THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 1: The global biodiversity crisis and related policy challenge

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THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY
TEEB for National and International Policy Makers

Chapter 1
The global biodiversity crisis and related policy challenge

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Key Messages of Chapter 1

Ecosystems and their biodiversity underpin the global economy and human well-being and need to be valued and protected. The world's 'natural capital' is not a luxury for the rich but a necessity for all. The figures speak for themselves: over a billion people in developing countries rely on fish as a major source of food and over half of all commercial medicines derive from natural substances, mostly sourced in rainforests.

Damage to global ecosystem services and biodiversity is acute and accelerating. In the last century we have lost 35% of mangroves, 40% of forests and 50% of wetlands. 60% of ecosystem services have been degraded in fifty years. Species loss is 100 to 1,000 times than in geological times and will get worse with climate change. 80% of the world's fisheries are fully- or over-exploited. Critical thresholds are being passed: for example, coral reefs risk collapse if CO2 emissions are not urgently reduced.

Ecosystem damage carries costs for business and society: the number of sectors benefiting from natural capital represents a far larger share of the economy than many policy-makers appreciate. Failure to halt biodiversity loss on land may cost $500 billion by 2010 (estimated value of ecosystem services that would have been provided if biodiversity had been maintained at 2000 levels). At sea, unsustainable fishing reduces potential fisheries output by an estimated $50 billion/year.

Growing demand from an expanding wealthier population is a key cause of biodiversity loss. At a deeper level, economic signals from policy and market prices fail to reflect the true value of biodiversity. Incentives are not in place to encourage sustainable practices or to distribute costs and benefits efficiently and fairly. The imbalance between private gain and public loss runs through most of today's policy failures.

Understanding value is critical to inform trade-offs in decision-making on land conversion and ecosystem management. When the true value of ecosystem services are included, traditional trade-offs may be revealed as unacceptable. The cost of acting to sustain biodiversity and ecosystem services can be significantly lower than the cost of inaction.

Understanding the limited substitution potential of ecosystem services and the scale of the social and economic impacts caused by loss or degradation of natural capital, is critical for policies that seek to integrate environmental, economic and social concerns. Finding substitute sources of services - water, fuel wood, food provision - or creating substitutes - e.g. water purification - can lead to higher social costs, to higher economic costs beyond the reach of some social groups and to potential loss of quality. In some cases (e.g. species extinction) there are no substitutes.

Investing in ecological infrastructure can offer greater returns than man-made alternatives and thus makes economic sense. It can also help alleviate poverty and address commitments under the Millennium Development Goals.

1 The global biodiversity crisis and related policy challenge

"In our every deliberation,
we must consider the impact of our decisions
on the next seven generations."

From The Great Law of the Iroquois Confederacy

Chapter 1 provides an overview of key issues and priorities related to the global biodiversity crisis. **1.1** introduces policy-makers to **basic terms, concepts and the reasons for urgent concern** at the highest levels. **1.2** highlights the **seriousness of current biodiversity loss**, backed by concrete examples, and analyses the causes of ongoing and future projected losses. **1.3** summarises the critical **importance of ecosystem services for economic prosperity** and shows how valuation can support informed and cost-effective policy trade-offs and investments. **1.4** emphasises the scale of **human dependence on ecosystem services and biodiversity**, particularly for the poor with limited access to alternatives, and the need to engage communities in developing and implementing policy solutions.

1.1 WHAT IS BIODIVERSITY AND WHY DOES IT MATTER

'Biodiversity' is an umbrella term that covers all life on the planet, from the genetic level to terrestrial, freshwater and marine habitats and ecosystems. It underpins our global economy as well as human well-being. **Biodiversity offers essential benefits to people** and contributes to society as a whole by providing knowledge, protection, medicine and community identity. Eco-systems in their turn provide a range of vital services, including regulation of nutrient and carbon cycles (see Box 1.1 for key terms).

Despite these benefits, damage to global biodiversity is acute and accelerating. Ongoing and predicted future losses are discussed in 1.2 below but we can already highlight alarming statistics. Species are going extinct 100 to 1,000 times faster than in geological times (Pimm et al. 1995). During the last century, the planet has lost 50% of its wetlands, 40% of its forests and 35% of its mangroves. Around 60% of the Earth's ecosystem services have been degraded in just 50 years (Millennium Ecosystem Assessment 2005a).

Box 1.1: Key definitions: biodiversity, ecosystems and ecosystem services

Biological diversity means *"the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems"* (Article 2, Convention on Biological Diversity (CBD)). The term covers all the variety of life that can be found on Earth (plants, animals, fungi and micro-organisms), the diversity of communities that they form and the habitats in which they live. It encompasses three levels: ecosystem diversity (i.e. variety of ecosystems); species diversity (i.e. variety of different species); and genetic diversity (i.e. variety of genes within species).

Ecosystem means *"a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit"* (Article 2, CBD). Each ecosystem contains complex relationships between living (biotic) and non-living (abiotic) components (resources), sunlight, air, water, minerals and nutrients. The quantity (e.g. biomass and productivity), quality and diversity of species (richness, rarity, and uniqueness) each play an important role in a given ecosystem. The functioning of an ecosystem often hinges on a number of species or groups of species that perform certain functions e.g. pollination, grazing, predation, nitrogen fixing.

Ecosystem services refer to the benefits that people obtain from ecosystems (Millennium Ecosystem Assessment 2005a). These include: ***provisioning services*** (e.g. food, fibre, fuel, water); ***regulating services*** (benefits obtained from ecosystem processes that regulate e.g. climate, floods, disease, waste and water quality); ***cultural services*** (e.g. recreation, aesthetic enjoyment, tourism, spiritual and ethical values); and ***supporting services*** necessary for the production of all other ecosystem services (e.g. soil formation, photosynthesis, nutrient cycling).

These **losses harm the economy** (see 1.3) **and human well-being** (see 1.4). Unfortunately, we usually appreciate what we have lost too late and/or where there are no available substitutes. The poorest people and developing countries are hit hardest by the loss, but richer nations are not immune. For example, the loss of bees sparks global concern because it directly affects natural pollination capacity. Declining fish stocks are worrying for all but especially the one billion or more people in developing countries who rely mainly on fish for protein. Over half of the world's fish stocks are already fully exploited and another quarter over-exploited or depleted (FAO 2009a).

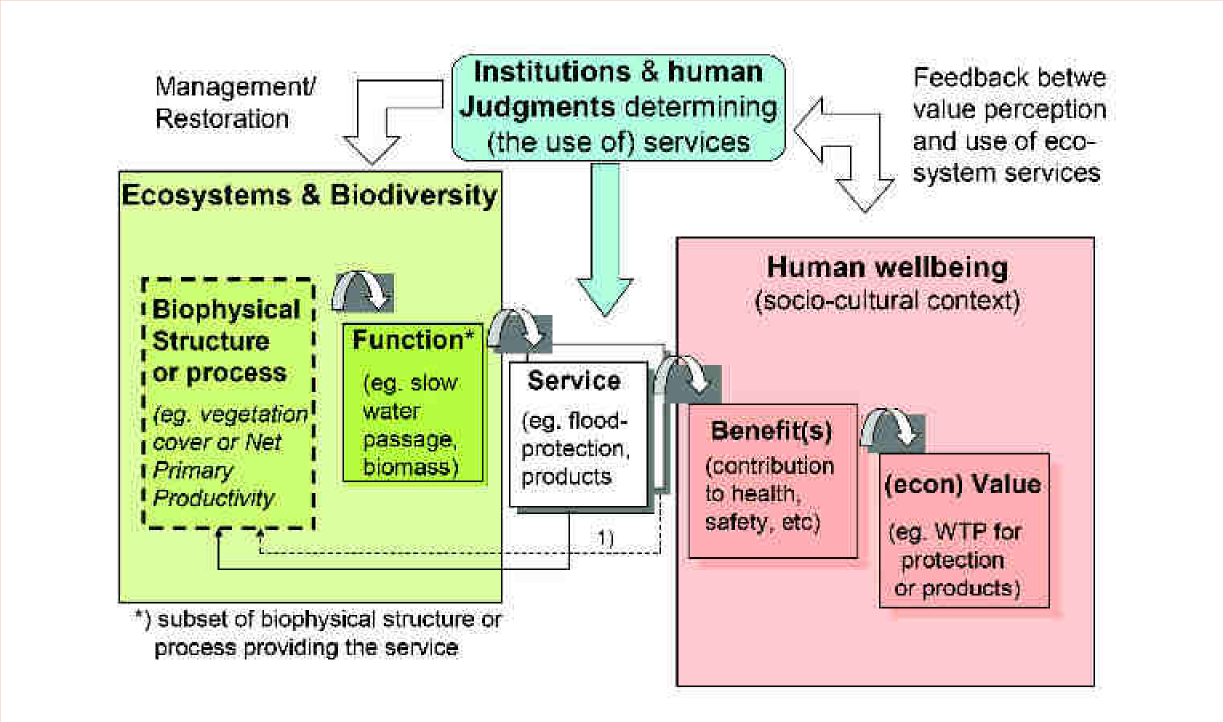
The relationship between biodiversity, ecosystems and delivery of their services is complex (see Box 1.2).

Box 1.2: How does loss of biodiversity affect ecosystem services and benefits to society?

Ecosystems are components of biodiversity; at the same time, species and their diversity are essential components within ecosystems. Biodiversity plays a fundamentally, though variable, role in the provision of ecosystem services. If an entire ecosystem is lost, this has a significant structural impact with direct human, social and economic costs. If other components of biodiversity are lost, this leads to a change in the services provided by an ecosystem but such changes can be more subtle, making ecosystems less stable and more vulnerable to collapse.

The extent and rate of changes to ecosystem services will depend on many factors such as: abundance of species/biomass (e.g. carbon storage); quality and structure of habitats and ecosystems (e.g. landscape values and tourism); and level of diversity (e.g. genetic variety within crops helps to maintain their resistance to diseases). Some ecosystem services (e.g. pollination, many cultural services) are a direct consequence of species' detailed composition and diversity. For others (e.g. flood regulation), the role of physical structures and processes at the ecosystem scale is more important (for more detailed scientific discussion, see **TEEB D0**.

The pathway from ecosystem structure and processes to human wellbeing



1) One function is usually involved in the provision of several services and the use of services usually affects the underlying biophysical structures and processes in multiple ways. Ecosystem service assessments should take these feedback-loops into account.

Source: Adapted from Haines-Young and Potschin 2009 and Maltby 2009

Many economic sectors are directly concerned with biodiversity and ecosystems services, including agriculture, fisheries, forestry, development, health, energy, transport and industry. Several depend on natural capital for their flow of inputs, research, new products and business innovation. An obvious example is the pharmaceutical industry: 25-50% of the sector's turnover (about US$ 650 billion/year) is derived from genetic resources. Ecotourism is another fast-growing sector which generates significant employment and is now worth around US$ 100 billion/year. Biomimicry (learning from nature) is expanding in areas such as architecture, engineering and product development. With appropriate investment, it offers major potential for new markets.

Policy-makers too have a common interest in maintaining this natural capital – to avoid significant financial costs. Nature frequently offers the same services as man-made technological solutions for far less money: examples range from maintaining soil fertility to carbon storage to reducing impacts from storms and tsunamis (see 1.3.4). In times of limited government and private budgets, avoiding unnecessary costs is fundamental to efficient administration.

Failing to take steps to halt global biodiversity loss carries increasing costs in terms of damage to human health and property, erosion of ecosystem services and reduced economic opportunities. The consequences are socially inequitable and economically inefficient. Despite this, our balance sheets and national accounting systems give almost no visibility to biodiversity-related costs and benefits – or to the way they are distributed.

This report shows how and why existing prices, markets and public policies do not reflect the true value (or damage) of ecosystem services and biodiversity. It sets out a roadmap for decision-makers to reform policy frameworks at all levels, building on best practice and innovative solutions from around the world.

Source: Dirk van der Made licensed under http://commons.wikimedia.org/wiki/Commons:GNU_Free_Documentation_License

A canopy walkway disappearing into a cloud forest near Santa Elena, Costa Rica.

1.2 THE BIODIVERSITY CRISIS: SCALE AND CAUSES

"…our natural environment is critical to intelligent economic growth and it is very easy to take for granted what nature provides for free."

Chris Carter, Minister of Conservation, New Zealand

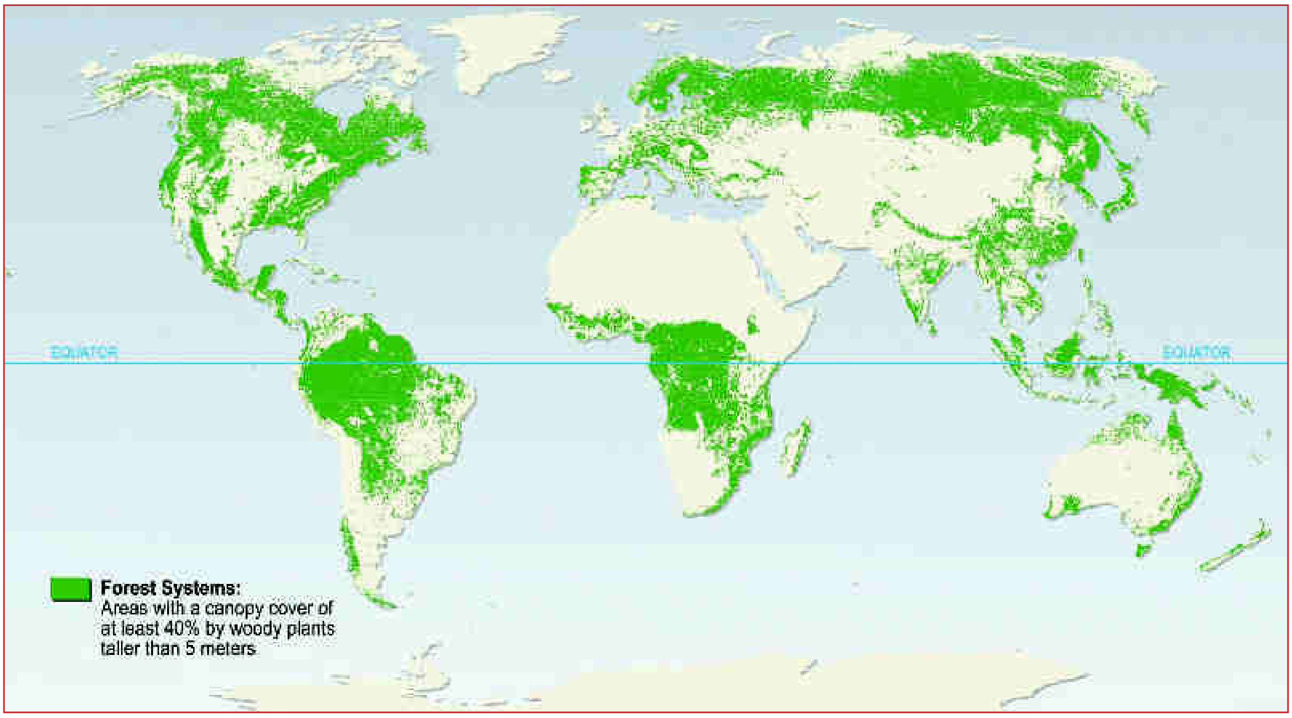
1.2.1 HOW MUCH OF OUR NATURAL CAPITAL IS BEING LOST?

This section provides an introduction to key facts about the planet's natural capital and how it is increasingly being lost. Information and examples are grouped by ecosystem types for ease of reference. The implications of species and genetic diversity loss are treated separately at the end of this section.

FORESTS

Forests in different forms cover an area of around 4 billion hectares (30.3% of total global land area) (Figure 1.1). The world's forests contain 80-90% of the world's remaining terrestrial biodiversity (Costanza et al 1997, see also FAO 2000). Forests provide many valuable goods and services, including timber, food, fodder, medicines, climate regulation, provision of fresh water, soil protection, carbon sequestration, cultural heritage values and tourism opportunities (Shvidenko et al. 2005).

Figure 1.1: Map of Forest Areas



Source: Millennium Ecosystem Assessment (2005b): 28

The FAO Global *Forest Resources Assessment 2005* (2006) found that:

- forests have completely disappeared in 25 countries;
- about 12 million hectares are lost to deforestation each year, including 6 million hectares of primary forests particularly in Latin America, South-East Asia and Africa;
- however, some countries are seeing a net increase in forest coverage (e.g. countries in Europe, China, Costa Rica);
- global net loss of forest area between 2000-2005 was 7.3 million hectares/year (about the size of Sierra Leone or Panama and over twice the size of Belgium). This is down from an estimated 8.9 million ha/yr between 1990-2000 but still equivalent to a net annual loss of 0.18% of global forests.

Standing forests are an important net carbon sink. Old-growth tropical forests are estimated to absorb up to 4.8 Gt CO_2 per year, equivalent to around 0.67 t CO_2 per capita (IPPC 2007; Eliasch 2008; Lewis and White 2009); this is assumed to amount to approximately 15% of annual human induced CO_2 emissions. **Deforestation** releases CO_2, into the atmosphere and at current rates, **may account for 18-25% of global CO_2 emissions.**

NATURAL AND SEMI-NATURAL GRASSLANDS

Grasslands (land used for grazing) cover an estimated 52.5 million km2. This is about 40.5% of terrestrial land cover, which breaks down into wooded savannah and savannah (13.8%), open and closed shrub (12.7%), non-woody grassland (8.3%) and tundra (5.7%) (FAO 2005b).

The biggest change to ecosystem structure has been the **transformation of nearly a quarter (24%) of the Earth's terrestrial surface to cultivated systems** (Millennium Ecosystem Assessment 2005a, see Figure 1.2). Since 1945, 680 million hectares out of 3.4 billion hectares of rangelands have been affected, while 3.2 million hectares are currently degraded every year (FAO 2005b)..Over 50% of flooded grasslands and savannahs and tropical and sub-tropical grasslands and savannahs, and nearly 30% of montane grasslands and shrublands, have been destroyed. Cultivation of grassland has led to problems of access to water for livestock and wildlife, loss of lean season grazing, obstruction of migration routes and loss and fragmentation of wildlife habitat. **Soil degradation has damaged the productive capacity** of both cultivated lands and natural rangelands (FAO 2005b).

This is a global problem with **serious implications for food security** but it also has a significant local dimension. In Africa 40% of farmland suffers from nutrient depletion rates greater than 60 kg/hectare/year. The highest rates are in Guinea, Congo, Angola, Rwanda, Burundi and Uganda (Henao & Baanante 2006).

AGRICULTURAL LAND

Of the world's 13.5 billion hectares of total land surface area, about 8.3 billion hectares are currently in grassland or forest and 1.6 billion hectares in cropland (Fischer 2008):

- An additional 2 billion hectares are considered potentially suitable for rain-fed crop production, but a 2008 FAO study suggests prudent use of this figure, as it also includes forests and wetlands which are extremely important for climate changes and for the provision of ecological services (FAO 2008).
- Additional demand for agriculture production has been created from biofuels production request. The experienced and foreseen increase in biofuel production and recent food shortages due to adverse climatic conditions have had a very sharp impact on the price of agricultural commodities, an effect that is expected to continue. A push in commodity prices of 12–15 percent above the levels that would have prevailed in 2017 is projected, even if biofuels were held at 2007 levels (OECD–FAO 2008).
- FAO estimates that 1.02 billion people are undernourished people in 2009, the vast majority in Asia and Pacific, as well as Sub-Saharan Africa (907 million in total). Agriculture production and yields is not the real issue here; poor people can not really face the globally increasing food prices, a situation aggravated by the current economic crisis (FAO 2009c).

