).

Box 5.6 Underperforming fish stocks in Argentina

In Argentina continued overfishing of the Argentinean Hake (Merluccius Hubbsi) is threatening the long term ecologic and economic viability of the fish stock mainly because total allowable catch is ignored and exceeded by up to 90%. At the same time discards increase due to the increased catch of juvenile fish representing an annual loss of US$ 11-77 million. Ecological models project that if existing quota were met, the already created no-fishing zones in the nursery grounds around the Isla Escondida were respected, and the current 120% overcapacity of fishing vessels were reduced by 25-50%, the stock of hake would recover leading to significant economic gains: compared to a continued →*overexploitation* the compliance with the existing policies for the protection of the fish stocks would increase the Net Present Value (NPV) from US$ 65.7 million to 118.5 million for the fresh fish fleet, and from US$ 263 to more than US$ 460 million for the freezer fleet, over the period 2010 to 2030 (Villasante et al. 2009).

Source: Better fishery management could significantly increase catch, Argentina. TEEBcase based on Villasante et al. (see TEEBweb.org).

Box 5.7 The benefits of protecting critical habitat in Bangladesh

The wetland of Hail Haor, in north-east Bangladesh, provides fish and aquatic plants that are essential sources of food and income for local communities. Severe over-exploitation put the annual benefits of US$ 8 million at risk. This motivated local and regional efforts to improve wetland management and install protection zones. Protecting just 100 ha of wetland, by restoring some critical habitats and establishing closed seasons for fishing, contributed to increased fish catches across the 13,000 ha of the entire Hail Hoar wetland by over 80% and local fish consumption by 45%.

Source: Wetland protection and restoration increases yields, Bangladesh. TEEBcase by Paul Thompson (see TEEBweb.org)

OPTIONS FOR LOCAL ACTION

Local responses to declining fish populations can include, for instance, pollution control, restoration of coastal habitats such as salt-marshes and mangroves, anti-poaching patrols and changes to fishing practices in addition to protection. Many national and local governments have regulated fishing, with varying success. **Co-management regimes**, where local fishing communities manage fishing practices jointly with the government, as well as management by local fishing communities themselves, have also proved successful in managing fish stocks. Research in Lao PDR found that co-management can be particularly successful for protecting fish (Baird 2000). Policy makers can help local fishing communities to learn from such cases. **Successful management practices** include: changes in mesh size (to reduce by-catch of young fish); better sorting; bans or restriction on bottom trawling; and protection of fish breeding sites. These can all help maintain a rich and stable marine environment, thus securing the livelihoods of subsistence or commercial fishing communities. In some parts of the world such practices have been known for centuries; in places where these ideas are still new, their introduction often takes careful negotiation, trials and →*trade-offs*, which usually need to be undertaken at a very local scale.

Water resources are under pressure in many parts of the world and are proportionately far less protected than terrestrial ecosystems (Abell et al. 2007). Decisions about wetlands are usually made on a local scale and need to be based on wide ranging assessments that **take all values into account**. Recognising the multiple values of wetlands is critical to their maintenance and sustainable management.

Box 5.8 Collaborative management of wetlands in Kenya

The Kipsaina Crane and Wetlands Conservation Group formed in 1990 as a partnership of local communities to conserve and restore the Saiwa Swamp National Park in Kenya. As a result of the group's efforts, neighboring communities have a reliable and clean water source all year round, and community members are now engaged in new types of business such as beekeeping, eco-tourism, and agro-forestry. There has also been a fivefold increase in the grey crowned crane population as well as increased income from fish and produce sales.

Source: Equator Initiative Prize 2006 (www.equatorinitiative.org)

5.3 FORESTS AND WATERSHED MANAGEMENT

Throughout history, forests have been a source of subsistence, not only for hunters and gatherers, but also as part of farming systems, providing construction timber, cooking fuel, animal fodder, wild game, medicinal herbs and other products for subsistence and market (Box 5.9). Furthermore, forests not only prevent soil erosion but also contribute to the formation of topsoil, which serves as an important sink for carbon (more details below).

Box 5.9 Wild products and wild animals from natural and semi-natural ecosystems

Wild products are often dismissed as being of minor importance but they remain a critical resource for many poor people, who have no safety net if these resources become unavailable. All countries have significant wild forest products markets and recent immigrants are also revitalising collection in some countries. It is important to **check if, and for whom wild products are important and how their availability is altered by policy decisions and lack of good governance**.

Foods: particularly wild fruits, nuts, and fodder for livestock. FAO estimates that 18,000-25,000 tropical wild plant species are used as food (Heywood 1999), supplying hundreds of millions of people. Collecting wild food also provides income; international trade in wildlife products like medicinal plants, live animals and animal products including game meat and fur (excluding fisheries and timber trade) have been estimated at US$ 15 billion a year (Roe et al. 2002).

Bushmeat is a source of protein and makes up more than a fifth of animal protein in rural diets in over 60 countries (Bennett and Robinson 2000). It is an important food and income source for 150 million people with a global value of US$ 7 billion (Elliott et al. 2002). However, over-collection is now creating a conservation crisis in many countries (Redmond et al. 2006). Managing wildlife allowing a sustainable off take, often combined with tourism, offers important income potential; options include game conservancies (Jones et al. 2005), private farms or hunting reserves. The most famous example is Campfire, where local communities obtain significant income from fees for trophy hunting (Frost and Bond, 2008).

Benefits from wildlife need to be balanced against costs; **human wildlife conflict** is a growing problem in many countries as rising human populations are forced into close proximity with wild animals. Wildlife managers need to design and implement increasingly sophisticated methods for conflict management through compensation payments for crops and livestock damage. An innovative idea is currently being considered in Sri Lanka (TEEBcase Human-elephant conflict mitigation through insurance scheme, Sri Lanka) and Pakistan (TEEBcase Insurance scheme to protect Snow Leopards, Pakistan).

Medicines: Medicines from wild plants play a key role in many pharmaceuticals (ten Kate and Laird 1999) and in traditional herbal medicines, which are still the primary medicines for 80% of the world's people (*WHO* 2002). Global sales of pharmaceuticals based on materials of natural origin are worth US$ 75 billion a year (Kaimowitz 2005). Collection of wild medicines can be an important income source for rural women (Steele et al. 2006).

Materials: Non-timber forest products (NTFPs) such as rubber, latex, rattan, and plant oils remain important for subsistence and trade. Annual trade in NTFPs globally is estimated at US$ 11 billion (Roe et al. 2002). A meta-study of 54 cases of income generation amongst people living near or in forests found that forests provided important resources at every income level and on every continent, providing an average of 22% of total income (Vedeld et al. 2004).

Fuel: More than a third of the world's population (2.4 billion people) relies on wood or other plant-based fuels for cooking and heating (IEA 2002).

At present, forests occupy 31% of the world's land area, of which one-third are primary and relatively undisturbed forests. Forest cover is being rapidly lost; 13 million hectares of forests (equal to the size of Greece) are being cut down each year to make way for agriculture and human settlements (FAO 2010). Deforestation is a major cause of land degradation and destabilization of natural ecosystems and contributes significantly to climate change.

One response to this pressure has been to increase the area of protected forests. Currently, 13.5% of the world's forests are in protected areas (IUCN categories I-VI) (Schmitt et al. 2009). In the last decade, efforts have also been made to increase reforestation through plantations as well as landscape restoration. Notwithstanding these efforts, the net loss was still 5.2 million hectares per year (an area the size of Costa Rica) between 2000 and 2010 (FAO 2010). Furthermore, the ecosystem services provided by plantations are not equivalent to primary forests. There are important benefits for local policy makers in reducing the loss of primary forests and ensuring good management of secondary forests and plantations. Since the benefits are not only local but also accrue globally, this opens possibilities for gaining technical and financial support for these activities at national or international level (Box 5.10). Carbon sequestration and watershed protection are two highly relevant ecosystem services of global significance provided by forests.

CARBON SEQUESTRATION

Industrial societies have recently started to recognize the **critical role of forests in regulating the global carbon cycle** and thus the earth's climate. Carbon dioxide is one of the gases that, in excess, can lead to higher global temperatures due to the greenhouse effect and the potential to 'capture' carbon dioxide in vegetation is one important component of a strategy to address the problems of climate change. Most well-functioning natural ecosystems sequester carbon: forests and also peatlands; grass; seagrass beds; kelp; mangroves; marine algae; coastal marshes and soil are all important. The threat of losing these critical climate change mitigation functions through land conversion leads to the risk that many ecosystems could soon switch from being net sinks of carbon, to net sources if they continue to degrade. Most predictions of rapidly accelerating climate change are based on this scenario.

Box 5.10 Reduced Emissions from Deforestation and Forest Degradation – REDD and REDD-Plus

Keeping carbon stored in ecosystems is increasingly a major business opportunity. Voluntary carbon offset schemes are already operating and plans for official REDD (Reduced Emissions from Deforestation and Forest Degradation) schemes are advancing. REDD-Plus goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. Countries receive 'carbon credits' for maintaining carbon stored in ecosystems and for improving this storage (for example through vegetation restoration activities). REDD and REDD-Plus schemes are being explored in managed forests and in protected areas.

There are still many practical problems to be solved; for example, how to reduce 'leakage' – conservation in one place leading to people simply clearing more forest elsewhere; how to avoid perverse incentives by rewarding countries with a high deforestation risk; and even how to measure accurately carbon stored or sequestered (see TEEB in National Policy 2011, Chapters 3 and 5; TEEB Climate Issues Update 2009)

Locally, this could be a direct source of raising revenue and will become an argument for particular management choices regarding land within local planning decisions. Local governments will have a role ensuring that local communities are represented in discussions about REDD and carbon offsets, to avoid all decisions being made by powerful players at national level. The political and economic contexts and the debates arising will change over time – currently there are opposing views amongst NGOs concerning social rights versus the economic benefits arising (Dudley et al. 2009).

Box 5.11 Water funds

Water users have an incentive to find the lowest cost option for maintaining access to a clean, regular water supply. In the Andean region, natural ecosystems provide these ecosystem services at low cost, so investing in nature conservation makes economic sense. Downstream users participate in 'Water Funds' to compensate upstream land users for managing forests and grasslands that provide clean water. They are long-term trust funds that involve a public-private partnership of water users who determine how to invest in priority areas. The tool InVEST (Chapter 6 Box 6.7) was used in the East Cauca Valley Water Fund in Colombia to help direct the fund's conservation investments towards areas with the highest potential for reducing sedimentation and maintaining water yield.

Source: Water Funds for conservation of ecosystem services in watersheds, Colombia. TEEBcase by Rebecca Goldman et al.(see TEEBweb.org)

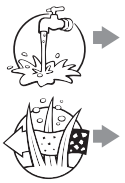
Scientists have estimated that the world's forest ecosystems presently stock between 335 – 365 gigatons of carbon (MA 2005b), and an additional 787 billion tons in the top one metre layer of soils (IPCC 2001). Deforestation and forest fires not only release this carbon into the atmosphere, but also reduce the earth's capacity to sequester carbon emissions from industrial activity. Forests and peatlands have the ability to offset part of the carbon balance in the atmosphere and help mitigate climate change, thus giving fresh impetus to their conservation. (See TEEBcase Peatland restoration for carbon sequestration, Germany)

Natural forests are known to keep accumulating carbon at a higher rate than we had previously understood (Baker et al. 2004; Luyssaert et al. 2008; TEEB 2009; Lewis et al. 2009). Although planted forests can also sequester carbon, sometimes very quickly, their establishment can also result in a huge release of carbon from the soil. From a carbon perspective, draining peat to plant fuel crops makes no sense. It has been calculated that it would take 420 years of biofuel production to replace the carbon lost in establishment (Fargione et al. 2008).