- Enough food could be produced on currently cultivated land for the projected global population of 9 billion, provided that adequate investment was made in sustainable management (including intensification of agriculture and innovation) and further land conversion (i.e. forestry loss) could be avoided.

Significant local risks are generated by loss of agricultural production or productivity. This can happen where over-abstraction reduces groundwater aquifer levels to a point where they either pass a critical threshold and salt water intrusion occurs or where levels are too low for access to agriculture, compromising yields, activities and livelihoods. The result may be social tension and even conflict (see Box 1.3).

FRESHWATER SYSTEMS

Freshwater systems are aquatic systems which contain water of almost no salt content and include lakes and ponds, rivers and streams, reservoirs, wetlands (see below and groundwater. At global level:

- they provide most global drinking water resources, water resources for agriculture, industry and sanitation, and food such as fish and shellfish;
- they also provide recreational opportunities and a means of transportation;
- they cover 0.8% of the Earth's surface and contain 0.009% of its total water (Daley et al 1997);
- they house 40% of all known fish species on Earth (Master et al. 1998).

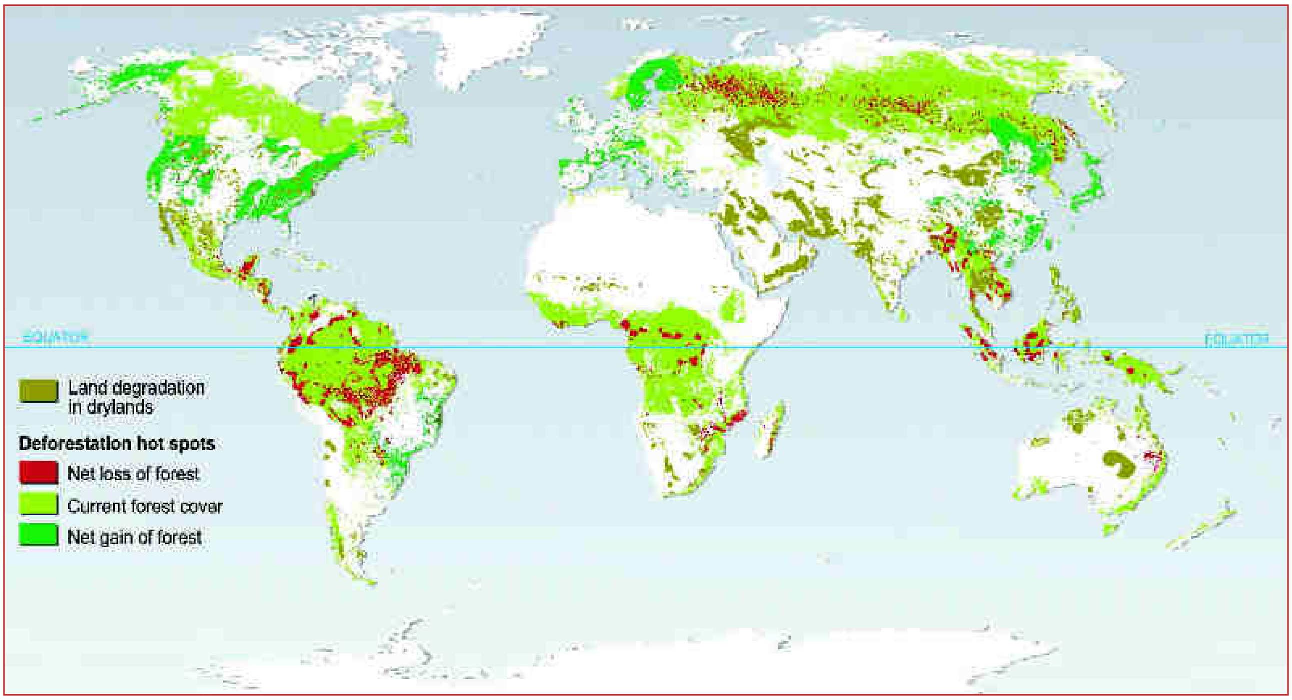
Box 1.3: In India, the spectre of 'water wars' arrives

The subcontinent is extracting water from its groundwater at a rate that will compromise the sustainability of the resource.

Key extracts translated: India is caught in a trap between consumption that does not stop rising, and groundwater stocks that are falling by 4 cm/year. There is an increasing risk of salination in certain regions, and access to water for some of the farming community is being compromised - the viability of farming in some areas and the viability of ecosystems are under increasing risk. While some farmers can dig deeper wells and afford more powerful pumps to access the resource, others cannot afford to. Furthermore, city dwellers extract water that should 'belong' to locals. Tensions over water scarcity are rising. Groundwater is free and 19 million wells were dug in the absence of laws and control.

Source: Le Monde Friday 14th August 2009

Figure 1.2: Areas of rapid land cover change



Source: Millennium Ecosystem Assessment (2005b): 3

All continents unsustainably exploit freshwater resources. 5-25% of global freshwater use exceeds long-term accessible supply (Vorosmarty et al. 2005). Water withdrawals from rivers and lakes for irrigation, urban uses, and industrial applications doubled between 1960 and 2000. The construction of dams and other structures along rivers has moderately or strongly affected flows in 60% of the world's large river systems, fragmenting the ecosystems. Water removal for human uses has reduced the flow of several major rivers, including the Nile, Yellow, and Colorado Rivers, to the extent that they do not always flow to the sea (Millennium Ecosystem Assessment 2005a). Forest loss, watershed degradation, wetland drainage and infrastructure that accelerates water run-off all reduce the potential for this 'natural infrastructure' to store, purify and provide water.

Risks arising from loss of clean water provision occur both at the local level (loss of forests, degradation of watersheds) and at international level. The possible future loss of the 'Amazon water pump' is an example of potentially dramatic international impact (see Chapter 5).

WETLANDS

Wetlands include swamps, marshes, mangrove forests and wet prairies and cover 6% of the Earth's land surface. Another 2% is covered by valuable **coastal ecosystems** such as estuaries, dunes, seagrass beds and lagoons. Wetlands help maintain the water cycle by capturing and holding rainfall and snowmelt, retaining sediments and purifying water. They are important biodiversity areas and provide breeding grounds for fish, grazing lands and the source of staple food plants. Wetlands can also act as water recyclers and carbon sinks, provide protection from floods and storms, control soil erosion and even serve as a natural wastewater treatment system for some cities. Coastal ecosystems are highly productive and have been estimated to account for up to 40% of the total value of global ecosystem services (Valiela et al 2001).

Since 1900, the world has lost around 50% of its wetlands (UNWWAP 2003). Since 1980, 20% of mangrove area (3.6 million hectares) has been lost (FAO 2007) but some countries have lost up to 80% through conversion for aquaculture, overexploitation and storms. Coastal wetland loss in some places has reached 20% annually (Agardy et al 2005).

A range of ecosystems act as important buffers for natural hazards: wetlands for flood control, mangroves against sea surges and tsunamis forests against landslides and mudslides and mixed forests for reduced fire risk. The risks of such hazards thus increases along with the conversion of mangroves, deforestation and drainage of wetlands, For example, during typhoon Wukong in 2000, areas planted with mangroves in Vietnam remained relatively unharmed while neighbouring provinces suffered significant losses of life and property (Brown et al. 2006).

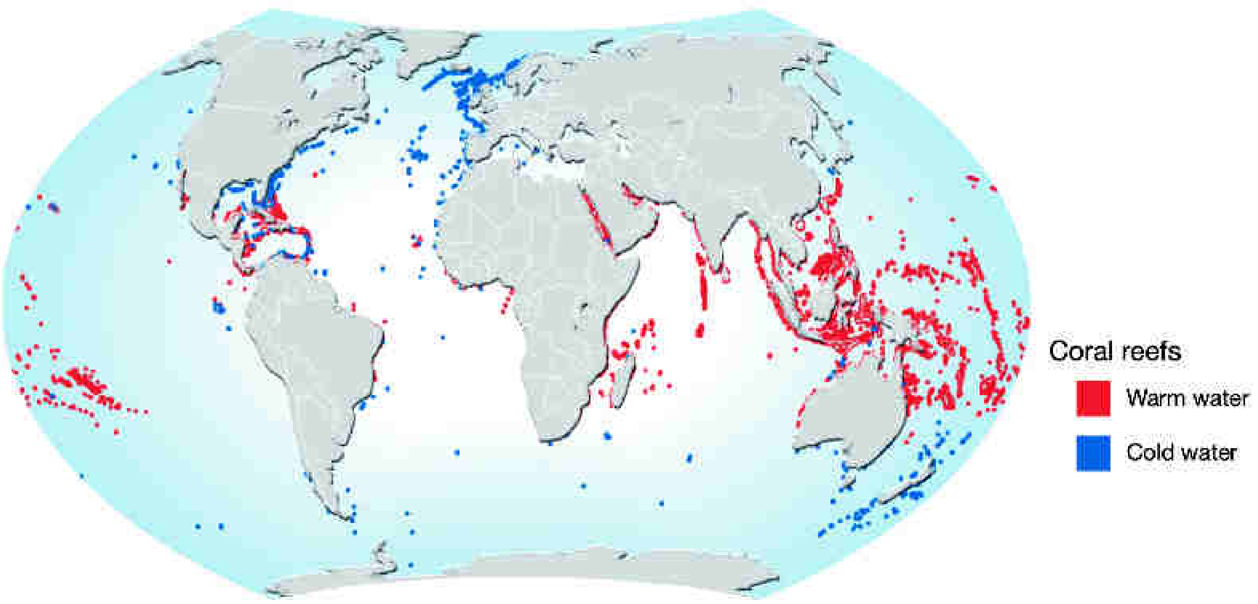
TROPICAL CORAL REEFS

Tropical coral reefs cover just 1.2% of the world's continental shelves but they are the most diverse marine ecosystems. They are often likened to 'oases' within marine nutrient deserts (see Figure 1.3) as they **have a crucial role in shaping tropical marine systems** which, are highly productive despite surviving in very low nutrient condition (Odum and Odum 1955):

- coral reefs harbour an estimated 1-3 million species, including over a quarter of all marine fish species (Allsopp et al. 2009), and often have even higher levels of biodiversity than tropical forests;
- 20% of reefs have been destroyed (Millennium Ecosystem Assessment 2005a, Wilkinson 2008);
- 30% have been seriously damaged through destructive fishing practices, pollution, disease, coral bleaching (Wilkinson 2008), invasive alien species and tourism;
- 58% of the world's reefs are potentially threatened by human activities at the global scale (Bryant et al 1998).

The risks of climate change for coral reef biodiversity and ecosystems now look greater than initial forecasts. Temperature rise is expected to make major (further) loss of warm water coral reefs inevitable. New scientific evidence points to the fact that coral reef recovery is seriously hampered by CO_2 concentrations above 350 ppm (see TEEB Climate Issues Update 2009).

Figure 1.3: Map of Coral Reefs



Source: Nellemann et al 2008: 22

MARINE SYSTEMS

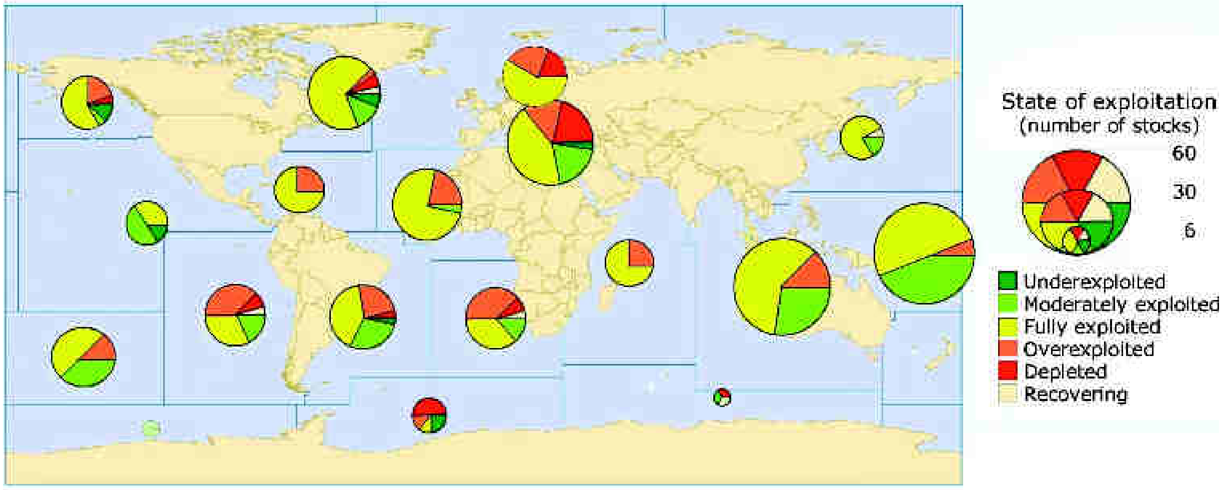
Oceans account for 90% of the habitable volume for life on earth and contain 90% of Earth's biomass (Rogers 2009). Recent statistics (FAO 2009a) demonstrate their importance as a provider of food and other goods:

- in 2006, global capture fisheries represented 92 million tonnes of fish, of which nearly 90% was from the marine environment;
- since industrial fishing began, the total mass of commercially exploited marine species has been reduced by 90% in much of the world;
- 52% of marine fisheries are fully exploited (at or near maximum sustainable yields), 17% over exploited, 7% depleted and 1% recovering; 18% are moderately exploited, with only 2% 'underexploited' (see Figure 1.4).

Lowered biomass and habitat fragmentation resulting from fisheries impacts have led to local extinctions, especially among large, long-lived, slow-growing species with narrow geographical ranges (Pauly et al. 2005). Yields from global marine capture fisheries are lower than maximum potential owing to excess fishing pressure in the past, with no possibilities in the short or medium term of further expansion and with an increased risk of further declines and a need for rebuilding (FAO 2009a).

Improved governance could greatly increase economic benefit from existing fisheries. **The difference between the potential and actual net economic benefits from marine fisheries is in the order of $50 billion/year** in an industry with an annual landed catch value of $86 billion. The cumulative economic loss to the global economy over the last three decades is estimated to be in the order of US$2 trillion (FAO 2009a). There is also enormous waste: by-catch (unused catch) amounts to 38 million tonnes/year or 40% of total catch (Davies et al 2009).

Figure 1.4: State of exploitation of selected stock or species groups for which assessment information is available, by major marine fishing areas, 2004



Source: adapted from FAO 2005a: 7

Under current policies, there is an increased risk of a series of collapses in fish stocks, with impacts on target stocks, entire marine ecosystems, food security, protein input and economies. In the near future, global fleets have potential for substitution but local fleets will not always be able to find alternative sources of fish which has knock-on implications for food supply and local and livelihoods. At the global level, fishery substitution potential will decrease with time.

SPECIES AND GENETIC DIVERSITY

Historically, natural loss of biodiversity occurred at far slower rates and was countered by origination of new species (Millennium Ecosystem Assessment 2005a). Today, current extinction rates are estimated to be 100 to 1,000 times faster than those in geological times. Recent tracking of losses by the Living Planet Index (trend) and IUCN Red List (rarity) offer similarly bleak pictures of the situation. A number of terrestrial, marine and freshwater species are in steady decline (see Living Planet Report 2008) and the number of globally threatened species has been steadily increasing for the past ten years. Latest estimates in the Red List (IUCN 2009) indicate that:

- nearly a quarter (22%) of the world's mammal species and a third (32%) of amphibian species are known to be globally threatened or extinct;
- over a third i.e. 3,481 species out of the 30,700 estimated described species are endangered;
- 12% of the world's bird species are under threat;
- the highest levels of threat are found in island nations: 39-64% of mammals are threatened in Mauritius, Reunion and The Seychelles and 80–90% of amphibian species are endangered or extinct in the Caribbean.

Globalisation has also contributed to species populations and ecosystems becoming increasingly dominated by a few widespread species. The spread of invasive alien species (IAS) is known to increase the similarity between habitats and ecosystems around the globe, with isolated islands rich in endemic species particularly hard hit by biological invasions. This 'biotic homogenisation' represents further ongoing losses in biodiversity (Millennium Ecosystem Assessment 2005a).

Species extinction and population loss in different ecosystems has also reduced global genetic diversity. Such losses reduce the fitness and adaptive potential of both species and ecosystems, thus limiting the prospects for recovery after possible disturbance. More specifically, agricultural intensification - coupled with selective breeding and the harmonising effects of globalisation - has significantly reduced the genetic diversity of cultivated plants and domesticated animals in agricultural systems. A third of the 6,500 breeds of domesticated animals are estimated to be threatened or already extinct due to their very small population sizes (Millennium Ecosystem Assessment 2005a; FAO 2009b).

1.2.2 GLOBAL PROJECTIONS OF FUTURE LOSS

Under current policies, the losses outlined above are expected to continue, leading to an increasingly acute global biodiversity crisis. Recent global environmental assessments provide specific projections on the scale of likely changes in biodiversity, based on potential scenarios and policies (see Box 1.4).

The assessments are unanimous that **significant biodiversity loss will continue under all considered policy scenarios**, with the rate of loss projected to accelerate and exceed that of the last century. Predictions for the period 2000-2050 include:

- **terrestrial biodiversity:** Under business-as-usual scenarios, a further 11% of biodiversity would be lost, with higher rates of loss in Africa and Latin America (OECD 2008). Even under global sustainability policies, 7.5% would be lost, with higher rates of 10.5% and 9% for Africa and Latin America/Caribbean respectively (UNEP 2007);

- **forest cover** would decrease under all scenarios, with the highest predicted losses (16%) occurring under sustainability scenarios due to an increased land demand for biofuels to combat climate change (UNEP 2007);

Box 1.4: Global Assessments and the use of scenarios to make future projections

In 2005, the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment 2005a) assessed the consequences of ecosystem change for human well-being, establishing the scientific basis for actions to enhance their conservation and sustainable use. It was followed by the Global Biodiversity Outlook 2 (GBO-2, see SCBD 2006), the Global Environmental Outlook-4 (GEO-4, see UNEP 2007), the OECD Environmental Outlook (OECD 2008) and the International Assessment of Agricultural Science and Technology (IAASTD 2008).

Scenarios used in the assessments
Assessments typically use a set of different scenarios outlining likely global situations (the best-known is the IPCC's Special Report on Emissions Scenarios). The MEA and GEO-4 have developed broadly comparable sets, based on four categories:

- **conventional markets:** continued focus on liberalised markets, leading to rapid economic and technological growth with a reactionary approach to environmental protection;
- **global sustainable development:** a global response to sustainability issues, average economic and technological growth and proactive approach to environmental protection;
- **competition between regions:** countries shun global cooperation in favour in protectionist policies, leading to slower economic and technological growth, and a reactionary approach to environmental protection;
- **regional sustainable development:** sustainable development is prioritised at a regional level without cooperation at a global scale leading to average economic and technological growth.

Shortcomings in the models
The projections for biodiversity, though severe, are likely to be underestimates. None of the models consider Invasive Alien Species (IAS) impacts, considered one of the most serious threats to global biodiversity, or potential unpredictable shocks to the system, such as the reaching of tipping points or economic shocks,. The marine models are also hampered by a lack of information and are likely to underestimate the scale of fishing effort, particularly artisanal.

- **agriculture:** Poor agricultural practices associated with unfavourable socioeconomic conditions could create a vicious circle in which poor smallholder farmers are forced to use marginal lands, increasing deforestation and overall degradation. The assessments are unanimous that increased productivity is key to protecting terrestrial biodiversity (i.e. improved yield reduces the need to convert remaining natural areas to cultivation. If this does not occur, biodiversity loss would be even higher than the assessments project). IAASTD (2008) predicts that land demanded for agriculture will increase by 10% by 2050, even with high investment leading to substantial increases in yield (up to 300% in Sub-Saharan Africa and 200% in Latin America). GBO-2 predicts that poverty alleviation measures in Sub-Saharan Africa (e.g. sustainable meat consumption, increased protected area coverage) could reduce the rate of biodiversity loss, with little impact on global GDP. However, pressure for additional agricultural produce for bio-energy will put additional pressure;

- **energy demand** is projected globaly to almost double between 2000 and 2030 under business-asusual scenarios (IAASTD 2008). For biofuels, the International Energy Agency (IEA) in its World Energy Outlook 2006 presented various scenarios for the development of biofuel demand up to 2030. Its 'Reference Scenarios' project that around 4.2% of arable land will be needed to satisfy growing demand, assuming an increase in demand of 10% of global share of biofuels in transport. Even under a second-generation scenario, a hypothetical large-scale substitution of liquid biofuels for fossil-fuel-based petrol would require major conversion of land;

- **trade liberalisation** may stimulate more efficient use of resources (OECD 2008) but would be likely to shift agricultural production to Africa and South America where the land and labour costs are lower. This would have an unintended net negative impact on biodiversity due to impacts on grasslands and tropical forests;

- **fisheries:** One study predicts a global fish stock collapse by 2048 without major additional policy response, noting that 29% of edible fish stocks have already declined by 90% (Worm 2006). All the assessments predict improvements if ecosystem-based conservation policies are deployed (e.g. total catch limits, designated fishing seasons and zones, regulated fishing methods, elimination of capacity subsidies) although much depends on regional policy.

Source: André Künzelmann, UFZ

1.2.3 WHAT IS DRIVING THESE LOSSES?

The global assessments identify a range of direct causes and key underlying drivers for biodiversity and ecosystem losses.

DIRECT CAUSES

These can be grouped into five main categories and will vary between ecosystems and regions (as summarised in Figure 1.5 below).

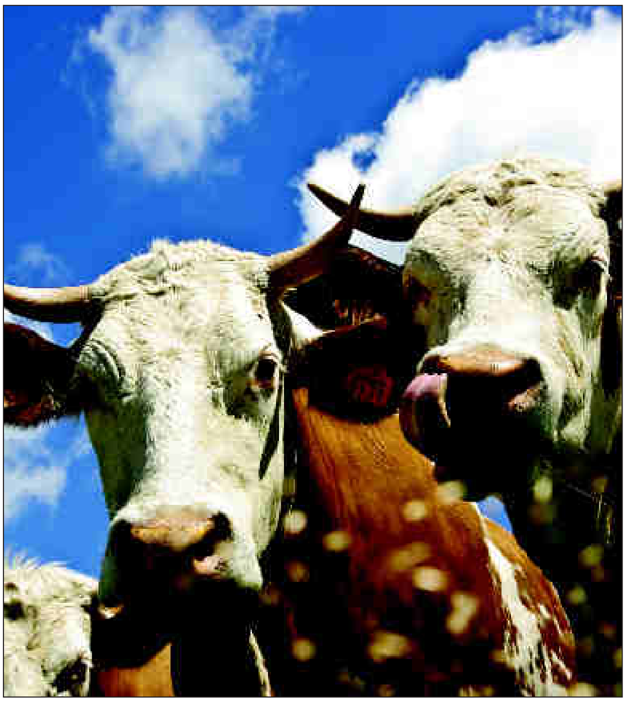
Habitat loss results from land use change, mainly through conversion for agriculture as well as urban, industrial and infrastructure development, and has impacted over 2,000 mammal species (IUCN 2009).

Over-exploitation of resources, such as fish, energy, mining and soil, reflects increased prosperity as well as poverty (see Box 1.5). Use of species for their (perceived) medicinal properties affects over 900 mammal species, mainly in Asia (IUCN Red List 2009).

Box 1.5: How human demand can affect biodiversity

- global meat, fish, and dairy consumption is now causing around 30% of biodiversity loss;
- 80% of agricultural area is currently devoted to meat and dairy production;
- on average, a world citizen consumes 39 kg of meat per year. In the US, this figure is 121kg, in EU-15 91kg, in China 54kg and in Africa 14 kg;
- 10% of the world's population consumes 25% of animal protein (fish, meat, and dairy) and world consumption has doubled since 1970;
- in sub-Saharan Africa, 71% of World Heritage Sites are affected by over-extraction of resources (illegal hunting or fishing, fuelwood collection, etc.) and 38% by encroachment for agriculture.

Source: PBL 2009



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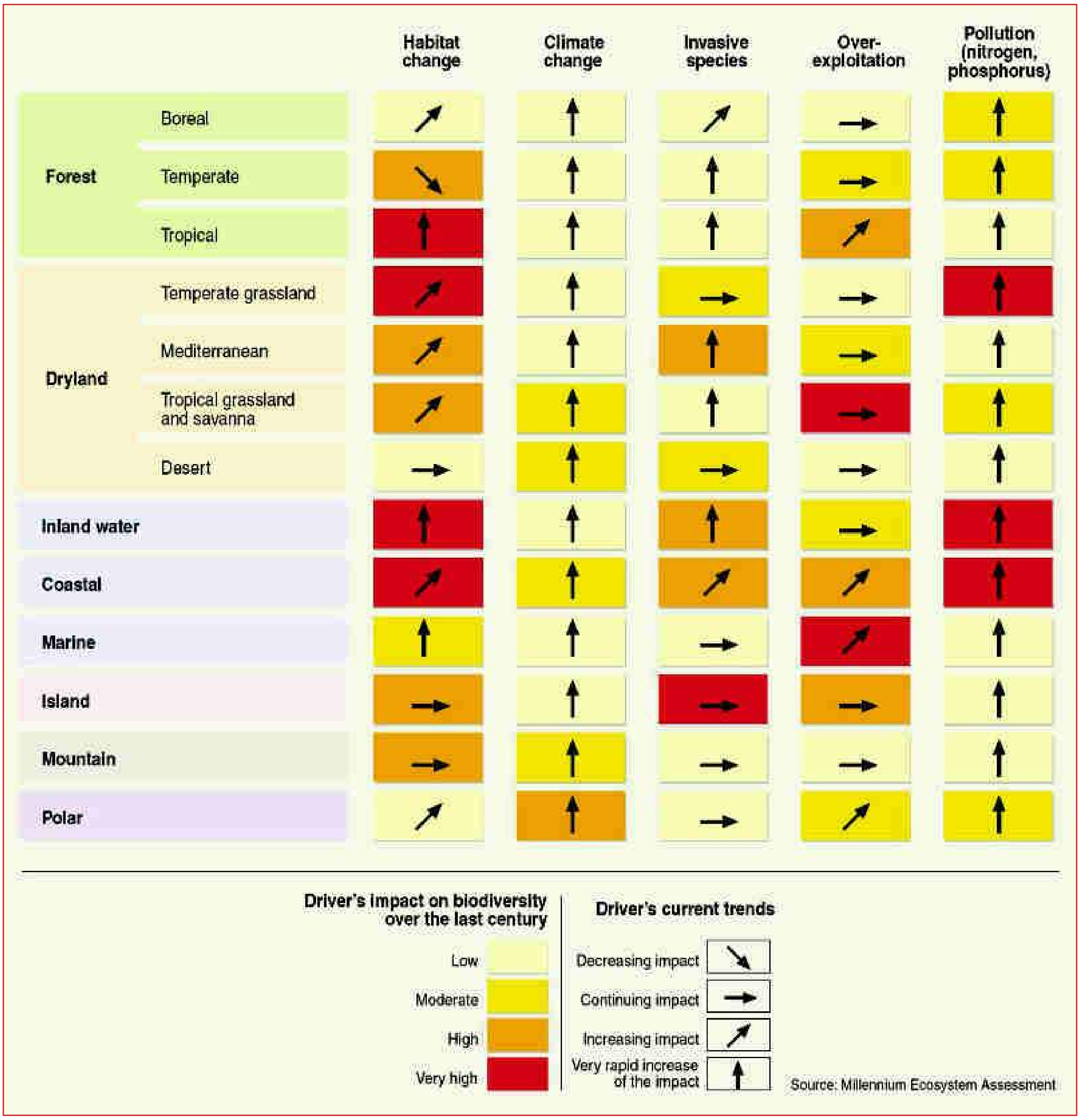
Pollution from multiple sources contributes to cumulative impacts on natural capital and results from a wide range of mainstream economic sector activities.

Climate change impacts on biodiversity and ecosystems are now considered likely to be greater than initial forecasts. Although scientists indicate that ecosystems will be able to adapt to a certain extent to rising temperatures, changes in evapotranspiration and rising sea levels, the combination of human-induced pressures and climate change will increase the risk of losing numerous systems. Coral reefs are a well documented example (see TEEB Climate Issues Update 2009).

Invasive alien species (IAS) have wide-ranging impacts on species types and levels, the food web and habitat structure and functions. An estimated 480,000 IAS have been introduced around the world, invading virtually every ecosystem type , with potential estimated costs of damage and control reaching almost 5 per cent of global GDP (US$ 1.4 trillion/year) (Pimentel et al. 2001, 2005). Environmental degradation already creates favourable conditions for some introduced species to establish and spread. Climate change may in turn modify the whole process of an invasion, increase ecosystem vulnerability and alter species' distributions (Capdevila-Argüelles and Zilletti 2008).

Figure 1.5: Main direct drivers of change in biodiversity and ecosystems



Source: Millennium Ecosystem Assessment 2005b: 16

UNDERLYING DRIVERS

The assessments identify **growing demand for goods and services** from an increasingly wealthy and expanding population as the main underlying cause of biodiversity loss and ecosystem conversion or degradation. This type of consumption is based on choice, not survival.

In contrast, those living below the poverty line are more likely to directly depend for their livelihood and possibly their survival on local resources or land. Short term needs will take precedence over long term considerations particularly where there is no clear and immediate incentive to preserve under-valued ecosystems.

At a deeper level, economic signals from policy and market prices rarely reflect the true value of biodiversity, including the social costs and benefits of ecosystem services. Most ecosystem services are unpriced or underpriced (see also chapters 5 and 7), such as:

- **water:** extraction from groundwater aquifers rarely faces resource extraction cost;
- **fish in the high seas:** no-one pays for exploitation rights for this common resource and there are as yet few mechanisms for payments in territorial waters (see Chapter 7);
- **forests:** these are often de facto 'commons', exploited by the few. Where payment systems exist for the resource extracted (e.g. stumpage fees, concessions) or land conversion fees, these are generally too low to reinvest in future forests;
- **regulating services provided by ecosystems.** As land managers rarely receive income for carbon storage, water regulation, maintenance of air quality or protection against natural hazards, they have little incentive to conserve or manage ecosystems to maintain these services. In general, providing marketable commodities (often through the modification, simplification and degradation of ecosystems) will take precedence.

Many ecosystem services are difficult or impossible to price or trade in conventional markets. There is a clear **rationale for public intervention to protect services with the following characteristics:**

- **public goods:** services such as maintenance of air quality and climate regulation are *non-excludable* (i.e. people cannot be excluded from consuming them) and *non-rival* (one person consuming them does not prevent another from doing so);
- **services with strong externality effects:** for a range of regulating services (e.g. water supply, pollination, erosion control), the actions of some landowners and managers generate benefits to neighbouring landowners and communities which tend to be difficult to capture in market transactions;
- **services for which markets are hard to design:** e.g. fisheries are not pure public goods, but are rarely priced because organising and policing markets in fishing rights is complex.

More often than not, negative impacts generated by the primary production, transport, mining and energy sectors are not monetised. No compensation for damage is paid. There is an imbalance between rewards from providing marketable goods and services and rewards from providing services that benefit the wider population, including future generations.

Responding to these drivers will be critical to address the biodiversity challenge. Current losses reflect multiple failures of public policy and, too often, the lack of high-level political backing for conservation. We can turn the situation around by better appreciating the value of ecosystems and biodiversity and integrating such values into all areas of policy making (see Chapters 2 and 4).

1.3 ECONOMIC DIMENSIONS OF THE BIODIVERSITY CRISIS

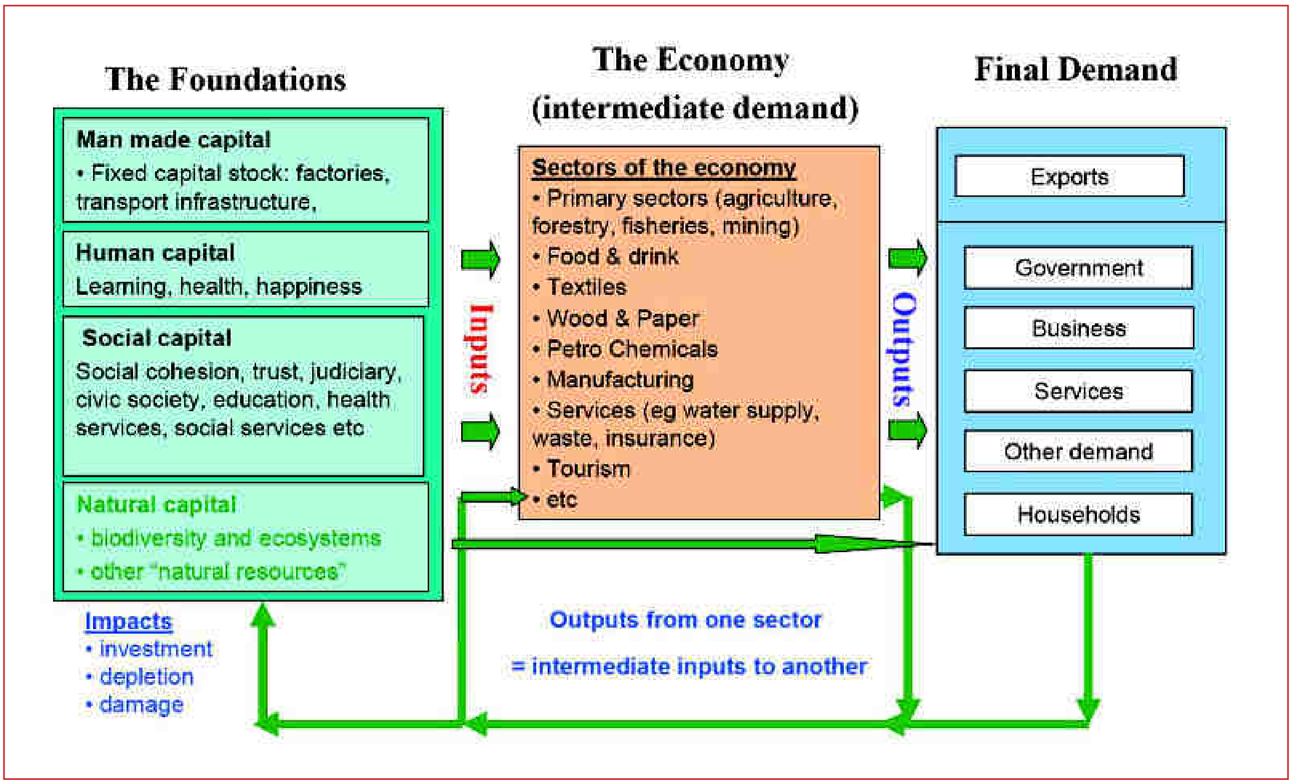
We need to understand the value of what we have today in terms of natural capital wealth, the value of what will be lost if biodiversity and ecosystem loss is not halted and share insights on the potential added value of investing in natural capital.

1.3.1 HOW DO ECOSYSTEM SERVICES UNDERPIN THE ECONOMY?

Economic prosperity depends on the flow of services from at least four types of capital: natural capital (level of reliance depends on the sector and country), man-made capital (buildings, machines and infrastructure), human capital (people and their education, skills and creativity) and social capital (the links between people and communities in terms of cooperation, trust and rule of law) (see Figure 1.6) [3].

Gross domestic product (GDP) therefore builds on natural capital. This can be done sustainably without loss or destruction of biodiversity (i.e. ecotourism that works within renewable limits of ecosystems). More often, GDP relies on extractive uses and either draws down natural capital (e.g. deforestation, overfishing) or replaces it with other forms of capital (e.g. replacement of natural habitats with built infrastructure). Box 1.6 puts this into economic context.

Figure 1.6: Natural capital: its contribution to the economy and livelihoods



Source: own representation, Patrick ten Brink

Box 1.6: Natural capital: its relationship to productivity

The growth rate of the economy is traditionally split into (i) weighted growth rates of the various factors of production and (ii) total factor productivity (TFP) covering growth that is not accounted for by productive inputs (e.g. resulting from technological progress). Environmental economists have long maintained that the importance of natural capital as a production factor is often overlooked and that many TFP estimates do not take adequate account of the draw-down of the stock of natural capital (Ayres and Warr 2006; Dasgupta and Mäler 2000; Repetto et al. 1989).

One study found that when the environment is not considered as a factor of production, TFP estimates are biased upward. This means that part of the economy's productivity growth can be specifically attributed to natural capital and conversely, that loss of natural capital has a negative impact on productivity. Failing to internalise the cost of an environmental externality is equivalent to using an unpaid factor of production. Continued reduction in natural capital will thus compromise the potential for economic growth (Vouvaki and Xeapapadeas (2008) (see further TEEB D0, Chapter 6).

The number of sectors benefiting from natural capital represents a far larger share of the economy than many policy-makers appreciate. In some cases, their dependence on ecosystem services is obvious e.g. the primary production sectors, water supply and growing parts of the tourism sector. In others, the relationship is less obvious but the economic benefits derived from biodiversity are still huge e.g. pharmaceuticals and cosmetics, chemicals, plastics, food, drink and ornamental fish. Data for 2006 shows how widely products derived from genetic resources contributed to the economy, including:

- 25-50% of pharmaceutical turnover (total US$ 640 billion);
- many products (e.g. enzymes, microorganisms) used in biotechnology (total US$ 70 billion);
- all agricultural seeds (US$ 30 billion) (SCBD 2008, see further TEEB D3 Report for Business forthcoming).

1.3.2 UNDERSTANDING THE VALUE OF ECOSYSTEM SERVICES

Appreciating value - to understand what is being lost and the value of what is being lost - **is the first step towards changing the way in which policy trade-offs and investment decisions are made** (see 1.3.3 and 1.3.4).

The **first step** is to understand the whole set of services - what they are, what helps create them, how they link to activities on the site, who benefits and the spatial relationship between service provision and the beneficiary. Section 1.1 outlined the scientific relationship between ecosystems, their services and benefits to users, and showed how change in the ecosystem could trigger changes to such services and benefits. In practice, there is rarely a simple linear relationship between ecosystem damage and a loss of service that applies to all services: the reality is usually more complex (see Balmford et al. 2008 and TEEB D0).