Conserving forests and increasing their area is becoming a priority not only for governments but is now recognized as a business opportunity in terms of carbon credits (Box 5.10; Chapter 8; TEEB in Business 2011 Chapter 5). **Payments for carbon sequestration**, when embedded in careful overall management strategies, **can help increase market income from forests** while allowing them continually to provide the other services local development relies upon. Many local authorities are currently looking at options for using the carbon sequestration role of forests in their region to enhance forest value and benefit local communities.

WATERSHED MANAGEMENT

Many countries are already facing severe water shortages and these are likely to get more serious; by 2025 around three billion people could be experiencing water stress (Human Development Report 2006). Hydrologists are turning to natural ecosystems for key water services. **Well-managed natural forests almost always provide higher quality water**, with less sediment and pollutants than water from other catchments. Other natural habitats, including wetlands and grassland, also play a key role in reducing pollution levels. These values are recognized and used by many local governments. Research has shown that around a third (33 out of 105) of the world's largest cities by population obtain a significant proportion of their drinking water directly from protected areas or from forests that are managed in a way that gives priority to maintaining their hydrological system functions (Dudley and Stolton 2003).



About 80% of Quito's 1.5 million population receive drinking water from two protected areas; Antisana (120,000 ha) and Cayambe-Coca Ecological Reserve (403,103 ha). To ensure that the reserves remain in good enough condition to secure high quality water, the city authority is working with NGOs to protect the watersheds. Following initial investments from The Nature Conservancy, a trust fund was set up in 2000 in which water users helped to support conservation

Box 5.12 Forest Conservation for Environment and Health in Nepal

The government has transferred the management of the Khata Corridor to local communities after together developing strategies for sustainable forest management. Groups of forest users charge membership fees, sell non-timber forest products and levy fines. The income has been used to purchase biogas systems for the production of gas from manure. By using gas for cooking, less fuel wood is needed. This has reduced forest degradation and reduced exposure by women and children to indoor smoke pollution and the consequent acute respiratory infections. The new fuel also saves women time and effort, allowing them to increase their income from trading non-timber forest products.

Source: Community forestry for public health, Nepal. TEEBcase based on D'Agnes et al. (see TEEBweb.org)

projects in the watershed; revenue is now in excess of US$ 1 million a year. (TEEBcase Water Fund for catchment management, Ecuador).

Some natural forests, particularly tropical montane cloud forests (forests often surrounded by mist), play an economically and socially important role in **increasing total water supply**, by 'scavenging' droplets from humid air onto leaves, which then run down into the watershed (Hamilton et al. 1995). Water gains from cloud forest can be 15-100% or more than from ordinary rainfall. This function is lost if forests are cleared. Local authorities in a number of cloud forest countries, particularly in Central America, have collaborated with landowners to maintain forest cover and thus water flow, for example, around Tegucigalpa in Honduras. Cloud forests, and some other vegetation types such as the paramos of the Andes, also release their water relatively slowly, thus providing an important storage function.

OPTIONS FOR LOCAL POLICY

In addition to the policy options discussed in the agricultural section to inform or provide incentives to private forest owners, many **municipalities own forests** themselves. This offers the possibility to assess the entire range of ecosystem services and adapt management practices to take all relevant services into account. Local authorities can help with negotiation of **Payment for Ecosystem Services schemes** or can even be direct contributors to such schemes, for example, in the case of paying forest owners to maintain high quality water supplies. A further interesting option is the support of **community forestry**. While not always a success, in many regions of the world this management option has enabled secure benefits for local communities while at the same time conserving forests and biodiversity. An analysis of several studies reporting on the social and economic effects of community forestry (McDermott and Schreckenberg 2009) found that access to decision making by poor and marginalised people generally enabled them to gain a bigger share of the benefits. Box 5.12 shows an example where integrated forest management was used to support community health care. Further policy options are discussed in the final section of the chapter.

5.4 MANAGING ECOSYSTEMS FOR TOURISM

Ecosystems not only provide us with a wide range of practical services, but **also contribute to many cultural aspects of our lives**. For most rural and traditional societies, the natural environment often serves a spiritual function. In some societies this is manifested in the creation of sacred groves and in elaborate rites to appease nature, either to protect the community from calamities or to ensure abundance; in others it takes a less formalized recognition of the cultural importance of particular landscapes. For urban dwellers, nature offers a temporary escape from the mayhem of day to day city life. Landscapes are increasingly seen as spaces where nature and culture meet (Svensson 2000) and many believe that humans

need to connect with nature in order to function and flourish (Smith 2010). One consequence of this is a growing desire by people to travel and experience new landscapes and seascapes.

A RAPIDLY GROWING SECTOR

The tourism sector is one of the major employers in the world supporting over 200 million workers (Backes et al. 2002). The rate of growth is enormous. In 2008, 922 million international tourists were recorded compared with 534 million in 1995 (UNWTO 2009; Kester 2010). Remarkably 40% of these journeys were directed towards a developing country (Mitchell and Ashley 2010). In many countries, such as Australia, Belize, Brazil, Costa Rica, Kenya, Madagascar, Mexico, South Africa and Tanzania, biodiversity represents the primary tourism attraction (Christ et al. 2003). According to the UN World Tourism Organization, the earnings from tourism in 2008 touched a record US$ 944 billion (provisional data, UNWTO 2009). Of the total in 2007, US$ 295 billion were spent in developing countries, almost three times the official development assistance (Mitchell and Ashley 2010).

Thus, tourism is the primary source of foreign exchange earnings for the vast majority of Least Developed Countries (UNWTO 2010). In Tanzania in 2007, for example, tourism contributed US$ 1.6 billion (11% of the total economy). Tanzania also secured about half the total value of the global value chain (the total amount tourists spend on a particular holiday) for Mount Kilimanjaro and Northern Safari Circuit, of which 28% (US$ 13 million) and 18% (US$ 100 million) respectively went to the local poor (Mitchell and Faal 2008). Many countries currently under-charge; a survey of willingness to pay amongst visitors to Uganda suggested that revenue at Mabira Forest Reserve could be maximised with a fee of US$ 47 (2001 prices) whereas the charge then was just US$ 5 (Naidoo and Adamowicz 2005). A survey of 18 studies of willingness to pay in marine protected areas found overwhelming support for higher entrance fees amongst tourists (Peters and Hawkins 2009).

Tourists are also visiting new places. In 1950, the top 15 destinations absorbed 98% of all international tourist arrivals; in 1970 the proportion was 75%, falling to 57% in 2007, reflecting the emergence of new destinations, many in developing countries (WTO 2010). At the same time, countries are developing domestic tourism, which may be more stable; in South Korea, 99% of visits to national parks is domestic (KNPS 2009). In Austria, about 40% of all tourism is domestic, with a large number of visitors spending their holidays in the countryside. Farmhouse and rural tourism is highly organized with farmers offering accommodation, food and recreation (Statistics Austria 2010).

AN OPPORTUNITY AND A CHALLENGE FOR LOCAL DEVELOPMENT

Such numbers should not disguise the fact that **tourism comes at a price**. In many tourist destinations, the largest share of tourism-related income goes to non-local service providers whereas the costs are mostly borne locally. Some of the impacts include: rising consumption of water; rising prices for local goods, services and property; increased waste and pollution and rapid changes in local public life. Local policy challenges are to **channel tourism development** in such a way **that a fair share of income is retained locally**, and that **locals remain 'sovereign' owners of their home place**. This takes careful government planning and marketing, as well as local regulation and capacity building. One important tool to help this process is the development of various national and international →*certification* systems to set basic →*standards* for sustainable tourism, such as the European Charter for Sustainable Tourism in Protected Areas, coordinated by the EUROPARC Federation and the Pan Parks certification system (www.europeancharter.org).

Local and national tourism can add value to natural resources, directly through fees paid to park authorities, private companies or in some cases to local communities, and through associated benefits and economic opportunities from having more tourists in the region. In Maldives, which harbours rich biodiversity, the contribution of tourism has been estimated at 67% of GDP, while that of the fishery sector is 8.5% of GDP (TEEBcase Tourism more valuable than fishing, Maldives). But important economic benefits from →*ecotourism* are not confined to poorer countries; it is

Box 5.13 Features of tourism to deliver pro-poor local growth

- Labor-intensive (although less so than agriculture);
- Links well with local industry, especially agriculture and fisheries;
- Provides opportunities for off-farm diversification, particularly in areas that offer few other development opportunities;
- Can create initial demand that can itself develop into a growth sector;
- Can generate demand for natural resources and culture, to which the poor often have access;
- Delivers consumers to the product rather than the other way around;
- Provides essential services for local communities through tourism infrastructure

Source: adapted from Mitchell and Faal 2008

calculated that nesting ospreys (Pandion haliaetus) in Scotland bring an addition US$ 7 million per year into the area as a result of nature tourism (Dickie et al. 2006).

Tourism management often involves some degree of ecosystem management to ensure the provision of the tourism services (recreation, adventure, etc.). This requires maintenance of landscapes and conserving habitats for local and regional biodiversity. Flagship species such as elephants, rhinoceros and tigers may require special attention to attract tourists interested in wildlife safaris. Development of tourism very much depends on the availability of other resources such as water, but also a local population that is receptive and hospitable to visitors. Equitable benefit sharing from tourism supports a culture of tourism, and not only reduces conflicts but provides incentives for people to take care of their natural and cultural heritage. Increased revenues can be generated by local governments in supporting local tourist-related businesses such as accommodation, guiding, adventure, or the sale of local handicrafts or consumer products. The revenue can serve as an incentive to protect and conserve biodiversity and the local ecosystem. Returns from tourism can be quite high. The gross earnings for a small island of Samothraki in Greece, with a population of less than 3,000, is about €19 million annually, most of it attracted by its pristine landscape (Fischer-Kowalski et al. forthcoming).

Box 5.14 Community-based initiatives for tourism

Federation for Ecuadorian Community Tourism (FEPTCE), Ecuador

This partnership of sixty community-based initiatives comprising indigenous peoples, afro-Ecuadorians, and farmers, focuses on encouraging eco-friendly tourism. Since its establishment in 2002, participating communities have experienced improved access to health services and education, and increased employment. It has also generated public interest in biodiversity and agriculture. Reforestation and the protection of native flora and fauna, has improved the environment and biodiversity of 25,000 hectares which has been used to promote the region's tourism. Conserving biodiversity has permitted the FEPTCE communities to diversify their economy, leading to added income and an improved standard of living (www.feptce.org).

Community Tours Sian Ka'an (CTSK), Mexico

Tourism alliance of three Mayan cooperatives in the UNESCO Sian Ka'an Biosphere Reserve (www.siankaantours.org). By regulating the influx of tourists and providing high quality services, they have been able to raise their tour prices by 40% leading to increased community income with the least amount of environmental impact. CTSK's cooperation with Expedia.com lead to an increase rate of tourists of more than 100 percent in 2006/2007. 5% of CTSK's annual income is dedicated to conserve the local ecosystem (Raufflet et al. 2008).

Source: Equator Initiative Prize 2006 (www.equatorinitiative.org)

The NGO Network for Sustainable Tourism Development lists **ten principles and challenges for a sustainable tourism development** in the 21st Century: tourism must help overcome poverty; use sustainable modes of transport; combine with regional development; protect nature and biodiversity; use water sustainably; maintain human dignity and gender →*equity*; ensure local people participate in decision-making processes; promote sustainable consumption and lifestyles; promote sustainable tourism and fair trade in developing countries and show political commitment (Backes et al. 2002).