The **second step** is to express the changes in ecosystem services in monetary terms. Their value per hectare depends on the nature of the land, its use, proximity to population groups making use of the service and the wealth of these groups. Actual values will obviously vary from place to place and between different land uses. Table 1.1 presents some examples to illustrate the range of potential values for selected ecosystem services of tropical forests (see further Chapter 4 on valuation and assessment frameworks and more detailed discussion of methodologies in TEEB D0).

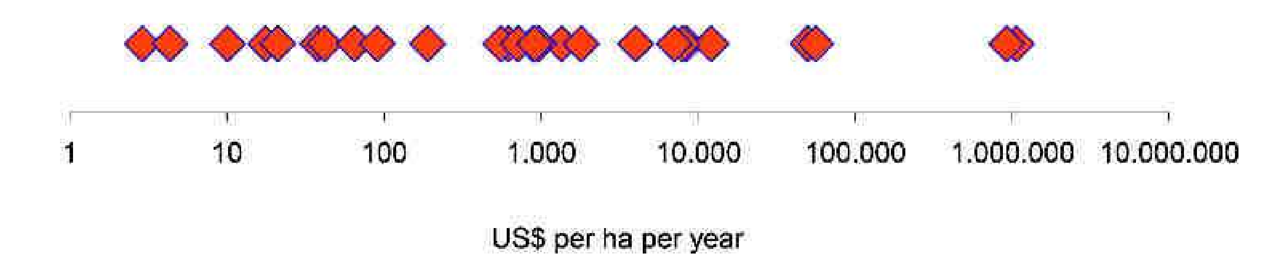
Table 1.1 shows that forests can have significant values in a range of regulating services – carbon storage, erosion prevision, pollution control, water purification - when their economic importance is often currently only perceived in terms of timber and non-timber products. As a rough proxy, it is not atypical to find that two thirds of the value of tropical forests derives from regulating services whereas only one third comes from provisioning food, raw material and genetic material for pharmaceuticals (see TEEB D0, Chapter 7).

Table 1.1: Examples of ecosystem service values from tropical forests

Service	Value
Food, Fibre and Fuel	Lescuyer (2007), based on a review of previous studies, estimated the annual per hectare average values of provisioning services for Cameroon's forests at US$ 560 for timber, US$ 61 for fuelwood and US$ 41-70 for non-timber forest products.
Climate Regulation	Lescuyer (2007), based on a review of previous studies, estimated the value of climate regulation by tropical forests in Cameroon at US$ 842-2265 per hectare per year.
Water Regulation	Yaron (2001) estimated the value of flood protection by tropical forests in Cameroon at US$ 24 per hectare per year. Van Beukering et al. (2003), estimate the NPV for water supply from 2000 to 2030 of the Leuser Ecosystem comprising approx. 25,000 km^2 of tropical forest at 2,419 Bio US$.
Groundwater recharge	Kaiser and Roumasset (2002) valued the indirect watershed benefits of tropical forests in the Ko'olau watershed, Hawaii, using shadow prices. The net present value of the contribution to groundwater recharge of the 40,000 hectare watershed was estimated at US$ 1.42 billion to US$ 2.63 billion.
Pollination	Priess et al (2007) estimated the average value of pollination services provided by forests in Sulawesi, Indonesia, at 46 Euros per hectare. As a result of ongoing forest conversion, pollination services are expected to decline continuously and directly reduce coffee yields by up to 18% and net revenues per hectare up to 14% within the next two decades.
Existence Values	Horton et al (2003) reported the results of a Contingent Valuation study in the UK and Italy, which evaluated non-users' willingness to pay for the implementation of a proposed programme of protected areas in Brazilian Amazonia. Estimated willingness to pay for forest conservation was $US 43 per hectare per year. Mallawaarachchi et al. (2001) used choice modelling to estimate the value of natural forest in the Herbert River District of North Queensland at AUS$ 18 per hectare per year.

Actual values are naturally site specific. This can be best exemplified by coral reefs. The value of coral reefs for tourism can range from low values (eg where fewer tourists for lesser known sites) to extremely high values, where tourism associated with the reef a key source of income and economic development of the areas (see Figure 1.7). In some tourist destinations the value of coral reefs can be up to US$ 1 million per hectare and year, as it is the case for Hawaii (Cesar et al 2002; Ruitenbeek and Cartier 1999). This is certainly an exceptional value, due to Hawaii's accessibility to high-income markets. However, even when these extreme values are put aside, the economic potential of coral reefs for tourism is considerable and highlights the potential that intact scenic and unique ecosystems can offer. At the same time it reflects the economic risk of a loss of these natural assets.

Figure 1.7: The range of the value of coral reefs for tourism



Source: TEEB D0, Chapter 7

As noted, benefits can arise at different geographic scales (global, national, subnational and/or local), depending on the ecosystem service provided. Some have global benefit, such as carbon storage and medicines, whilst others are mainly national (e.g. education, art and research) or local (e.g. pollination, water purification). Many services have the potential to deliver benefits at several levels e.g. ecotourism and recreation. Figure 1.8 illustrates this spread of benefits in a generic way: in practice, actual benefits will obviously vary on a case-by-case basis and also over time.

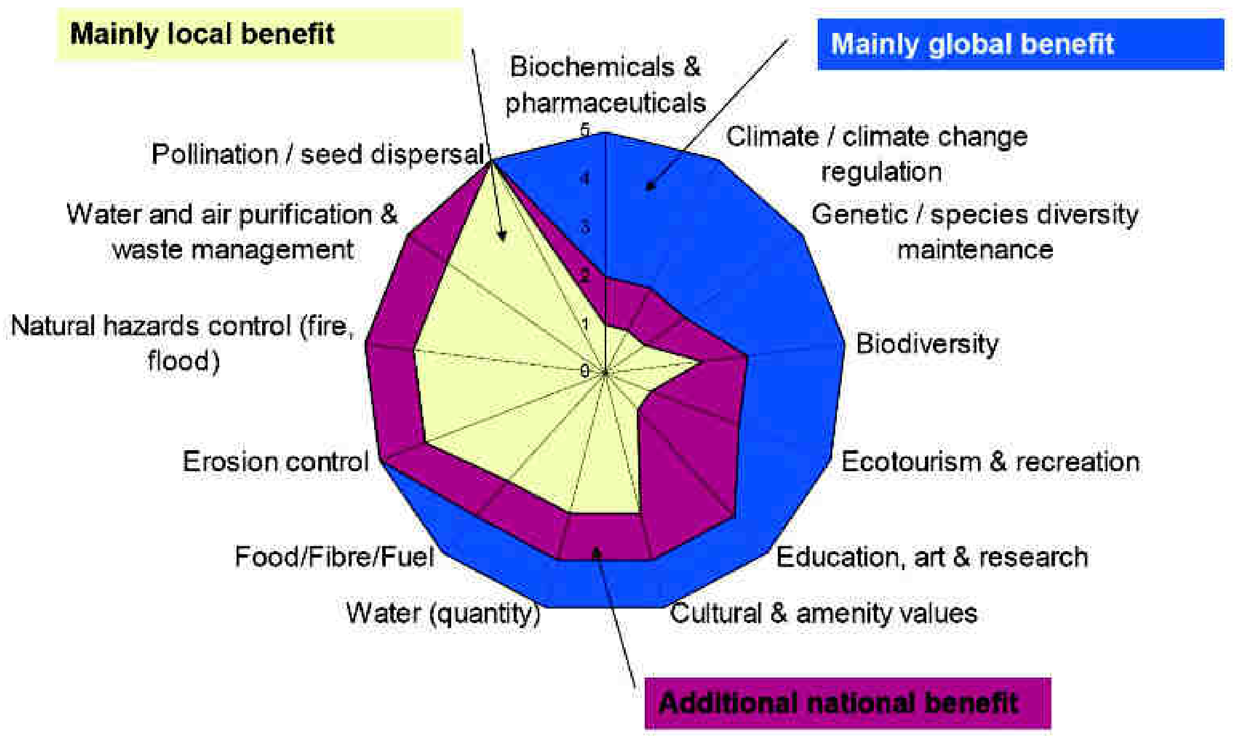
Any given area provides multiple services and thus offers a unique set of benefits. Focusing on a single service from an area risks ignoring the wide range of other services and can lead to potentially important losses, in terms both of cost and of opportunities foregone (see discussion on trade-offs below).

1.3.3 USING VALUATION TO ASSESS TRADE-OFFS, COSTS AND BENEFITS

Distributional impacts - who are the winners and losers? - are a fundamental element of decision-making.

Where ecosystem services are concerned, this question has not only a geographic dimension (see Figure 1.8) but also a time dimension. Conversion of natural systems may create immediate wealth and short term employment, but often ecosystem services would provide wealth and jobs indefinitely, albeit at lower levels. This is why the issue of how we compare impacts now and in the future can change decisions (see Chapter 4 and TEEB D0 chapter 6 on use of the discount rate).

Figure 1.8: Distribution of benefits over different geographic scales



Source: own representation, Patrick ten Brink

COSTS AND BENEFITS OF LAND CONVERSION

Any land use choice involves trade-offs. Decisions to convert imply that someone decides that the benefits outweigh the costs of conversion. However, often these decisions are systematically biased because they do not take into account the value of all the ecosystem services affected by the decision.

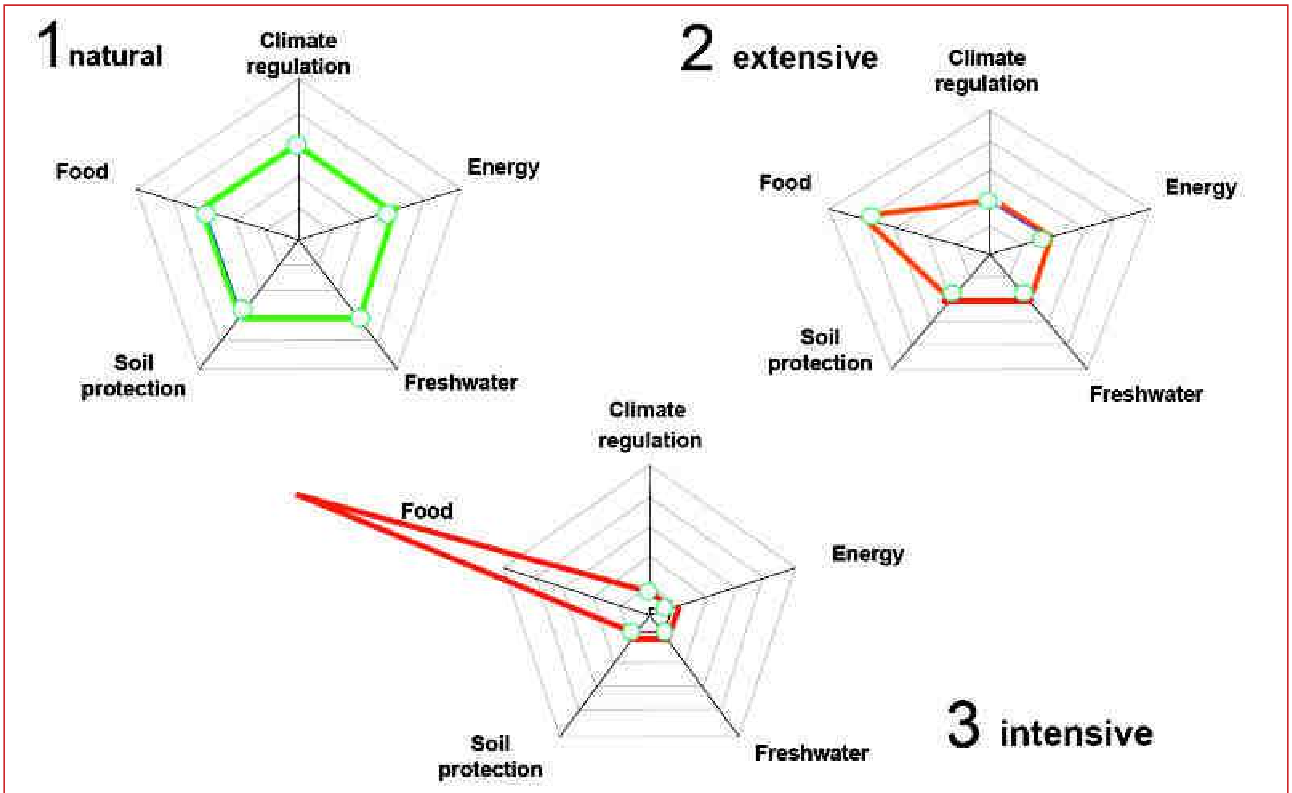
More specifically, the **choice of land use will affect the services produced and therefore who will benefit or lose and by how much**. Figure 1.9 gives a simplified example of the trade-offs involved in a decision to leave land in a natural state, convert it to extensive agriculture or convert it to intensive agriculture (excluding pollution issues). The example shows that the increasing focus on food provision entails greater loss of other services. In some cases, this may be essential and the benefits will outweigh the losses of other services. In others, the situation may be different and the main benefits from increased food provision may go to a different private interest than the former beneficiaries of the other services.

Land conversion decisions thus have important distributional impacts. Valuation helps to clarify the trade-offs between services provided and the associated trade-offs between beneficiaries of the different services. All evidence-based policy and decision-making (e.g. on spatial planning applications) should include an understanding of these implications.

Under current policy frameworks, most decisions consider trade-offs, either explicitly or implicitly e.g. for building roads and houses or designating areas as protected. However, the decision-making process does not generally see the whole picture and factor in all the benefits and costs. The loss of carbon stored in the soil when converting forests to biofuels production or the loss of species when fragmenting rivers by dams may remain invisible.

Where the value of ecosystem services are understood and included, what seemed an 'acceptable' trade-off may be found to have net costs (see site-specific example in Box 1.7). Conversely, including too little information in decision-making can lead to accidental 'lose-lose' decisions.

Figure 1.9: Land use choices and trade-offs of ecosystem service provision



Source: ten Brink, B. 2008

Box 1.7: To convert or not to convert - deciding between mangroves and a shrimp farm

Southern Thailand: Profits from commercial shrimp farming have been estimated at around US$ 9,632/ha* (Hanley and Barbier 2009). Returns to private investors in this case were particularly high not only because the farms receive subsidies but also because mangroves are an open-access resource (i.e. the investors do not have to bear the costs of mangrove rehabilitation after farm abandonment or the costs of property depreciation). For those making the private gain, the conversion decision is clearly an easy one.

However, the conclusion changes if the whole set of costs and benefits to society are considered. The shrimp farm benefits from subsidies and generates significant pollution. Adjusting for these factors, the economic return of the shrimp farm is reduced to a mere $1,220/ha* and turns negative if rehabilitation costs (around $9,318/ha*) are included. In contrast, the estimated benefits of retaining the mangroves (mostly to local communities) are around $584/ha* for collected wood and non-wood forest products, $987/ha* for fishery nursery and $10,821/ha* for coastal protection against storms (Barbier 2007). The total value of the mangrove is therefore around $12,392/ha*.

*All values are NPV over 9 years, with a productive life of 5 years of the shrimp farm, and a 10% discount rate. They are 1996 US$.

Putting private gain above public loss is a very common factor in decisions leading to loss of ecosystem services and biodiversity. As the example shows, a private investor, who receives public subsidies without having to pay for pollution or resource impacts of the activity has no incentive to avoid such damage. **The result is a potentially major public loss for a smaller private gain.** Only with a complete analysis and a due policy response (e.g. subsidy reform, payment of meaningful compensation, refusal of a permit) can cases like this be avoided.

This is a critical issue for policy-makers to address and indeed represents a fundamental argument for active public policy - to avoid global, national, or social losses that result from private gain.

COSTS AND BENEFITS OF PRO-CONSERVATION POLICIES

The issue of trade-offs is equally important for pro-conservation policies (see chapter 8). Choosing to protect a site has implications both for those already benefiting from the site and for those hoping to make use of the site by using it in another way:

- existing and potential beneficiaries include direct users (e.g. those harvesting timber) and indirect users (e.g. those dependent on filtration of water or maintenance of air quality):

- a site not under conservation will provide a range of benefits e.g. extractive benefits of timber for a private user plus other ecosystem services depending on the nature of the land, the links to population groups and the nature of the extractive activity;

- a move to conservation status is usually designed to reduce extractive use and pollution and increase provision of other ecosystem services. Conservation may therefore lead to a net benefit, although it will often be necessary to pay compensation to former users, address incentives for lost opportunity costs and pay for site management;

- there is a clear case for pro-conservation policies when the benefits of conservation (measured in terms of ecosystem services provided to wider society) outweigh the costs (including financial costs and opportunity costs). However, costs of implementing conservation are generally met locally whereas the benefits occur at multiple levels. This raises questions as to **who should pay for the conservation and what mechanisms are needed** (see in particular Chapters 5 and 8).

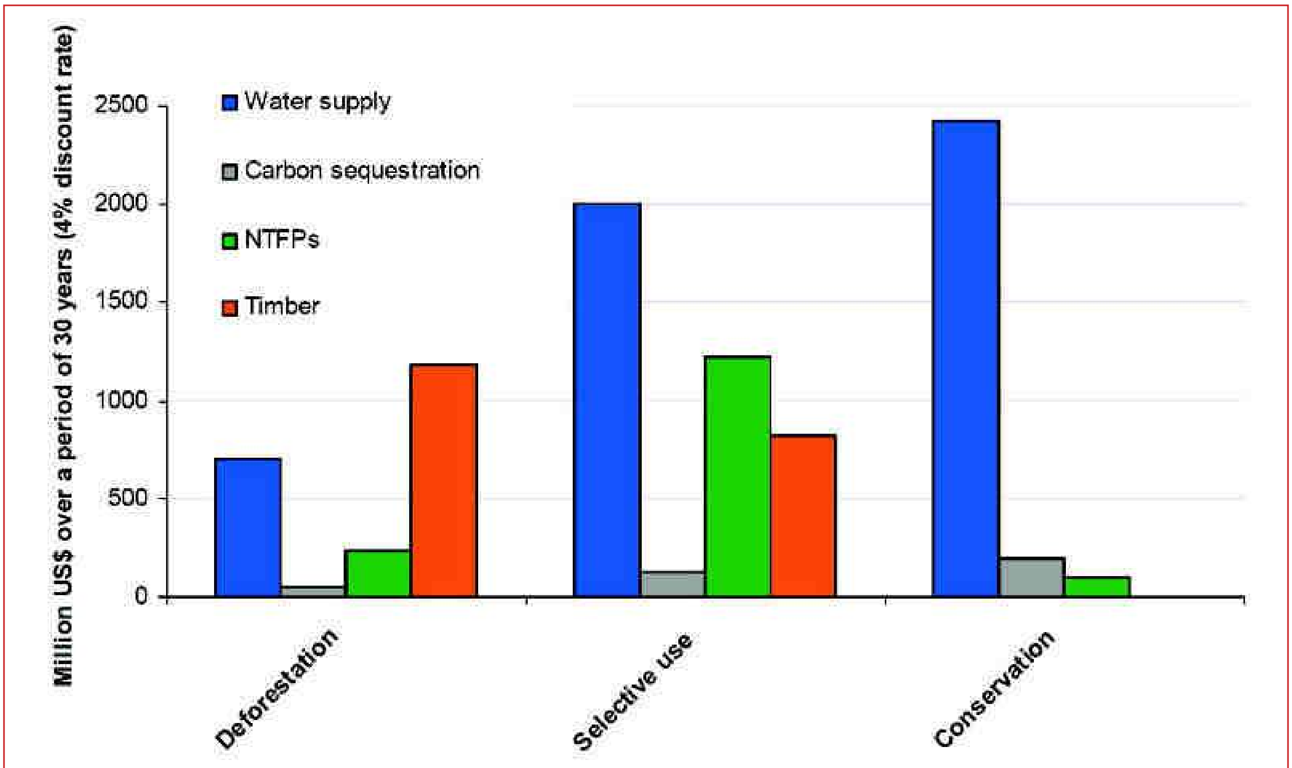
Trade-offs can be illustrated with the example of the Leuser National Park in Indonesia. Van Beukering et al. (2003) assessed the value of eleven ecosystem services of the Leuser Ecosystem in Indonesia under different land use scenarios (see Figure 1.10). Over a period of 30 years the total economic value of all eleven ecosystem services was estimated at US$ 9.5 billion for the conservation scenario and US$ 9.1 billion for the selective-use scenario, compared to an estimated income of US$ 7 billion under the deforestation scenario. The total value of four of the ecosystem services under the different land use scenarios over the period of 30 years, using a discount rate of 4%, is presented in the Figure 1.10. Deforestation is causing the degradation of important ecosystem services which leads to a decline in the overall benefit from the forest ecosystem. The conservation and selective use of the forest ecosystem allows using and maintaining a broad range of ecosystem services creating greater benefits for the local population.