LOCAL POLICY PLAYS AN IMPORTANT ROLE

Tourism development is a typical case where it is worthwhile to adopt an integrated planning approach based on a careful assessment of the benefits of ecosystems as well as the probable impacts of tourism operations on ecosystems as outlined in Chapter 2. How tourism develops depends on different departments of policy, planning and management as do the implications for local people and local ecosystems:

- **Which type of tourists to attract?** The 'holistic' who follow the classical traveller's tradition of seeking the sublime in an idyllic landscape; the 'fragmented' who are driven by a distinct interest such as in birds, butterflies, or fishing; those that cherish 'a gentle engagement with nature' through activities such as bicycling, canoeing, walking or picking berries; the 'adventurer' with a determination to confront and conquer the perils of nature through activities such as mountain climbing, big game hunting, or rafting and finally the 'eco-tourists' that derive their satisfaction from living green and healthy while benefiting nature and those engaged with it;
- Planning: **what infrastructure to provide** and where? Building and maintaining access roads or nature trails, how to avoid selling off the entire waterfront to hotels and holiday houses;
- **Service provisioning:** water and waste, information? This also affects what rates are charged for municipal services such as water and waste, which in many locations do not cover full costs of these services.

Being aware of the implications for ecosystem services can help to answer these questions so that local population does not lose out. Certification and →*labelling* can help to communicate this to tourism operators as well as tourists (see Chapter 9).

Box 5.15 Tourism instead of logging in Rennell Island, South Pacific

In 1998, permission was granted to a foreign logging company to extract timber from the small island of Rennell, part of the Solomon Islands. Logging has been very destructive on other Melanesian islands, where clear-logging has destroyed unique environments as well as the livelihoods of local populations.

Rennell was a very special case, being one of only 25 raised atoll islands in the Island Pacific, all comprised of porous coral rock. Soils are very shallow, and very vulnerable to being washed into the sea and lake by heavy rain after logging. Rennell also has a very high endemicity index; numerous plants, at least 60 species of insects, 11 species of birds, and snake, land snails and flying fox all endemic to the island. The loss of the Rennell forest would have been a catastrophe for the local Rennellese as well as for science.

Despite time constraints, the people of Rennell with my support developed a proposal for nature tourism to present to parliament. It was calculated that a small guesthouse facility with 20 rooms and an occupancy rate of 60% over 12 years would give a return equal to what the Rennellese had been offered by the loggers. The proposal was accepted and the logging license revoked. Today the forest on Rennell is thriving and there has been no loss of endemic species. There are now 10 small guesthouses on the island, and Rennell has been named a world heritage site by UNESCO – the first in Melanesia.

Source: by Nils Finn Munch-Petersen (Tourism expert and consultant)

5.5 ECOSYSTEM RESILIENCE AND DISASTER MITIGATION

Natural ecosystems can absorb or deflect natural hazards. Today, ecosystem management is seen as a vital component for disaster risk reduction. The Millennium Ecosystem Assessment estimates that 60% of global ecosystem services are degraded, contributing to a significant rise in the number of floods and major wild fires on all continents (MA 2005). The latest report from the Intergovernmental Panel on Climate Change states 'Increased precipitation intensity and variability are projected to increase the risks of flooding and drought in many areas' (Bates et al. 2008:3). If ecosystems are degraded and the effectiveness of ecosystem services reduced, natural hazards are more likely to lead to disasters particularly affecting poor communities which lack the money, effective emergency services and other safeguards to recover from them.

Studies have shown that every dollar invested in risk reduction can save between two and ten dollars in disaster response and recovery cost (IFRC 2007). This approach to disaster risk reduction is now receiving greater attention. The International Strategy for Disaster Reduction notes that protection of vital ecosystem services is fundamental to reducing →*vulnerability* to disasters and strengthening community →*resilience* (Stolton et al. 2008b) and includes ecosystem approaches within its comprehensive guide to risk reduction (ISDR 2005).

FLOODS

Floods cost approximately US$ 1 trillion in damage during the 1990s, notwithstanding the 100,000 lives lost (Laurance 2007). Analysis of flood data from 56 developing countries found a significant link between forest loss and flood risk, 'Unabated loss of forests may increase or exacerbate the number of flood-related disasters, negatively impact millions of poor people and inflict trillions of dollars in damage in disadvantaged economies over the coming decades' (Bradshaw et al. 2007). The UN Task Force on Flood Prevention and Detection has stated, 'Natural wetlands, forested marshlands and retention areas in the river basin should be conserved, and where possible restored or expanded' (Anon 2000).

Protecting and restoring natural water flows and vegetation can be a **cost-effective method of addressing flood-related problems**. This may involve setting aside flood-prone areas as temporary pasture or protected areas, restoring traditional flooding patterns and removing dykes and barriers to provide space for flood waters to escape, reducing downstream impacts. Forest protection or restoration strategies also help to mitigate floods with positive results. Many countries are cooperating in restoring natural ecosystem functioning for flood control and pollution reduction (Nijland 2005).

The city of Vientiane (Lao PDR), for example, has frequent heavy rainfall which results in overflowing drains and urban flooding. Flooding occurs at least 6 times annually, damaging buildings and infrastructure. Several wetlands, however, absorb a proportion of the floodwater, dramatically reducing damages. The value of the ecosystem services of the wetlands has been measured (using annual value of flood damages avoided), calculating the value of the wetlands to be just under US$ 5 million (TEEBcase Wetlands reduce damages to infrastructure, Lao PDR).

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The city of Napa, California has successfully restored floodplains which provide cost-effective protection against floods. Such actions have the added benefit of creating considerable investment opportunities and increased property values (TEEBcase River restoration to avoid flood damage, USA and Box 6.5). In Sri Lanka, two reserves in the Muthurajawella Marsh have a flood attenuation value (2003 values) estimated at US$ 5,033,800 per year.

LANDSLIDES

A European Commission review of landslides noted that 'The reforestation of hill slopes can help to reduce the occurrence of shallow but still dangerous landslides (mainly mud flows and debris flows)' and 'excessive deforestation has often resulted in a landslide' (Hervas 2003). The retention of vegetation on steep slopes to control landslides, avalanches and rock falls has been used as a practical management response for hundreds of years (Rice 1977). In China, policies in Sichuan are starting to shift from planting fruit trees on steep slopes to planting natural forests because natural vegetation tends to be denser and therefore more effective in landslide prevention (Stolton et al. 2008b).