1.3.4 RETURNS ON INVESTMENT IN ECOLOGICAL INFRASTRUCTURE

Avoiding unnecessary or excessive costs is in the interests of all policy-makers and economic sectors. Many services can usually be more efficiently provided by ecosystems than by artificial structures or processes. In addition to the examples below (including Box 1.8), these include fire protection by native vegetation, maintaining natural soil fertility and safeguarding genetic diversity (including crops and livestock breeds) as insurance for future food security. Investing in ecological infrastructure can be cheaper than investing in man-made technological solutions (see further Chapter 9).

Carbon capture and storage: Finding cost-effective means to mitigate climate change is essential given the scale of the challenge. Proposed man-made solutions include allocating substantial sums of money to artificial carbon capture and storage (CCS) e.g. by pumping CO_2 into the ground. Natural ecosystems (forests, agri-

Figure 1.10: Value of selected provisioning and regulating ecosystem services under different land use scenarios in the Leuser National Park, Indonesia



Source: van Beukering et al. 2003

cultural land and wetlands) already store vast quantities of carbon above the ground and in the ground, water or soil. They absorb additional amounts every year but, when lost to deforestation or degradation, lead to very significant emissions.

The proposed instrument REDD (Reducing Emissions from Deforestation and Forest Degradation), based on payment for carbon storage ecosystem services, could lead to an estimated halving of deforestation rates by 2030, cutting emissions by 1.5–2.7 Gt CO_2 per year. It has been estimated that this would require payments of $17.2 billion to $33 billion/year, but the estimated long-term net benefit of this action in terms of reduced climate change is assessed at $3.7 trillion in present value terms (Eliasch 2008). Delaying action on REDD would reduce the benefits of the instrument dramatically - delaying action on REDD by just 10 years could reduce the net benefit of halving deforestation by US$ 500 billion (see Eliasch 2008 and McKinsey 2008: see further Chapter 5 on the benefits of early action).

Box 1.8: Value for money: natural solutions for water filtration and treatment

Forests, wetlands and wetlands provide filtration for clean water at a much lower cost than man-made substitutes like water treatment plants:

- the catskills mountain case (US): $2 billion natural capital solution (restoration and maintenance of watershed) versus a $7 billion technological solution (pre-treatment plant), (Elliman and Berry 2007);
- New Zealand: in Te Papanui Catchment, the Central Otago conservation area is contributing to Dunedin's water supply, saving the city $93 million;
- Venezuela: the national protected area system prevents sedimentation that would reduce farm earnings by around $3.5 million/year (Pabon et al. 2009a);
- a third of the world's hundred largest cities draw a substantial proportion of their drinking water from forest protected areas (Dudley and Stolton 2003).

Flood control and coastline protection: Natural hazard control and mitigation can be provided by forests and wetlands (e.g. flood control) and on the coast by mangroves (e.g. reducing impacts from storms and tsunamis). Public expenditure dedicated to coastline protection against the risk of erosion and flooding reached an estimated EUR 3.2 billion in 2001, yet coastal ecological infrastructure can often do this more cheaply (see Box 1.9 and also Chapter 9).

Box 1.9: Forest investments to reduce flooding: experience from China

As a consequence of the severe floods of the Yangtse River in 1998, the Chinese government decided to invest over US$40 billion into the Sloping Land Conversion Programme. It intends to convert farmland along the river into forested area, by offering the farmers cash incentives to cede their land. This instrument aims to decrease soil erosion significantly, in order to mitigate the consequences of a flood (see further Chapter 9).

Source: Tallis et al. 2008

Fishstock regeneration in mangroves, coral reefs and inland waters: These habitats provide key fish nurseries. Protecting them from destruction and degradation can be a cost-effective means of supporting fishing whilst providing a range of other ecosystem services. In Cambodia, for example, the Ream National Park provides fish breeding grounds and other subsistence goods from mangroves worth an estimated $US 600,000 per year as well as an additional $300,000 in ecosystem services such as storm protection and erosion control (Emerton et al. 2002, see also Chapter 8).

1.3.5 IMPLICATIONS FOR POLICY-MAKERS

New public policy solutions are urgently needed to enhance the benefit that society as a whole obtains from ecosystems. This will require us to level the tilted playing field that currently favours private production over conservation of natural resources and ecosystems. Improved decision-making should take full account of the wider social benefits they provide for current and future generations and encourage markets and prices to reflect the true value of ecosystems, biodiversity and other natural resources.

Better measurement is required with regard to the role of ecosystems and biodiversity in providing services and of the value of these services, alongside improved policy assessment and tools to help make use of natural assets more efficiently.

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The tools and approaches presented in this report will therefore be relevant not only to central administrators but also to:

- statistical officers (given importance of measurement);
- planning administrators (given spatial planning needs and also permit issues);
- monitoring, permitting and inspection officers (for implementation and compliance);
- judges (for compliance and enforcement); and
- state auditors (to assess value for money on government spending).

1.4 HUMAN DIMENSIONS OF THE BIODIVERSITY CRISIS

1.4.1 ECOSYSTEM SERVICES: A LIFELINE FOR THE POOR, A NECESSITY FOR EVERYONE

It is not just wealth that is in danger, but also 'well-being' – both individual well-being and health (human capital) and social well-being and stability (social capital). The poor are often much more directly dependent on ecosystems for basic provisioning services but ultimately we all depend on nature and healthy natural systems. It is not all about dependency and negative impacts; the engagement of local communities is also a key part of the solution.

Poor populations are often the first to suffer the impact of degraded or lost biodiversity because the connection between their livelihoods and biodiversity is direct. Natural resources are a basic source of their income generation (see the discussion on 'GDP of the Poor' in Chapter 3). One less well-known aspect is that healthcare needs for the world's poor are mostly met by traditional medicines and treatments extracted from natural sources. They suffer directly from the loss of biodiversity as the cost of 'formal' healthcare medicines is often prohibitive. The TEEB Interim Report (TEEB 2008) demonstrated that there are critically important links between ecosystem services (loss) and the feasibility of achieving the Millennium Development Goals (see also Chapter 5).

Beyond material dependency, biodiversity often plays an important role in religious beliefs, traditional knowledge and social institutions. Many communities are enmeshed with the ecosystems within which they live and this connection often forms the basis of their collective identity and culture (see Box 1.10).

Box 1.10: Forests are essential for the well-being of the poor… and rural communities are often essential for the well-being of the forests

Over 90% of the world's poorest people depend on forests for their livelihoods. Some populations are entirely dependent on forests (e.g. indigenous forest peoples) and for a wide range of others, their livelihoods are fundamentally linked.

The value of non-timber forest products (NTFPs) is variously estimated at between $1/ha and $100/ha (SCBD 2001). However, in certain countries, the share of NTFP of household income as massively higher e.g. 40-60% in Chivi (Zimbabwe) (Lynam et al. 1994), 47% in Mantandia (Madagascar) (Kramer et al. 1995) and 49% in Madhya Pradesh, Orissa and Gujarat (India) (Bahuguna 2000). A loss of forest can represent a fundamental loss of income/well-being for population groups that often have no easy substitute for the loss.

At the same time, the communities can and do play an important role in the well-being of forests and there are strong arguments for making communities part of the solution to deforestation and forest degradation. 22% of all developing country forests are owned by communities. Community tenure is expected to double again by 2020 to more than 700 million hectares. In some countries the benefits communities bring is rewarded financially, for example in:

- **Ecuador:** municipal government pays communities $11-16 per hectare/year for maintaining natural forest cover and ensuring clean water supplies in the Pisque watershed;
- **Uganda:** ECOTRUST pays villagers $45.60 per hectare/year ($8 per tonne of carbon sequestered) for reforestation with native trees.

Source: Borges 2007

Vulnerability to climate shocks is unequally distributed. Hurricane Katrina provided a potent reminder of human frailty in the face of climate change, even in the richest countries – especially when the impacts are aggravated with institutionalised social inequality. Across the developed world, public concern over exposure to extreme climate risks is mounting with every flood, storm and heat wave.

Yet **climate disasters are heavily concentrated in poor countries**. Some 262 million people were affected by climate disasters annually from 2000 to 2004, over 98% of them in the developing world. In richer countries forming part of the Organisation for Economic Co-operation and Development (OECD), one in 1,500 people was affected by climate disaster over this period. The comparable figure for developing countries was one in 19 (UNDP 2007).

1.4.2 SUBSTITUTION POTENTIAL: LIMITS AND IMPLICATIONS

Typically, if we lose or damage something, we ask ourselves where to find a replacement. When a natural resource is depleted, we look for ways to acquire a substitute e.g. another fishing ground, another forest for fuel wood, another aquifer for water. In some cases, substitution of ecosystem services can happen by natural means: the services lost from the original ecosystem may be (partly) substituted for by exploiting another, similar ecosystem in some other location. In other cases, substitution of ecosystem services can be by artificial means: their loss may be substituted by technical solutions (artificial substitutes) – e.g. desalinated water or bottled water.

However, **there are limits to substitution potential** and this has very important human implications. For some services and groups of society, there are:

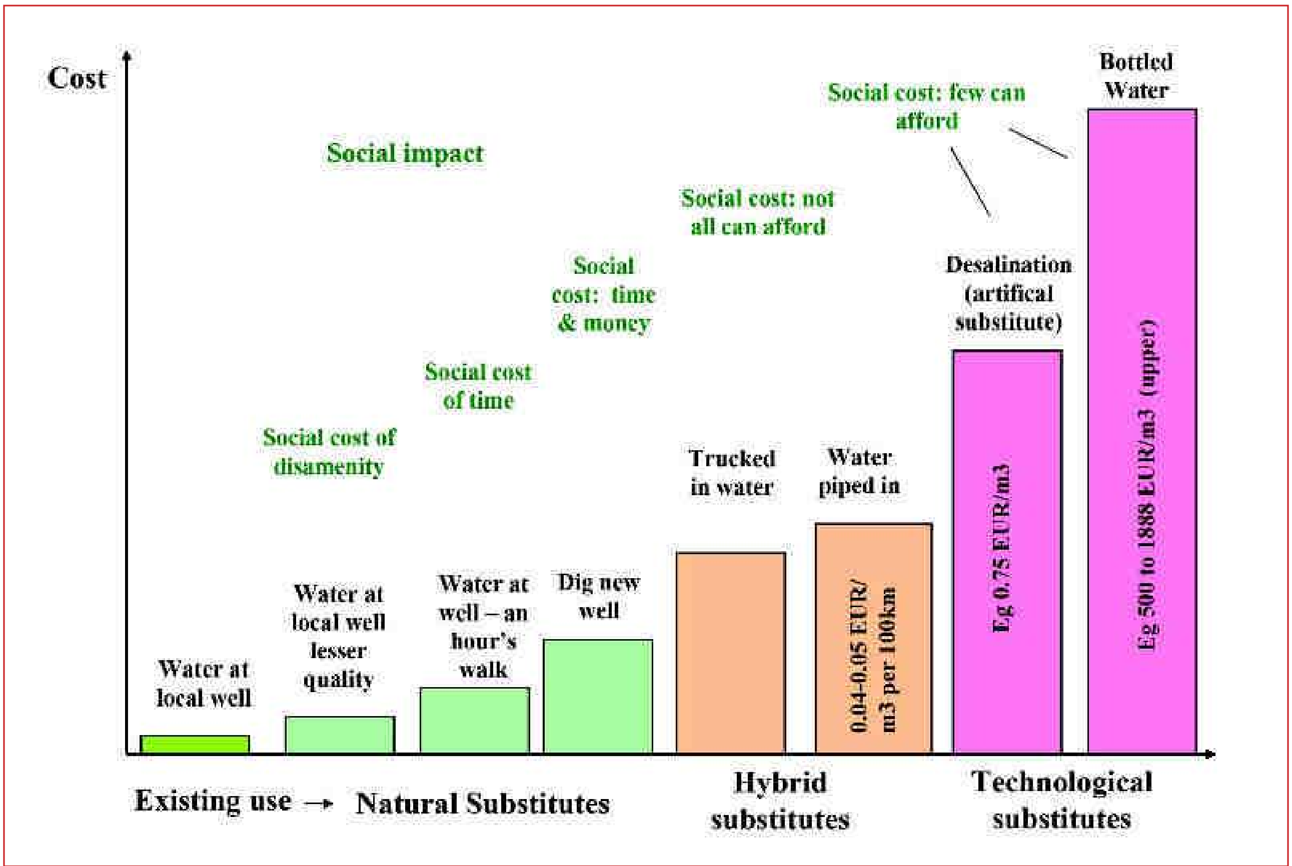
- no alternatives;
- only degraded alternatives; or
- much more costly – even unaffordable – alternatives.

Resource depletion has direct social impacts in such cases. Take fuelwood as an example. More and more time must be spent on collecting fuel or on earning money to pay for it, so less energy is available for cooking and heating. In some countries, women and children may spend 100-300 work days a year gathering wood: in Mali, some fuel wood collecting trips require walking 15 km one way and in urban areas, an average of 20-40% of cash income must be set aside to buy wood or charcoal. Fuelwood is thus a dwindling resource that is becoming more costly in every sense: deforestation can thus be a four fold loss (FAO 2006).

Figure 1.11 shows the social and cost implications of seeking substitutes. The values are illustrative as they are case specific: actual costs will obviously depend on location.

Source: André Künzelmann, UFZ

Figure 1.11: Substitution potential for ecosystem services



Source: ten Brink et al 2009

Other limits on substitution potential depend on timescale and geography as well as wealth. For example, global fishing fleets can move from one fishery to the next so for the short and probably also medium term, there is substitution potential. In the long term, however, without proper fisheries management/governance this will also hit a threshold. For local fishermen a local fish stock collapse may lead them to having no substitute to fish. The global incentives and local incentives can therefore be fundamentally different.

The situation is similar for fish protein – rich urban populations will hardly be affected by a loss of a fishery in one part of the world as there will still be fish in the supermarket. For local populations dependent on artisanal fishing, there may be no immediate substitute to loss of fish protein in their diet. This will either have health implications or knock-on effects in terms of them searching for protein elsewhere.

Substitution is of course more complex than simply finding other sources of the ecosystem service. Ecosystems are often interdependent on each other, and individual components cannot just be extracted and replaced without impacting on other associated ecosystems.

1.4.3 ENGAGING COMMUNITIES TO DEFINE POLICY SOLUTIONS

Engaging communities to be part of the process and part of the solution is invaluable. Local knowledge of ecosystems and biodiversity can reveal many opportunities (medicines, pharmaceuticals, other uses of biomimicry). Without local input, implementation may be inefficient or ineffective. Without changing the incentives people now have to convert forests or hunt for bush meat or rare species, any solution that looks good on paper is likely to fail.

This report provides many concrete examples of success stories for which local engagement has proven critical. For payments for environmental services (PES) or carbon storage programmes supported through REDD, it is generally local people who are paid for the maintenance or restoration of watersheds, forests and wetlands. Local knowledge of medicinal properties of plants makes bioprospecting more cost effective, and due sharing of the benefits can facilitate cooperation (see generally Chapter 5 on rewarding benefits).

In many southern African countries, community-based natural resource management is considered a good strategy not only to develop multi-resource livelihood activities, but also to stimulate local self-reliance and poverty alleviation (Wily 2000; Benjaminsen et al. 2002).

These types of approaches link natural capital and creation of social capital. Typically, attention is focused on restructuring the rights of access to and use of communal and/or state lands. For these programmes to be successful, the role of farmers in conserving biodiversity on their farmlands needs to be recognised, particularly the fact that rural communities through different uses have created a diversified landscape. For example, in Tanzania local communities often consciously preserve and cultivate endemic species on their village lands, because of their role to fulfil household needs, but also of wider value for crop diversity.

A country or region where the natural capital – its forests, watersheds, soil and crop varieties - is acutely run down will find it particularly difficult to meet the Millennium Development Goals (UN 2000). A concerted effort to restore natural capital will therefore be an essential part of a strategy to address the social challenges and improve community health and livelihoods.

Chapter 1 has highlighted the main issues for policy-makers raised by the **global biodiversity crisis** and outlined the economic and social case for integrating valuation across relevant policy areas. **Chapter 2** describes the **framework for the policy response** and shows how and when the benefits of biodiversity and ecosystems can be linked to policy process, opportunities and instruments.

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THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 2: Framework and guiding principles for the policy response

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Chapter 2

Framework and Guiding Principles for the Policy Response

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Key Messages of Chapter 2

TEEB shows that we sustain economic values if we reduce biodiversity loss and ecosystem degradation. Neglecting biodiversity in decision-making is economically inefficient and socially inequitable. When economic values inform policy, we improve the quality and durability of the choices we make across all sectors and levels.

Changing the tide: using economic information to improve public policies

Economic analysis needs to make visible and explicit the full value of ecosystem services and biodiversity to society, in order to expand understanding and integration of the issues at all political levels and demonstrate the risks and costs of inaction.

Economic information should be fed into each stage of the policy-making and review process to:

- identify opportunities to build on successful practices developed elsewhere;
- evaluate and improve existing biodiversity policies so that they reach their full potential;
- prioritise and guide the design of new policies;
- provide a solid basis to reform policies and consumption patterns in other areas that are shown to cause damage to ecosystem services and biodiversity.

Guiding principles for policy change

Policy makers need to consider four key factors to maximise social acceptance and meet policy objectives efficiently and fairly:

- address the right actors and balance diverse interests between and within different groups, sectors and areas, supported by robust coordination mechanisms;
- pay attention to the specific cultural and institutional context when designing policy to ensure that proposed solutions are appropriate, timely, harness local knowledge and can deliver policy goals efficiently;
- take property rights, fairness and equity into account and consider distributional impacts of costs and benefits, including on future generations, throughout the policy development process;
- base all policies on good governance: economic information leads to increasing transparency and supports good governance practices, while good governance opens the field for economic information.

2 Framework and Guiding Principles for the Policy Response

"Success will require two major shifts in how we think - as policy makers, as campaigners, as consumers, as producers, as a society.

The first is to think not in political or economic cycles; not just in terms of years or even decade long programs and initiatives. But to think in terms of epochs and eras...

And the second is to think anew about how we judge success as a society. For 60 years we have measured our progress by economic gains and social justice. Now we know that the progress and even the survival of the only world we have depends on decisive action to protect that world".