In the Swiss Alps, policy recognizes that healthy forests are a major component of disaster prevention: 17% of Swiss forests are managed to protect against avalanches and floods. These services are valued at US$ 2-3.5 billion per year (ISDR 2004). Similar to flood strategies, decisions about which slopes to protect are determined at a local level.

TIDAL SURGES AND STORMS

Blocking the movement of water with coral reefs, barrier islands, mangroves, dunes and marshes can help mitigate the impacts of storm surges and coastal erosion. A study in Sri Lanka following the Indian Ocean Tsunami found that although the tidal wave was six metres high when it reached shore and penetrated up to 1 km inland, mixed landscapes of mangrove, coconut plantation, scrub forest and home gardens, absorbed and dissipated much of the energy (Caldecott and Wickremasinghe 2005).

Investment in natural buffers saves money. An investment of US$ 1.1 million in Vietnam (planting mangrove forests) saves an estimated US$ 7.3 million annually in dyke maintenance. During typhoon restored areas experienced far less harm than neighboring provinces, which suffered significant loss of life and property (TEEBcase Mangrove rehabilitation for coastal protection, Vietnam). Conversely, reef damage in Sri Lanka has led to erosion estimated to be 40 cm a year on south and west coasts. The cost of replacing reefs with artificial forms of protection has been calculated at US$ 246,000-836,000/km (UNEP-WCMC 2006).

Photograph courtesy of the U.S. Geological Survey

Local community involvement can play a key role in developing response strategies. In Honduras, the Ibans Lagoon in the Río Plátano Biosphere Reserve, home to three indigenous groups is threatened by the erosion of a narrow coastal strip between lake and ocean. In 2002, MOPAWI, an NGO, began collaborating with communities to identify strategies for addressing these problems. They developed a community action plan for ecosystem management and protection prioritising the restoration of mangrove and other species to reduce erosion and improve fish habitats (Simms et al. 2004).

FIRE

Due to warmer climates and human activity, fire incidence is increasing around the world. Ecosystem-scale responses include limiting encroachment into fire-prone areas, maintaining traditional management systems to help control fire and protecting intact natural systems that are better able to withstand fire. In Indonesia, selectively logged forests suffer comparatively more fire damage due to open canopies and logging debris that provides additional dry fuel. More mature protected forests tend to be much less vulnerable to fire, which tends to sweep rapidly through undergrowth (MacKinnon et al. 1997).

DROUGHT AND DESERTIFICATION

An extreme form of soil degradation is desertification, driven mainly by forest destruction, intensive agriculture, overgrazing and excessive ground water extraction. At present, desertification affects over 100 countries, mainly in Asia and Africa, with high population pressure and livestock units. Desertification leads to a drastic decline in an area's biological productive capacity and the economic and social cost is high. China experiences US$ 6.5 billion in damages each year from sandstorms alone (UNCCD 2001).

The combination of **natural vegetation restoration and maintenance**, reduced grazing and trampling pressure and maintenance of drought-resistant plants are seen as key steps in slowing or halting dryland degradation and desertification. Conserving wild food plants can provide critical emergency supplies for people and livestock if crops fail due to drought. Local responses to environmental problems in drylands can include re-introducing traditional management approaches, such as the hima reserves in the Arabian Peninsula (Bagader et al. 1994). The implementation of such approaches is spreading. In Mali, protected areas are seen as reservoirs of drought-resistant species (Berthe 1997). In Djibouti, regeneration and protection projects have been initiated to prevent desert formation (UNCCD 2006). Morocco is also establishing eight new national parks largely to control desertification (Stolton and Dudley 2010).

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EARTHQUAKES

Although ecosystem management clearly has no role in preventing earthquakes, it can help prevent the aftermath – landslides and other environmental hazards. Analysis of several thousand landslides triggered by the 2005 earthquake in Kashmir found that forested slopes suffered less slippage than bare, agricultural and shrub-covered slopes (Kamp et al. 2009). Similarly, analysis of landslides following an earthquake in the Neelum Valley (Pakistan) found landslide risk higher in deforested areas (Sudmeier-Rieux et al. 2008).

ROLE OF POLICY AND MANAGEMENT

Disasters hit at the local level and planning for and response to disasters is predominantly a role for local government. It requires steps that are unlikely to be taken solely by individuals because some wider decisions and trade-offs are often necessary. **Coordinated action** is required for adequate **land use planning** (see Chapter 6), choosing adequate strategies for disaster prevention and management and investment planning. In most localities, disaster prevention is in the domain of engineers who may not be familiar with the potentials of well managed ecosystems in disaster prevention and what management practices are required to achieve this. **Awareness raising and capacity building** are therefore essential if the potential of ecosystems to mitigate disasters is to be used. Options include: maintaining or restoring wetlands capable of

absorbing floods; restoration of flood plains on rivers; protection or restoration of forests on steep slopes (through legislation, purchase, incentives or agreement); protection; good management or if necessary, restoration of natural coastal defences including coastal marshes, coral reefs and mangroves; protective planting against soil erosion and desertification.

Reorganizing disaster prevention can create interesting opportunities to rearrange land management so that different sector needs can be addressed simultaneously. In the Napa Valley example mentioned above, the floodplains restored with appropriate trails and green areas led to revitalization of the inner city. A further case from Belgium (TEEBcase Changed agro-management to prevent floods, Belgium) illustrates this potential for a rural setting: restructuring land use for mudflow management not only reduced soil erosion, but also led to an increase of biodiversity and en-hancement of landscape quality. These new green corridors attracted cyclists and allowed an increase in the recreational potential through bicycle trails and accommodation.

5.6 OPTIONS FOR INTEGRATING ECOSYSTEM SERVICES

Ecosystems provide a range of services. Recognizing and capturing the value of nature's services presents positive opportunities for both local development and the enhancement of quality of life. Because they play a key role in people's lives and livelihoods, it is important to consider them in decision making. The key challenge is balancing the different services – enhancing some at the expense of others. Due to this challenge, assessment tools have been developed to aid decision makers who have to weigh the costs and benefits of many different services.

There are eight key areas for local engagement:

1. **Planning:** Land use and sectoral planning present opportunities to combine agriculture and forest management with other land uses, while maintaining important ecosystem services. Planning can also balance productive industry with maintaining a landscape attractive for tourism. For further details see Chapter 6.
2. **Management:** Where local governments are directly involved in land management they can identify ways to integrate the economic benefits of ecosystems services into management practices. By choosing integrated approaches to municipal forest management, groundwater management and the maintenance of local reserves and tourist destinations such as beaches and parks they can provide exemplary practices for private land users to follow.
3. **Regulation and protection:** Local governments play a critical role in interpreting and implementing regulations that encourage best practices and ecosystem protection. There are opportunities for leaders to encourage sustainable harvesting through regulations. There are many legislative opportunities for ecosystem protection such as harvest laws (timber, caps on fishing seasons, mesh size of nets); supporting efforts to ensure that ecosystem services are protected both for and from tourists (preventing illegal fishing with patrols) and approving innovative infrastructure (stables for animal husbandry). The police force and local courts may also play a role in making sure that laws relating to natural resources are implemented, monitored and enforced.
4. **Coordination and collective action:** Negotiation and coordination between different interest groups inevitably takes place at the local level. Certain areas require collective action. There are many examples of local communities effectively managing common resources such as grazing lands, fisheries or forests (see Library of the Commons dlc.dlib.indiana.edu/dlc). Local governments can support the formation of resource management committees where these do not yet exist; they can integrate formal and informal institutions to ensure effective participation and outcome. Coordination is also useful between different government departments or agencies, here a focus on ecosystem services can help to avoid contradictions in

Box 5.16 A tool to assess and integrate ecosystem services in land-use decision making

A quantitative ecosystem services assessment helped Kamehameha Schools (KS), the largest private landowner in Hawai`i, to design and implement a plan that fulfils its mission to balance environmental, economic, cultural, educational, and community values. With the Natural Capital Project, KS used the InVEST software (see Box 6.7) to evaluate the impacts on ecosystem services of alternative planning scenarios on its iconic 10,500 hectare landholding on the North Shore of O`ahu. The scenarios included biofuel feedstock, diversified agriculture and forestry, and residential development. Carbon storage and water quality were quantified, as well as financial return from the land. Cultural services were also addressed. The results informed KS' decision to rehabilitate irrigation infrastructure and make the other investments required to pursue diversified agriculture and forestry.

Source: Integrating ecosystem services into land-use planning in Hawai'i, USA. TEEBcase by Goldstein et al. (see TEEBweb.org).

sector planning. Furthermore, local actors can play a role as an intermediary between local farmers or forest owners willing to protect watersheds and distant beneficiaries of the enhanced water supply.

5. **Investment:** Local governments can invest in ecosystem services through purchasing policy. They can choose to buy local timber for government buildings or create an atmosphere that supports buying locally-produced food, eg through local labels for local products. Some local governments have invested in ecotourism ventures, thereby supporting an industry that boosts the economy without overexploiting natural resources. Restoring ecosystems and thereby recovering degraded ecosystem services can be a very good investment (TEEB in National Policy 2011, Chapter 9).
6. **Incentives:** Local governments can create positive incentives for improved ecosystem services management. There are opportunities for Payment for Ecosystem Services schemes at private, public and government levels (see Chapter 8). In some cases authorities, sector agencies, regional development banks and other programs have funds to help promote green business ventures or investments that aim to secure the long-term viability of ecosystem services. (see also TEEB in Business 2011).
7. **Extension services and capacity building:** Many environmental problems occur because people do not understand the full implications of their actions or the available alternatives. Farmers may not be aware of alternatives that allow for a more →*sustainable land use*, while at the same time being economic from their perspective. Once the benefits of an ecosystem have been identified, local leaders can share what they have learned, offering advice about disaster mitigation, best fishing practices, water conservation and opportunities for tourism.
8. **Research and promotion:** Local agencies often carry out research (alone or collaboratively with research institutions) in order to assess the role of local ecosystem services. Determining their value is a prerequisite for establishing what the best resource management practices are. Much of the monitoring that forms the basis of such research is coordinated at a local level. The success of monitoring and other measures often depends on collaborating with well-informed local →*stakeholders*. Once benefits are assessed this information can be used to promote local products or services; examples include local labels for agricultural produce or sustainable tourism.

The following table provides an overview of TEEB-cases available on teebweb.org that illustrate these areas of intervention in practical applications. The last column refers to further relevant chapters in this report and in TEEB in National Policy, also available on TEEB web.org.

Table 5.1: Options for integrating ecosystem services in selected sectors illustrated by TEEBcases.