Gordon Brown, British PM (2009), speech on the "Roadmap to Copenhagen manifesto on the challenge of climate change and development" (London, 26 June 2009)

Chapter 2 calls for stronger public policy to tackle the global biodiversity crisis. **2.1** outlines **obstacles to policy change** linked to the lack of economic information on ecosystem services and biodiversity. **2.2** shows through concrete examples **how** and when **economic values can be incorporated** into decision-making. **2.3** sets out **guiding principles** for policy change, paying particular attention to equitable distribution of costs and benefits. **2.4** summarises the **range of instruments available** to decision-makers, with cross-references to relevant chapters of this TEEB report.

2.1 WHY IS BIODIVERSITY NEGLECTED IN DECISION-MAKING?

Biodiversity policy is not a new field. In recent decades, nearly all countries have adopted targets and rules to conserve species and habitats and to protect the environment against pollution and other damaging activities. **Policies and measures that have positively affected biodiversity and ecosystem services can take a wide variety of forms** (see Box 2.1).

BOX 2.1: Examples of policies that have provided biodiversity conservation benefits

- Growth of protected area systems in developed and developing countries;
- Development of integrated water resource ma nagement (e.g. EU Water Framework Directive);
- Legal recognition of liability for environmental damage (e.g. for oil spills);
- Incentives to reward biodiversity management (e.g. payments for ecosystem services in Costa Rica);
- Protection of critical habitats (e.g. through the Natura 2000 network, EU Habitats Directive);
- Market based instruments (e.g. green tax transfer scheme between states in Brazil, wetland mitigation banking in US);
- Regulations to stop or limit the release of pollutants into rivers and groundwater systems, improve air quality and reduce the emissions of greenhouse gases (GHG) into the atmosphere.

Despite this progress, **the scale of the global biodiversity crisis (see Chapter 1) shows that current policies are simply not enough to tackle the problem efficiently**. Some of the reasons are only too familiar to policy-makers, such as lack of financial resources, lack of capacity, information and/or expertise, overlapping mandates and weak enforcement. But there are also **more fundamental economic obstacles** in this policy field which we need to understand to make meaningful progress.

A root cause of the **systematic neglect of ecosystems and biodiversity** in economic and development policy is their characterisation as a **public and often global good**:

- **benefits take many forms and are widespread,** which makes it difficult to 'capture' value and ensure that beneficiaries pay for them. For example, a forest provides local benefits to local people (timber, food, other products); the forest ecosystem mediates water flows and provides regional climate stability; and forests are globally important because they sustain biodiversity and act as long-term carbon sinks;

- **existing markets and market prices only capture some ecosystem services** (e.g. ecotourism, water supply). More commonly, individuals and businesses can use what biodiversity provides without having to pay for it, and those providing the service often don't get due recompense;

- **costs of conservation and restoration are paid immediately, often at local level, yet many benefits occur in the future.** For example, creating a protected area to save endangered species can cause short-term losses to user groups, which may lead us to give little or no weight to the possible long-term benefits (e.g. discovery of medicinal traits in such species).

Further factors include:

- **uncertainty about potential future benefits is matched by ignorance about the risks of inaction.** We know too little about why each species is important, what its role in the food web is, what could happen if it goes extinct and the 'tipping points' of different ecosystems. Uncertainties lead policy makers to hesitate: spending money on policies with clear returns seems preferable to spending on policies with less assured outcomes;

- **deterioration of ecosystem services and biodiversity often occurs gradually: marginal impacts of individual and local action can add up to severe damage at the global scale.** For example, small-scale assessment of individual development projects (e.g. forest clearance for agriculture or housing) can indicate a positive cost-benefit ratio but cumulative impacts in terms of deforestation and habitat fragmentation can be far higher.

These factors all contribute to a systematic bias in decision-making. Decisions about management of biodiversity involve trade-offs: if we want to keep ecosystem services, we often give something up in return. Currently, where trade-offs have to be made between biodiversity conservation and other policy areas (e.g. agriculture, industry, transport, energy), the lack of compelling economic arguments means that decisions very often go against biodiversity.

Source: André Künzelmann, UFZ

Newly constructed highway cutting protected area near Leipzig, Germany.

2.2 CHANGING THE TIDE: USING ECONOMIC INFORMATION TO IMPROVE PUBLIC POLICIES

"Poverty and environmental problems are both children of the same mother, and that mother is ignorance".

Ali Hassan Mwinyi, Tanzanian President in 1998

There is a compelling rationale for governments to lead efforts to safeguard ecosystem services and biodiversity. Public environmental policy needs to be based on moral values (concern for human well-being), intrinsic values (not letting species go extinct) and good stewardship, whilst taking economic considerations into account. These overarching values need to guide and shape new policy responses to reduce current losses and invest in healthy functioning ecosystems for the future.

Private actors (businesses and consumers) have a growing role to play in choices that affect our natural capital. However, a strong policy framework is needed to ensure that decisions are efficient (society gets the most it can from its scarce biodiversity) and equitable (the benefits of biodiversity are distributed fairly). Appropriate regulation provides the context in which markets for certain ecosystem services can evolve as well as mechanisms to monitor their effectiveness.

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2.2.1 HOW CAN ECONOMIC VALUES HELP?

Focusing on the services provided by biodiversity and ecosystems is critical to overcome their traditional neglect. The Millennium Ecosystem Assessment (see Chapter 1) paved the way for indicators to show the status of ecosystem services (see Chapter 3). TEEB goes one step further by using information on the value of such services to give new impetus to decision-making.

The transition from acknowledging services to valuing them may seem a small step but it is a huge step towards raising awareness. We can now demonstrate that biodiversity and ecosystem services have value, not only in the narrow sense of goods and services in the marketplace but also – and more importantly – because they are essential for our lives, survival and well-being. This is the case even if markets do not exist or if these values are not expressed in monetary terms: values can also be based on qualitative or semi-quantitative assessments. What we actually measure in monetised form is very often only a share of the total value of ecosystem services and biodiversity. 'True' values are usually much higher (see Chapter 4).

Valuation can help policy-makers by shedding light on the contribution made by different ecosystem services, whether directly and indirectly (see Box 2.2).

Using economic values during the choice and design of policy instruments can:

- help overcome the systematic bias in decision-making by demonstrating the equivalence of values (between e.g. manufactured capital and natural capital, present and future benefits/costs, and different resource types) even where these are not monetised or represented by market prices;

Box 2.2: Multiple values of wetlands: example of the Daly River catchment (Australia)

A 2008 study to assess the value of one catchment in the Northern Territory covering over 350,000 hectares put the current use value at about Aus$ 390/hectare (almost Aus$ 139 million for the whole catchment). Estimated values in 2004 per hectare for different catchment benefits included:

- carrier function for crop growing, pastoralism and crocodile hunting: Aus$ 31/ha;
- habitat function as a contribution to nature conservation: Aus$ 1/ha;
- regulation function (water use, carbon sequest-ration): Aus$ 298/ha;
- information function/cultural service (tourism, recreational fishing): Aus$ 57/ha.

Source: de Groot et al. 2008

Source: Christoph Schröter-Schlaack

- demonstrate that even if biodiversity benefits are multi-faceted and diffuse, they can be subsumed or aggregated within certain broader values (e.g. for forests);
- help create new markets where none previously existed (e.g. the recently created markets for GHG emissions are powerful examples from climate policy of what can be achieved where market-based approaches are developed for environmental goods within a strong policy framework); and
- help to make future benefits visible, rather than simply relying on today's costs (e.g. by identifying option values of plants from tropical forests relevant for pharmaceutical products, or the potential of tourism).

2.2.2 WHEN CAN ECONOMIC VALUES HELP?

There are many steps in the policy-making process where information on ecosystem and biodiversity values can be systematically used. Economic information is an important vehicle to raise public awareness and to address new policies in the process of agenda setting or policy formulation. It **can form the basis for new policies – and can provide starting points for policy change** (see Table 2.1).

Table 2.1: Where are economic insights useful to the policy process?

Stage	Major Steps	Type and role of economic information
Problem identification & agenda setting (Get safeguarding biodiversity and ecosystem services onto the political agenda)	• make the case for preservation of biodiversity by providing evidence of losses, ecological and economic impacts • illustrate the link between biodiversity with other pressing environmental, economic, or social pressures (e.g. climate change, financial crises, poverty reduction) - help policy coherence • involve other sectors in framing biodiversity concerns and link it to their concerns – engagement and ownership • conduct biodiversity analysis in advance to be prepared for opening new windows of opportunity	• e.g. economic numbers about values of biodiversity losses • e.g. carbon value of forests • give numbers on the option values of tropical forests with regard to pharmaceutical products
Policy formulation & decision- making (Formulate alternative policy options and decide which alternative should be adopted)	• analyse the root causes of the loss of biodiversity and ecosystem services • agree on objectives for the potential policy solution • set up rules for resolving biodiversity conflicts among stakeholders • formulate alternative policy solutions • weed out solutions that are clearly unfeasible on political or administrative grounds • agree on the criteria for comparing alternative policy solutions • select indicators for each criterion • project, compare, and communicate to decision-makers the impacts of each solution against the agreed indicators • decide on the most acceptable solution and define additional measures as needed to maximise synergies and minimise trade-offs	• costs and benefits of policy alternatives (e.g. comparing technical water treatment facilities with constructed wetlands) • developing indicators that show the values associated with biodiversity loss and the degradation of ecosystem services (quantitative and monetary)
Implementation (Carry out the adopted policy including 'planning' or making 'plans' to deliver expected policy outcomes & monitoring)	• secure formal authorisation and resource allocation proactively for implementation • conduct operational planning • ensure and manage stakeholder participation • strengthen administrative capacity by - ensuring that monitoring systems are in place to measure pressures or impacts on biodiversity and ecosystem services - providing adequate funding (e.g. for managing Protected Areas or for monitoring activities)	• evaluation of the costs of alternative monitoring schemes • identification of relevant stakeholders (beneficiaries and cost-carriers) and their respective interests • justify compensation payments for losers
Evaluation (Determine whether a policy has been implemented successfully or not based on the results of monitoring)	• determine and publicise the scope and criteria for evaluation based on the purpose of evaluation and information requirements • involve statistical offices and determine which data/ information systems to use from the outset • collect information through monitoring, conduct evaluation, and involve stakeholders • draw lessons and propose policy improvements and provide lessons generally	• e.g. local authorities' monitoring stations, statisticians' analysis, companies' monitoring demonstrate that economic values are lost • ex-post valuation of benefits and costs
Inspections, compliance enforcement and non-compliance response (check whether policies are being implemented and if not addressed by suitable means)	• ensure inspection capacity and plans to inspect • depending on national circumstances request technical measures/changes, administer fines, or send to courts for non-compliance response and penalties	• cost-effectiveness of inspection • implement the polluter pays principle • applying economic instruments such as fines/penalties, compensation payments or remediation in kind

Adapted from UNEP 2000: 8 (quoted source: Howlett and Ramesh 2003)

Box 2.3 provides examples of how **economic information can be applied at decision-making stage.**

Box 2.4 illustrates the use of economic valuation at a later stage, after damage has occurred, to guide legal remedies and the award of compensation.

Box 2.3: Using valuation as part of a decision support system

Indonesia: the Segah watershed (Berau District) contains some of the largest tracts of undisturbed lowland forest in East Kalimantan (150,000 hectares) which provide the last substantial orang-utan habitat. A 2002 valuation study concluded that water from the Segah river and the nearby Kelay river had an estimated value of more than US$ 5.5 million/year (e.g. regulation of water flow rates and sediment loads to protect infrastructure and irrigation systems). In response to these findings, the Segah Watershed Management Committee was established to protect the watershed.

Source: The Nature Conservancy 2007

Uganda: the Greater City of Kampala benefits from services provided by the Nakivubo Swamp (catchment area > 40 km^2) which cleans water polluted by industrial, urban and untreated sewage waste. A valuation study looked at the cost of replacing wetland wastewater processing services with artificial technologies (i.e. upgraded sewage treatment plant, construction of latrines to process sewage from nearby slums). It concluded that the infrastructure required to achieve a similar level of wastewater treatment to that naturally provided by the wetland would cost up to US$2 million/year c.f. the costs of managing the natural wetland to optimise its waste treatment potential and maintain its ecological integrity (about US$ 235,000). On the basis of this economic argument, plans to drain and reclaim the wetland were reversed and Nakivubo was legally designated as part of the city's greenbelt zone.

Sources: Emerton and Bos 2004; UNDP-UNEP Poverty-Environment Facility 2008

Box 2.4: Economic valuation of damages to enforce liability rules

The accident of the Exxon Valdez tanker in 1989 triggered the application of Contingent Valuation Methods for studies conducted in order to establish the magnitude of liability for the injuries occurred to the natural resources, under the Comprehensive, Environmental Response, Compensation and Liability Act (CERCLA). A panel headed by Nobel laureates K. Arrow and R. Solow appointed to advice NOAA on the appropriateness of use of CVM in nature resource damage assessments. In their report the panel concluded that CVM studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment including passive-use values. To apply CVM appropriately, the panel drew up a list of guidelines for contingent valuation studies. While some of the guidelines have attracted some criticism, the majority has been accepted widely.

Source: Navrud and Pruckner 1996

2.2.3 BROADER USES OF ECONOMIC VALUES IN POLICY-MAKING

Successful biodiversity policies are often restricted to a small number of countries, because they are unknown or poorly understood beyond these countries. **Economics can highlight that there are policies that already work well, deliver more benefits than costs and are effective and efficient.** The REDD scheme (Reducing Emissions from Deforestation and Degradation), introduced as a key climate policy instrument in 2007, has already stimulated broader interest in payment for ecosystem services (PES) (see Chapter 5). Several countries and organisations have collated case studies on REDD design and implementation that can be useful for other countries and applications (Parker et al. 2009). Other examples of approaches that could be used more widely for biodiversity objectives include e.g. green public procurement and instruments based on the polluter-pays principle (see Chapter 7).

Economic analysis can **help existing instruments work better.** Using assessment tools (see Chapter 4) to measure and compare the efficiency and cost-effectiveness of existing policies can ensure that instruments can reach their full potential. Assessment provides ongoing opportunities to review and improve policy design, adjust targets and thresholds and make the positive effects of protection visible (e.g. for protected areas). The process increases transparency and can contribute to acceptance of restrictive policies by stakeholders.

Economic assessment can **make explicit the damage caused by harmful subsidies.** Policy instruments that do not take nature into account often have a net negative impact because of their harm to biodiversity and eco-system services. Examples may include subsidies for housing that encourage land conversion and urban sprawl in natural areas and fisheries or agricultural subsidies that are harmful to biodiversity and ecosystems (see Chapter 6).

Economic information **allows policy makers to simultaneously address poverty issues** and social goals if the distribution of costs and benefits to different groups in society is included in the analysis. Such analysis can highlight the importance biodiversity and ecosystem services have for poorer segments of the population in many countries. When designed accordingly, biodiversity policies can contribute to alleviating poverty (see Table 2.2).

Table 2.2: How biodiversity policies affect development policy and poverty alleviation

Action	Country	Conservation	Development / Poverty alleviation	Further information
China's Sloping Land Program	China	• 14.6 million hectares reforested (by 2010)	• Alternative income • Targeted ethnic minority groups • Flood control	*http://www.cifor.cgiar.org/pes/publications/pdf_files/China_paper.pdf*
Quito's Water Fund	Ecuador	• 3.5 million trees planted • Nine park guards hired • Hydrology monitoring program started	• Alternative income • Education • Clean water • Conflict resolution training • Technical capacity building	*http://www.unep.org/gc/gcss-viii/USA-IWRM-2.pdf*
Il'Ngwesi Eco-lodge	Kenya	• Increasing wildlife populations • Poaching controls	• Alternative income • Education (school funded) • Security (poaching controlled)	*http://www.ilngwesi.com/*
Namibia's Conservancy Programme	Namibia	• Increasing wildlife populations • Overgrazing controlled • Landscape connectivity improved	• Alternative income • Property rights • Cultural equality • Gender equality	*http://www.met.gov.na/programmes/cbnrm/cons_guide.htm*
Cape Peninsula Biodiversity Conservation Project	South Africa	• Invasive plant eradication • Antelope species reintroduction • Increasing raptor population • Establishment of Protected Area	• Improved infrastructure • Alternative income	*http://www.ffem.fr/jahia/webdav/site/ffem/users/admiffem/public/Plaquettes_projet/Biodiversity_peninsuleCap_eng.pdf*

Source: adapted from Tallis et al. 2008

2.3 GUIDING PRINCIPLES FOR POLICY CHANGE

"The Earth is sick from underdevelopment and sick from excessive development"

UN Secretary General Boutros Boutros-Ghali
in his opening address to the 1992 Earth Summit

As well as taking economic values into account, policy makers need to consider the following factors when designing an effective process:

- many different actors are concerned, with highly diverse interests;
- each country's cultural and institutional context is different;
- ethical considerations and distributional issues are critical to fair and durable solutions; and
- good governance must underpin successful policy implementation.

2.3.1 ADDRESS THE RIGHT ACTORS AND BALANCE INTERESTS

Decisions affecting ecosystem services and biodiversity are made and influenced by widely varying actors.

Box 2.5: Actors and stakeholders in marine policy – more than just fishermen

Key players at sea range from those who pollute the seas to those who use its resources. Relevant policy areas cover not only shipping and dumping of waste at sea but also border/customs operations, land-based industry and agriculture (e.g. run-off from nitrates or chemicals). Very often, these same actors have a direct interest in conserving water quality (e.g. local communities, fishermen, public authorities). While some groups may be able to adapt to policy change and diminish their negative impacts (e.g. by adjusting shipping routes), others may have greater difficulty in reducing their impact on marine resources.

Source: Berghöfer et al. 2008

Governments and public authorities are responsible for setting policy but a whole series of other groups (industry and business, consumers, landowners, NGOs, lobbyists, indigenous people etc.) also make decisions that affect the natural environment (see Box 2.5). The challenge is to identify all relevant actors, mobilise 'leaders' and ensure that they have the necessary information and encouragement to make the difference.

Involving stakeholders is essential and has several advantages. Many of the people affected by damage to biodiversity and ecosystems have access to information or expertise not available to the general public. They also stand to win or lose most from policy changes. Such groups can play a central role in setting policy targets and implementing concrete solutions. One option is to reward local 'champions' active in taking up new challenges (see Box 2.6).

Box 2.6: Rewarding environmental leaders: two examples of national practice

In 2004, the Chinese Environmental Award was established to reward outstanding efforts to safeguard natural resources and capital. It has so far been granted to five groups and individuals e.g. the 2006 award for Best Ecological Performance on Environmental Protection went to the Forest Police Station of Xi Shuang Ban Na, Yunnan Province, a biodiversity hotspot (*http://www.cepf.org.cn/en/Leading*).

Similar programs include:

- the KEHATI award in Indonesia (*http://us.kehati.or.id/news/kehati-award-2009.html*);
- the *Premio de Reportaje sobre Biodiversidad* in South America (*www.premioreportaje.org*); and
- the Equator Prize for outstanding efforts to reduce poverty and biodiversity conservation (*http://www.equatorinitiative.org*).

Source: China's Third National Report on Implementation of the CBD

Biodiversity is the ultimate cross-cutting issue and **several policy fields have significant implications for biodiversity** (transportation, trade, land use policy, regional planning, etc.). Such policies can have negative impacts on biodiversity or be designed to promote positive synergies.