Sector	Agriculture	Fisheries, wetlands	Forestry	Tourism	Disaster prevention	Further chapters
Planning	Agro-ecological zoning, Brazil	SEA for including ecosystem services in coastal management, Portugal Wetland restoration incorporates ecosystem service values, Aral Sea, Central Asia	Integrating ecosystem services into spatial planning in Sumatra, Indonesia.		Preventing desertification by establishment of PAs, Morocco (section 5.5)	6,7
Regulation	Salinity Credits Trading Scheme, Australia (Australian Government)	Temporary closures in octopus reserves increase catch, Madagascar	Conservation law benefits communities and biodiversity, Papua New Guinea Benefits of Forest Certification, Solomon Islands	Local tourism within ecological limits (Box 7.4)		TEEB in National Policy, Ch7
Management	Re-introducing traditional practices, Ecuador (Box 5.13) Organic Farming in private protected area, Russia Planting orange orchards to curb soil erosion, China (in prep.)	Guidelines for harvesting crocodile eggs, Papua New Guinea (Equator Initiative) Wetland protection and restoration increases yields, Bangladesh Collaborative management of wetlands increase ecosystem service benefits and biodiversity, Kenya (Equator Initiative)	Community forestry for public health, Nepal (Box 5.12) Discounts on entrance fees for excercising in national park, India (in prep.)	Community restricts tourist numbers, Mexico (Box 5.14)	Changed agromanagement to prevent floods, Belgium Multiple benefits of urban ecosystems: spatial planning in Miami City, USA Adjusted forestry practices (section 5.5)	
Negotiation coordination		Community-based lake restoration increases income from fisheries, Nepal	Industries share sales revenue for watershed protection, China (in prep.) Voluntary user contributions for watershed protection, Mexico (in prep.) Protecting biodiversity through inter-agency cooperation, South Africa (in prep.)	Community networks for eco-tourism, Ecuador (Box 5.14)	Reforestation for flood mitigation, Switzerland (section 5.5, ISDR 2004)	
Incentives	Reducing nutrient loads by providing debt guarantees, Colombia Agri-env schemes (section 5.1) Valuation of pollination spur support for bee keepers, Switzerland	Carbon finance for conservation of native prairie, USA Reverse auctions help farmers to reduce phosphorous content in local waterways, USA (in prep)	Farmers invest in reforestation and conservation, Kenya (in prep.) Insurance scheme to protect Snow Leopards, Pakistan PES scheme funded by collections made from salaries, China (in prep.) Subsidy for traditional rubber production, Brazil (in prep.)	Blue Flag certification for beach quality, South Africa		8, 9
Investment infrastructure, restoration	Enhancing agriculture by ecosystem management, India (Box 5.1) Water tank rehabilitation benefits rural development, Sri Lanka (Box 5.3)		Payments and technical support for reforestation and soil conservation for watershed protection, Brazil		River restoration to avoid flood damage, USA (Box 6.5) Managed realignment for coastal protection, UK (in prep.) Mangrove rehabilitation for coastal protection, Vietnam	TEEB in National Policy, Ch9
Extension, capacity building			Economic value of Toronto's Greenbelt, Canada Carbon offsets for sustainable land use, Mexico			
Research and promotion	Benefits of genetic diversity for rice farmers in the Philippines (Box 5.2)	Wetland valuation changes policy perspectives, Burkina Faso	Watershed services crucial for economic development, Mongolia Participatory valuation of forest in subsistence economy, Lao PDR	Tourism more valuable than fisheries, Maldives Tourism value of San Rock Art, South Africa	Wetlands reduce damages to infrastructure, Lao PDR	4, for monitoring

All examples refer to TEEBcases on TEEBweb.org unless otherwise stated.

FOR FURTHER INFORMATION

Agriculture
FAO (2007) The State of Food and Agriculture 2007: Paying farmers for environmental services. Using the example of Payments for Ecosystem Services (PES) this report presents the link between ecosystems and agriculture in an easily accessible format. ftp://ftp.fao.org/docrep/fao/010/a1200e/a1200e00.pdf

Jarvis et al. (2000). A training guide for In Situ conservation on-farm: Biodiversity International. This handbook offers an introduction in situ conservation and a 'how to'-guide on the implementation of efforts to conserve crop genetic diversity. www.bioversityinternational.org/fileadmin/bioversity/publications/pdfs/611.pdf

World Bank (2008) World Development Report: Agriculture for Development. Especially chapter 8 of this report with many graphs and figures highlights the natural resource implications for the agricultural sector. http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf

Fisheries
IUCN (1999) Guidelines for Marine Protected Areas. Bests Practice Guidelines number 3. These technical guidelines provide detailed information about the establishment and management of areas to protect both biodiversity and fisheries. http://data.iucn.org/dbtw-wpd/edocs/PAG-003.pdf

MARE (2005) Interactive fisheries governance: a guide to better practice. This easily accessible guide gives advice on best practice governance. www.fishgovnet.org/downloads/documents/bavinck_interactive.pdf

Water management
WANI toolkit: The IUCN Water and Nature Initiative (WANI) together with 80+ partner organizations has developed a toolkit for practitioners to demonstrate best practice water management (incl. case studies) that supports healthy rivers and communities.

The WANI series covers the following topics:
FLOW: the essentials of environmental flows; CHANGE: adaptation of water resources management to climate change; VALUE: counting ecosystems as water infrastructure; PAY: establishing payments for watershed services; SHARE: managing waters across boundaries; RULE: reforming water governance; NEGOTIATE: reaching agreements over water. www.iucn.org/about/work/programmes/water/resources/toolkits

Forestry
Hamilton, L. 2005. Forests and water. Thematic study for the Global Forest. Resources Assessment 2005. FAO Technical paper that outlines issues related to management of forests in light of water requirements. ftp://ftp.fao.org/docrep/fao/011/i0410e/i0410e01.pdf

Step-by-step guidance on community forestry is provided by the multilingual FAO community forestry manuals which are available at www.fao.org/forestry/participatory/26266/en/

Tourism
Honey, M. (2008) Ecotourism and Sustainable Development: Who Owns Paradise? Island Press. The book provides an introduction to Eco-tourism and several case studies from the Americas and Africa.

Information and a multilingual guidance on how to integrate sustainable practices in tour operators' supply chains as well as a set of case studies is compiled on the website of the Tour Operator Initiative www.toinitiative.org

Disaster management
UN/ISDR (2005) Know Risk. The illustrated book provides many best practice examples of ecosystem related disaster risk management. 160 authors compiled examples from marine and coastal to urban and mountainous ecosystems.

Climate change adaptation
The World Bank website on the 'Economics of Climate Change Adaptation' provides reports on the costs of climate adaptation for the forestry and the fisheries sector as well as on implications for disaster management and infrastructure. http://beta.worldbank.org/climatechange/content/economics-adaptation-climate-change-study-homepage

Equator Initiative
The Equator Prize is awarded biennially to recognize outstanding community efforts to reduce poverty through the conservation and sustainable use of biodiversity. Many showcases illustrate best practice examples. www.equatorinitiative.org