Even within single sectors there is a broad range of different stakeholders and interests. Production patterns can vary from environmentally sensitive to high impact. Within agriculture, for example, eco-farming is associated with sustainable land use practices and mitigation of soil depletion or erosion whereas industrialised farming involves monocultures and intensive use of fertilizers and pesticides.

Additional challenges arise where policy-making involves several governmental levels e.g. global negotiation rounds or supranational organisations, national policy-makers, regional administration or local interest groups. Many international agreements and mechanisms are in place to streamline cooperation across boundaries. To improve water resource management, for example, more than 80 special commissions with three or more neighbours have been established in 62 international river basins (Dombrowsky 2008).

Policy makers can build on the high number of treaties that target the protection of species, habitats, genetic diversity or biodiversity as a whole (see Table 2.3 for some examples).

Table 2.3: International conventions addressing biodiversity issues

Name of Convention	Enactment	Signatories	Aim	Address
Convention on Biological Diversity	1993	191	• Conservation of biological diversity • Sustainable use of its components • Fair and equitable sharing of the benefits arising out of the utilization of genetic resources	*www.cbd.int/*
World Heritage Convention	1972	186	• Promote cooperation among nations to protect heritage of outstanding value	*http://whc.unesco.org/en/convention/*
Conv. on Intern. Trade in Endangered Species of Wild Fauna and Flora	1975	171	• Ensure that international trade in specimens of wild animals and plants does not threaten their survival	*www.cites.org/*
Convention on Wetlands (Ramsar Convention)	1975	159	• Conservation and use of wetlands through local, regional and national actions and international cooperation	*www.ramsar.org/*
International Treaty on Plant Genetic Resources for Food and Agriculture	2004	120	• Recognizing the contribution of farmers to the diversity of crops • Establishing a global system to provide farmers, plant breeders and scientists with access to plant genetic materials • Ensuring benefit sharing from the use of genetic materials within the originating countries	*www.planttreaty.org/*
Convention on the Conservation of Migratory Species of Wild Animals	1983	111	• Conservation of terrestrial, marine and avian migratory species throughout their range	*www.cms.int/*
International Convention on whaling	1946	75	• Provide for proper conservation of whale stocks	*www.iwcoffice.org/*
African Convention on the Conservation of Nature and Natural Resources	1969 (Update in 2003)	38	• Encourage individual and joint action for the conservation, utilization and development of soil, water, flora and fauna for the present and future welfare of mankind	*www.unep.ch/regionalseas/legal/afr.htm*

In parallel, however, **adopting the ecosystem services approach may necessitate amendments to international conventions** and standards in other policy sectors. For example, current WTO rules prohibit the introduction of certain environmental standards (e.g. with respect to timber) as they would violate free trade principles.

Mechanisms to ensure policy coordination and coherence between different sectors and levels of government are therefore essential, both within and between countries. Spatial planning is an important part of this equation. A large amount of environmental decision-making takes place close to the ground (e.g. permitting, inspection, planning decisions, enforcement) which means that local administrations and actors need to be aware, involved and adequately resourced (see TEEB-D2 Report for Local Policy Makers and Administrators forthcoming).

2.3.2 PAY ATTENTION TO CULTURAL AND INSTITUTIONAL CONTEXT

Policy makers need to consider local culture and institutions when deciding which policies are likely to be appropriate or acceptable. The success of policy reforms may also be influenced by right timing.

A country's cultural context (e.g. religious norms or morality, level of civil society engagement) and institutional context (e.g. laws, regulations, traditions) can provide useful entry points for biodiversity conservation.

Policy options may be easier to implement and enforce when they fit easily into existing regulations and do not need substantial legislative changes or re-allocation of decision-making power. Establishing a protected area or restricting use of a certain resource can be easier if backed by religious norms. Market-based tools to manage ecosystem services may be more easily accepted in countries that use markets for pollution control or nature protection (e.g. USA) than in regions relying on traditional regulatory norms (e.g. most European countries).

The importance of traditional knowledge related to biodiversity is increasingly recognised by scientists, businesses and policy-makers. In some countries, scaling up traditional use patterns and local management practices to the regional or national level may be more easily accepted than top-down approaches. The first step towards this goal involves the systematic collection of relevant local knowledge (see example in Box 2.7).

Box 2.7: Upholding traditional knowledge through People's Biodiversity Registers (India)

People's Biodiversity Registers (PBR) were initiated in India in 1995 to record rapidly eroding folk knowledge of medicinal uses of plants. Their focus has since been broadened to cover wild varieties of cultivated crops to support on-farm conservation and promotion of farmer's rights. PBR record information on species, their habitats, the price of biological produce and regulations governing harvests.

The most ambitious PBR to date covers 52 sites in 7 states. This huge database is designed to:

- facilitate community regulation of access to biodiversity resources leading to sustainable harvests;
- promote knowledge-based sustainable management of agriculture and the sustainable use of live stock, fish, forests to enhance public health and the quality of life of the community members;
- generate funds through imposition of collection fees for access to biodiversity resources;
- stimulate conservation of valuable natural resources; and
- achieve fair sharing in the benefits of commercial application of local knowledge.

Source: Gadgil et al. 2006; India's Third National Report on Implementation of the CBD; Verma 2009

As in any policy area, new instruments and measures can face difficulties not only when being negotiated but also in day-to-day implementation and enforcement. **Good design, good communication and good will are particularly important to boost compliance with environmental policy instruments** which need backing from affected stakeholders to be fully effective. For example, payment schemes to reward biodiversity-friendly agricultural practices will only work well if people fully understand the scheme and do not face other obstacles when participating (see example in Box 2.8).

Box 2.8: Obstacles to success: example of a carbon sink project, Colombia

The PROCUENCA project (Chinchiná river basin) was launched in 2001 to develop sustainable forestry in an area suffering from deforestation and expansion of agriculture and grazing, increase local biodiversity and improve ecosystem connectivity. Compensation to landowners was mainly provided through the sale of carbon credits resulting from the future forest's carbon storage potential. Although participants manage their plantations independently, this is conditional on the constraints imposed by selling credits on the carbon market. Uncertainty related to the process, prices and approvals meant that local farmers could not tell if income generated would cover the loans taken out to join the project. As a result, take-up was limited, few farmers attended special training, some local leaders denied the existence of the programme and 78% of farmers surveyed mentioned logging and sales as perceived economic benefits. Moreover, a study of CENSAT Agua Viva in 2008 found out that the project may have stimulated replacing old-grown forests by plantations eventually leading to a negative biodiversity impact.

Source: Global Forest Coalition 2008

Source: André Künzelmann, UFZ

'Windows of opportunity' can help decision-makers secure policy change. These can open in response to increased awareness of environmental problems (e.g. concern over ozone led to the Montreal Protocol and, over climate change, to the REDD mechanism which has great potential for broader application to biodiversity-related issues (see Chapter 5)). Current crises (e.g. food prices, oil prices, credit) **could provide new opportunities to phase out expensive subsidies harmful to biodiversity** e.g. in agriculture or fisheries (see Chapter 6). Policy windows can also result from reaction to catastrophe (see Table 2.4).

One countries' move is another country's (window of) opportunity to follow. Political 'champions' who propel a new problem up the policy agenda and offer innovative solutions (e.g. PES in Costa Rica, REDD in Guyana) can catalyse progress at a regional or global level. Sharing information about success stories through TEEB is a practical way to learn from experience elsewhere and develop solutions appropriate to national needs and priorities.

Table 2.4: Catastrophic events creating 'windows of opportunity' for policy change

Event (catastrophe; hazard, accident)	Policy Results
1976 industrial accident in chemical plant near Seveso, Italy, releasing highly toxic TCDD (dioxin) contaminating four communities.	Introduction of **Seveso Directive (EU)** (1982/1996/2003) requiring the establishment of emergency plan, regular security checks and inspections to reduce industrial accidents related to dangerous substances *http://ec.europa.eu/environment/seveso/index.htm*
1999 oil spill of tanker "Erika": lost 10 million litres of oil causing the death of up to 100,000 birds near the French Atlantic coast.	Within the EU, the "Erika I package" (legislation for **double hulled ships and** Liability Directive). 79% of oil tankers in global shipping are now double-hulled. *http://europa.eu/legislation_summaries/transport/waterborne_transport/l24231_en.htm*
2000 pollution of Danube River caused by a cyanide spill following a damburst of a tailings pond in Baia Mare/Romania	**Mining Waste Directive (EU)**, 2006, requiring a waste plan containing expected waste quantities, qualities and measures of disposal, to be proven by administrators *http://ec.europa.eu/environment/waste/mining/index.htm*
2004 Tsunami in South East Asia causing the death of more than 200,000 civilians	A range of international projects and investments in **mangrove restoration** to increase security through natural coastal barriers against waves (e.g. EU Asia Pro-Eco II B Post Tsunami Project, Mangrove Action Project) *http://ec.europa.eu/world/tsunami/rehab_reconstruc.htm*
2005 Hurricane Katrina in the U.S. with over 2000 casualties. Estimated cost US$ 90 billion (costliest tropical cyclone in history).	Arguably triggered greater support for a **commitment** to addressing climate change and for wetland restoration. Rising **awareness** and mainstreaming, e.g. mass media, documentary "An inconvenient truth". *http://www.hhs.gov/disasters/emergency/naturaldisasters/hurricanes/katrina/index.html*

Destruction after hurricane

2.3.3 TAKE PROPERTY RIGHTS, FAIRNESS AND EQUITY INTO ACCOUNT

"It took Britain half the resources of the planet to achieve its prosperity; how many planets will a country like India require?"

Mahatma Gandhi

New strategies and tools for protecting biodiversity and sustaining ecosystem services often involve changes in rights to manage, access or use resources ('property rights'). The distributional implications of policy change, particularly for vulnerable groups and indigenous people, require up-front identification and consultation throughout the policy development process.

Most people would agree that other species have a right to co-exist with us on Earth and that it is important to maintain biodiversity in a state able to provide benefits to humans.

The above statement raises **ethical issues and practical questions of responsibility for policy makers.** Should a landowner have to stop using part of his land to help a threatened species? Plant trees to protect freshwater resources? Be compensated for losses or reduced gains as a result of new biodiversity policies? Should people have to leave land to which they do not hold formally registered rights, even if they have lived there for generations? When a pharmaceutical company discovers an important drug derived from a plant species in a tropical rainforest, who will reap the benefits? The company? The country of origin? The forest people?

At least three **arguments support consideration of property rights and distributional impacts** as an integral part of policy development:

- reasons of equity: fairness in addressing changes of rights between individuals, groups, communities and even generations is an important policy goal in most countries;
- taking distributional issues into account makes it much more feasible to achieve other goals when addressing biodiversity loss, particularly related to poverty alleviation and the Millennium Development Goals (see Table 2.2 above);

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- there are almost always winners and losers from policy change and in most cases, loser groups will oppose the policy measures. If distributional aspects are considered when designing policies, the chances of successful implementation can be improved.

Rights to use, manage or benefit from natural resources can take many forms (see Box 2.9).

Box 2.9: How do 'property rights' apply to biodiversity and ecosystem services?

'Property rights' is a generic term covering a bundle of different rights over a resource (P). Not all of these are necessarily held by the same person:

- The **Right to Use**: A has a right to use P;
- The **Right to Manage**: A has a right to manage P and may decide how and by whom P shall be used;
- The **Right to the Income**: A has a right to the income from P i.e. may use and enjoy the fruits, rents, profits, etc. derived from P;
- The **Right of Exclusion**: Others may use P if and only if A consents:
  · If A consents, it is prima facie not wrong for others to use P;
  · If A does not consent, it is prima facie wrong for others to use P.
- The **Right to Transfer**: A may temporarily or permanently transfer user rights to specific other persons by consent.
- The **Right to Compensation**: If B damages or uses P without A's consent, then A typically has a right to receive compensation from B.

In addition, two rules are considered relevant to the concept of property rights:

- Punishment Rules: If B interferes with A's use of P or uses P without A's consent, then B may be punished in an appropriate way;
- Liability Rule: If use of P causes damage to the person or property of B, then A (as P's owner) may be held responsible and face a claim for damages.

Source: Birner 1999: 44

What complicates matters for the policy maker is that **different rights are often held by different people or groups in society**. A forest might be owned by the state, local people might have a right to use some of its products, rights for water coming from this area might be held by third parties and international companies might hold concessions for deforestation. This legal and historic complexity needs to be considered when adjusting or introducing policies for ecosystem services and biodiversity (see Box 2.10).

BOX 2.10: Policy challenges related to uncertain property rights in the Amazon

Only 14% of private land in the Amazon is backed by a secure title deed. Uncertainty over land ownership leads to violence between different groups, makes it hard for public authorities to prevent illegal deforestation and encourages short-term management (i.e. destruction of the forest through cutting timber and cattle grazing). In practice, deforestation is often used as a way of establishing property rights.

In 2009, Brazil announced its intention to transfer around 670,000 square kilometres (roughly the size of France) into private ownership "to guarantee that people have ownership of land, to see if we can end the violence in this country" (President Luna). Under the proposal, the smallest areas (<100 hectares) would be handed over for free, medium-sized plots would be sold for a symbolic value and larger estates (<1,500 hectares) would be auctioned at market prices. However, this fundamental change in property rights is contentious among Brazilians. Some NGOs have argued that this proposal amounts to an amnesty for land-grabbers and the "bill will be a major signal indicating to the people who enjoy impunity that it worth committing a crime in the Amazon".

Sources: The Economist, 13 June 2009; BBC News, 23 June 2009

The specific social context of each country will also influence the design and likely success of policy initiatives (see Box 2.11).

Copyright by Seppo Leinonen (Finland).

Box: 2.11: Impact of minority rights on conservation in China's Wolong Nature Reserve

This Reserve was established in 1975 as a flagship project to conserve endangered giant pandas. Research carried out 25 years later (Liu et al. 2001) showed increased fragmentation and decrease in the Reserve's forested area, leading to a significant loss of panda habitat. The rate of habitat loss was actually 1.15 times higher within the Reserve than in the surrounding area.

The reasons for this unexpected result are mainly socioeconomic. The local population belongs to an ethnic minority which is not covered by China's one child rule. The population inside the Reserve almost doubled from 1975 to 1995. Most inhabitants make their living by farming, fuel-wood collection, timber harvesting, road construction and maintenance – all leading to continuous destruction of forested areas. Outside the Reserve, the one child rule applied and people gradually switched to other types of energy, reducing the demand for wood.

Source: Liu et al. 2001

Distributional impacts occur at different levels: between nations, regions, sectors, groups in society and of course between generations (see Box 2.12). An important function of TEEB is to present a range of practical tools to identify and address such impacts.

Distributional issues specifically arise where benefits of ecosystem conservation go beyond local level (see 2.1). For example, restricting land use upstream is often necessary to maintain freshwater provision at adequate levels and quality downstream. Where distributional impacts are perceived as unfair, **compensation** may be necessary to ensure full implementation of selected policies. Some countries have introduced schemes for downstream water users to compensate upstream landowners (e.g. Mexico: see Chapter 5).

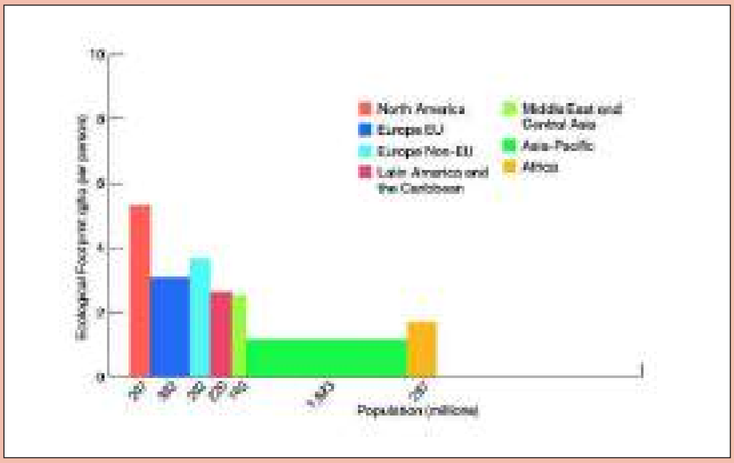
Decision making today also affects tomorrow's societies: The species we commit to extinction are clearly not available to future generations. If ecosystems can no longer provide important regulating services, the following generations will have to provide for them in a different manner. This has enormous implications. As noted in the TEEB interim report, **based on a 4% discount rate, our grandchildren 50 years from now have a right to only one seventh of what we use today** (see TEEB-D0, Chapter 6).

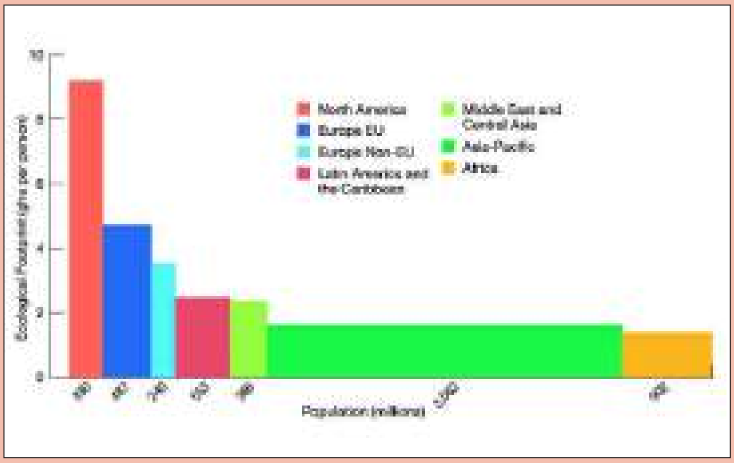
Box 2.12: Applying 'ecological footprint analysis' to the world's regions

Ecological footprint analysis compares human demands on nature with the biosphere's ability to regenerate resources and maintain ecosystem services. It does this by assessing the biologically productive land and marine area required to produce the resources consumed and to absorb the corresponding waste, using available technology.

Analysis carried out at the global level shows that since the mid 1980s, global human demand for natural capital has exceeded the planet's capacities to regenerate. The figure below shows the change from 1961-2005 in the average footprint per capita and population for each of the world's regions, with the area shown for each region representing its total footprint. Whilst the per capita footprint of the Asia-Pacific, Latin American and Caribbean regions remained stable, North America and Europe EU nearly doubled their per capita uptake of natural resources during that period.

WWF 2008: Living Planet Report 2008





2.3.4 BASE POLICIES ON GOOD GOVERNANCE

> ***"Good governance is perhaps the single most important factor in eradicating poverty and promoting development"***
>
> Former UN Secretary-General Kofi Annan

Good governance means that decisions are taken and implemented in an effective, transparent and accountable manner by all relevant institutions, with respect for the rule of law and human rights.

Good governance is needed to incorporate economic information in decision-making and avoid bias or misuse of economic values. Bias can take different forms (e.g. considering the interests of the elite over those of other social groups; excluding or concealing the amount and distribution of policy costs and benefits; failing to take account of local and indigenous property rights). This is often unintentional given the sheer complexity of biodiversity and the number of affected interests (see 2.1). However, there may also be other reasons related to the way information is used. Well-informed interest groups may be better placed to voice their concerns in decision-making processes (e.g. allocation of sectoral subsidies).

Economic information can provide strong support to good governance. Systematic and balanced information on costs and benefits makes transparent how different groups in society are affected by policy options and helps resist pressure of vested interests. This can be further supported by a broad approach of stakeholder participation.

Tools to consider costs and benefits of projects and policies affecting social and environmental interests are already in place in many countries (e.g. Environmental Impact Assessments, Cost-Benefit Analysis, Strategic Environmental Assessments). Feeding quality data on the value of ecosystem services and biodiversity into assessment frameworks can help decision-makers at relevant levels reach more informed decisions and improve policy design (see Chapter 4 and TEEB-D2 Report for regional and local policy makers).

Many regional processes and initiatives support international collaboration to improve governance and public decision-making. Some of the most important agreements are listed in Table 2.5 below.

Source: Agência Brasil (http://www.agenciabrasil.gov.br/media/ imagens/) licensed under http://creativecommons.org/ licenses/by/2.5/br/deed.en

62nd United Nations General Assembly, Sep 2007

Table 2.5: Examples of initiatives to facilitate Good Governance practices

Countries	Strategy	Date	Policy Results	Source
Organisation of American States (OAS), 34 American countries excluding Cuba	OAS - Convention	1996	Promotes, facilitates and regulates cooperation among the Parties to ensure the effectiveness of the measures. Incorporates actions to prevent, detect, punish and eradicate corruption in the performance of public functions and acts of corruption specifically related to such performance.	*http://www.oas.org/juridico/english/corr_bg.htm*
OECD, Argentina, Brazil, Bulgaria, Chile, Estonia, Israel, Slovenia, South Africa	Convention on Combating Bribery of Foreign Public Officials in International Business Transactions	1999	Incorporates legally binding standards to criminalise bribery of foreign public officials in international business transactions and provides for a host of related measures that make this effective.	*http://www.oecd.org/document/21/0,2340,en_2649_34859_2017813_1_1_1_1,00.html*
Arab Countries	The Good Governance for Development Initiative	2005	Promotes broad reforms to enhance the investment climate, modernise governance structures and operations as well as strengthen regional and international partnerships to facilitate investment in the participating countries.	*http://www.oecd.org/pages/0,3417,en_34645207_34645466_1_1_1_1_1,00.html*
Europe	European Governance	2001	Concept of governance based on the rules, processes and behaviour that affect the way in which powers are exercised at European level. Emphasizes on openness, participation, accountability, effectiveness and coherence.	*http://eur-lex.europa.eu/LexUriServ/site/en/com/2001/com2001_0428en01.pdf*
Africa	New partnership for Africa's Development (NEPAD)	2001	NEPAD is an initiative trying to put Africa on a path of sustainable development encompassing good governance and prosperity with a consolidation of peace, security and informed policy choices.	*http://www.nepad.org/home/lang/en*
Australia	Good Governance Guiding principles	2000	Set of criteria that must be aimed for in development assistance.	*http://www.ausaid.gov.au/publications/pdf/good_governance.pdf*

2.4 THE TEEB TOOLKIT FOR POLICY CHANGE

TEEB aims to help policy-makers reflect the wider **framework for policy change** when addressing biodiversity issues. It provides concrete examples showing how economic information and/or values can help overcome current difficulties with many biodiversity policies and accelerate policy reform.

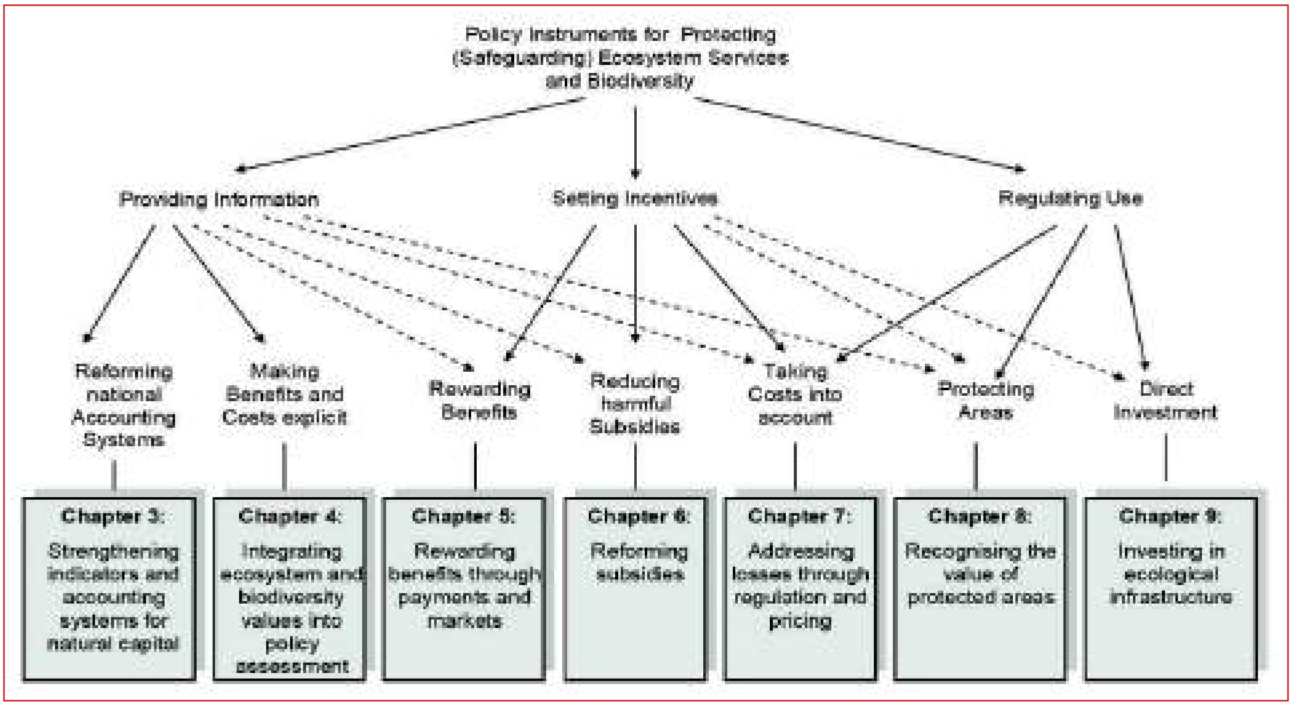
As noted in 2.2 above, policy makers have a range of options when taking action:

- **build on good practices that have been proven to work elsewhere;**
- **ensure that existing instruments reach their full potential;**
- **reform harmful subsidies;**
- **develop and implement new policies.**

Figure 2.1 provides an overview of available policy instruments analysed in this report. For ease of reference, it divides them into three broad groups:

- instruments providing information for biodiversity policies;
- instruments setting incentives for behavioural change; and
- instruments directly regulating the use of natural resources.

Figure 2.1: TEEB Policy Options Overview



Providing information helps us measure what we manage. **Chapter 3** focuses on new approaches to indicators and national accounting systems to integrate the values of natural capital. **Chapter 4** shows how valuation and policy assessment frameworks can be used more effectively to safeguard ecosystem services. These information tools feed into the design of policy instruments covered by later chapters (dotted lines in Figure 2.1).

Instruments that influence decisions on resource use by **setting incentives** are increasingly used in biodiversity policy and open up new opportunities for policy makers. However, incentives set in other policy fields could negatively impact biodiversity. Careful analysis of potentially conflicting provisions can be greatly improved by using economic valuation. **Chapter 5** presents a range of incentive-based instruments to reward currently-unrecognised benefits of biodiversity (e.g. PES, REDD and access and benefit sharing). **Chapter 6** discusses the scale and options for reform of existing harmful subsidies that lead to a loss of biodiversity and a degradation of ecosystems. **Chapter 7** considers the scope to use market-based instruments to provide incentives as part of a broad-based policy mix.

Policy tools to regulate use include three different sets of instruments: those that make the user or polluter pay; protected areas; and direct public investment. **Chapter 7** analyses use of regulatory instruments in different contexts, including related issues of liability, compensation and enforcement. **Chapter 8** shows how cost-benefit analysis and improved governance can strengthen the design and effectiveness of protected area instruments to safeguard biodiversity hot spots. Finally, **Chapter 9** assesses options for direct public investment either in ecological infrastructure or by restoring degraded ecosystems.

Each approach is associated with specific advantages and disadvantages depending on the characteristics of the ecosystem at hand and the concrete design and implementation issues. Some measures may be feasible for the management of ecosystems while others are not. **An appropriate mix is needed** which takes into account actors, institutions, policy cycle, distributional implications and instrument design.

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THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 3: Strengthening indicators and accounting systems for natural capital

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Chapter 3
Strengthening indicators and accounting systems for natural capital

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Key Messages of Chapter 3

Ecosystems and biodiversity are our stock of 'Natural Capital' – they lead to a flow of benefits that support societal and individual well-being and economic prosperity. We do not measure this capital effectively enough to ensure its proper management and stewardship. Without effective monitoring we will not understand the scale of the challenge or the nature of the response. Indicators feed into aggregate measures and are an integral component of accounting systems. Without suitable indicators or accounting, we lack a solid evidence base for informed policy decisions.

We already have a large amount of existing data, indicators and methods for accounting; there is huge potential for progress. What we lack is an implementation mechanism that makes best use of and produces maximum results from available information to feed into global discussions. A science-policy interface is essential for such implementation and could be provided through the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). In support of this process, the following improvements are urgently needed:

Improving the measurement and monitoring of biodiversity and ecosystem services

Headline indicators are needed now to set and monitor specific, measurable, achievable, realistic and time-specific (SMART) biodiversity and ecosystem services targets. These indicators should address the status of phylogenetic diversity (genetic diversity between species), species' populations, species' extinction risk, the quantity and ecological condition of ecosystems/biotopes and flows in related benefits. The status indicators should be part of an interlinked framework of driver, pressure, state, impact and response indicators.

More field data are required from biodiversity-rich countries. Some monitoring can be carried out by remote sensing (e.g. for deforestation) but more ground surveys are required (e.g. for degradation). Data are vital not just for monitoring but also for economic evaluation and designing effective policy instruments, particularly for defining 'baselines' and taking informed decisions. A select dashboard of indicators needs to be developed for policy makers and the public that takes biodiversity into account.

More effort is needed especially to develop indicators of ecosystem services. Further research is urgently required to improve understanding of and develop better indicators on the link between biodiversity and ecosystem condition and the provision of ecosystems services. However, the need for research should not prevent the selection and use in the short term of headline indicators for biodiversity and ecosystem services targets that can be refined later.

Better macro-economic and societal indicators

More effort is needed to use macro-indicators that take natural capital into account. The ecological footprint is a valuable concept for policy objectives and communication. The EU's Beyond GDP process is piloting an environmental index for use alongside GDP and launching macro indicators to communicate key issues on sustainable development. The Stiglitz-Sen-Fitoussi Commission on the Measurement of Economic Performance and Social Progress supports indicators and the need for well-being measurement in macro-economic policy and sustainable development.

Adjusted Income and Consumption aggregates reflecting **under-investment** in ecosystem maintenance and **over-consumption** of natural resource and ecosystem services should be introduced as international standards in the core set of headline macro-economic aggregates, alongside conventional GDP, National Income and Final Consumption. To be effective and efficient in budgetary and public debates, these need to be computed and published at the same date as conventional indicators, i.e. in relation to fiscal year deadlines.

More Comprehensive National Income Accounting

National accounts need to take the wider issues of natural capital into account, including well-being and sustainability dimensions. The 2003 UN System of Economic Environmental Accounting (SEEA) manual upgrade needs to be completed rapidly to include physical accounts for ecosystem stocks, degradation and services as well as valuation rules. Natural capital accounts should be developed to take the full set of ecosystem services (private or common-pool economic resources as well as public goods) into account.

Towards GDP of the Poor

The rural poor are the most vulnerable to loss of biodiversity and ecosystem services. Appropriate policies require an understanding of this link and ways to measure the importance of such services to incomes and livelihoods. Measuring the GDP of the Poor can clarify current dependence and risks to poverty, development and MDGs from losses of natural capital.

3 Strengthening indicators and accounting systems for natural capital

"The welfare of a nation can scarcely be inferred from a measurement of national income".

Simon Kuznets, principle architect of the GDP concept, in 1934.

In 1962, he added

"Distinctions must be kept in mind between quantity and quality of growth, between its costs and return, and between the short and the long term. Goals for more growth should specify more growth of what and for what."

Chapter 3 highlights the importance of measurement of ecosystems and biodiversity for the proper stewardship of our 'natural capital'. **3.1** introduces the key issues, underlining the predominance of GDP and economic measurement in political decisions, and argues that this needs to be complemented by other measures. **3.2** looks at useful types of measurement – e.g. in the policy cycle, where they help develop and communicate an understanding of the relationship between drivers and effect – and then in more depth at the role of biodiversity indicators and tools for measuring ecosystem services. **3.3** shows how such indicators feed into mainstream economic aggregates: it focuses on macro and societal indicators and indices to 'measure the true wealth of nations', comparing traditional tools with available equivalent indicators that take nature into account. **3.4** presents indicators and aggregate measures as an integral component of accounts: it explains the current System of National Accounts and shows what can usefully be done to improve its ability to measure nature systematically in a national framework. **3.5** completes the picture by discussing ways to better measure the social dimension – by looking at 'GDP of the Poor'.

3.1 WHAT MEASUREMENT PROBLEMS DO WE FACE?

"No one would look just at a firm's revenues to assess how well it was doing. Far more relevant is the balance sheet, which shows assets and liability. That is also true for a country."

Joseph Stiglitz, 2005 in Foreign Affairs

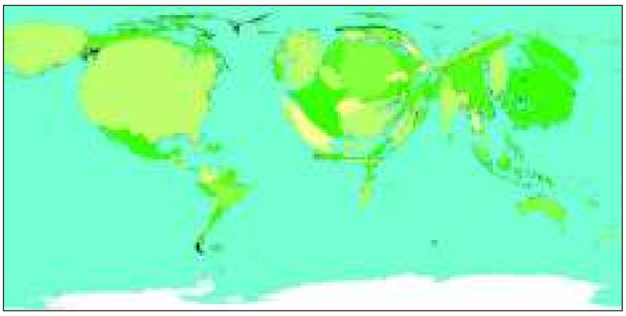
Newspapers, political speeches and policy decisions have until recently tended to focus on GDP growth, job losses/unemployment, trade issues and financial markets. Reporting on these issues is helped by the existence of accepted, timely and aggregated data. Despite their importance, it is increasingly recognised that such issues are only part of the picture. We also need to take account of our 'ecological footprint' – to measure how human demands on natural capital stocks (including ecosystems and biodiversity) affect the flows of ecosystem services which contribute to human well-being at all levels.

We measure economic transactions and assets through the System of National Accounts (SNA) which provides much used aggregated indicators such as GDP (United Nations 1968; United Nations et al. 2003). The SNA has evolved over time and is well respected for its core purposes. However, our valued **natural capital is almost totally excluded from these accounts and its depreciation is not reflected in the macro-economic aggregates used by policy makers or discussed in the press**. This means that fish stock losses, forest degradation, pollution and overuse of aquifers and species/habitat losses have little or no visibility in national accounting systems.

This lack of measurement and lack of reporting undermines efforts to ensure the future availability of resources. In particular, it means that public and political awareness of the status of and threats to ecosystem services is relatively poor. **This feeds into a lack of informed public discussion on what to do, where and by whom.**

If we don't know what we have, how can policy hope to manage it? Changes in our natural capital stock are important to understand because they affect the flow of goods and services from nature. Taking fisheries as an example, the catch that can be landed in a year is not just a function of effort and fishing fleet capacity, but also depends on the size of available fish stocks and on the status of each level of the fisheries' food chain. This information is increasingly understood for fish as a resource but still tends to be only half taken into account in fisheries quotas, subsidies, monitoring and enforcement. The same applies to genetic diversity of crops which is critical to long-term food security. In situations where there is low understanding even of basic information on natural capital stock and its changes (e.g. for functions of some marine ecosystems), the chance of an appropriate policy response is slighter still.

The current emphasis on 'evidence-based policy making' will be held back if we lack information on what is happening to our natural capital stock (see 3.2). TEEB therefore aims to offer new information on measuring the value of the nature we manage in order to help policy makers.



Map of the world according to the nations GDP

Copyright: Mark Newman, Department of Physics and Center for the Study of Complex Systems, University of Michigan. URL: http://www-personal.umich.edu/~mejn/cartograms/gdp1024x512.png

3.2 IMPROVING MEASUREMENT OF BIO-DIVERSITY AND ECOSYSTEM SERVICES

3.2.1 WHAT ROLE DO INDICATORS PLAY?

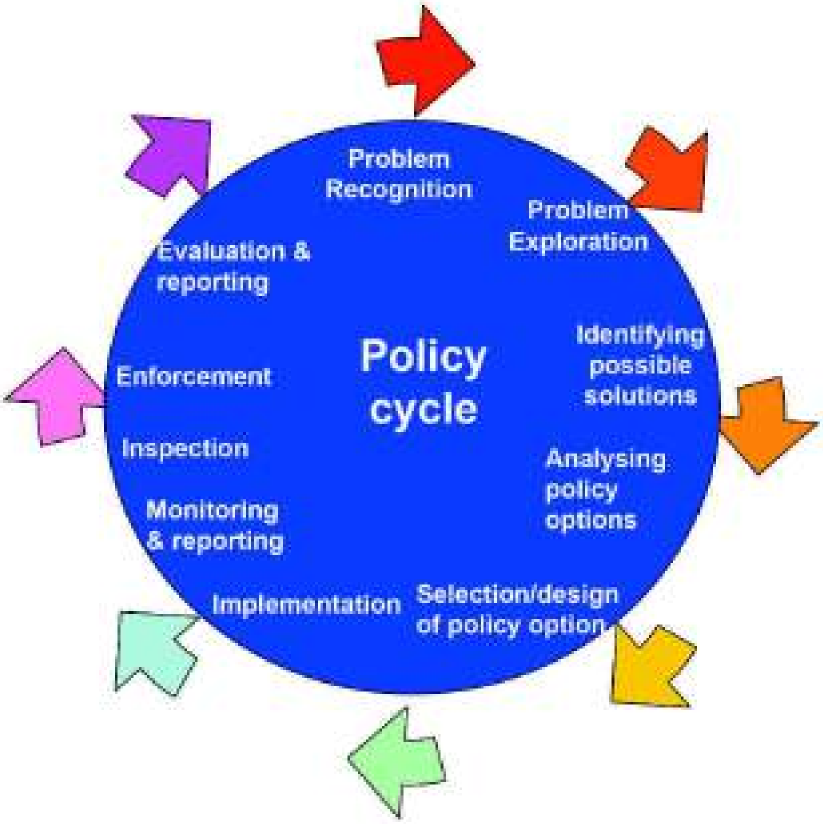
"Indicators arise from values (we measure what we care about) and they create values (we care about what we measure)"

Meadows D. 1998

'Indicators'[1] produce a manageable amount of meaningful information by summarising, focusing and condensing it (Godfrey and Todd 2001). Considering the huge complexity of biodiversity, its multi-faceted benefits for human well-being and the complicated interlinkages between the two, it is not an easy task to develop a commonly agreed set of indicators. Nevertheless, this task is vital because relevant indicators can play a decisive role in:

- helping decision makers and the public at large to understand status/condition and trends related to biodiversity and the ecosystem services it provides (e.g. which habitats/species and ecosystem services are in danger of being lost or damaged);

Figure 3.1: The policy cycle



Source: own representation, Patrick ten Brink

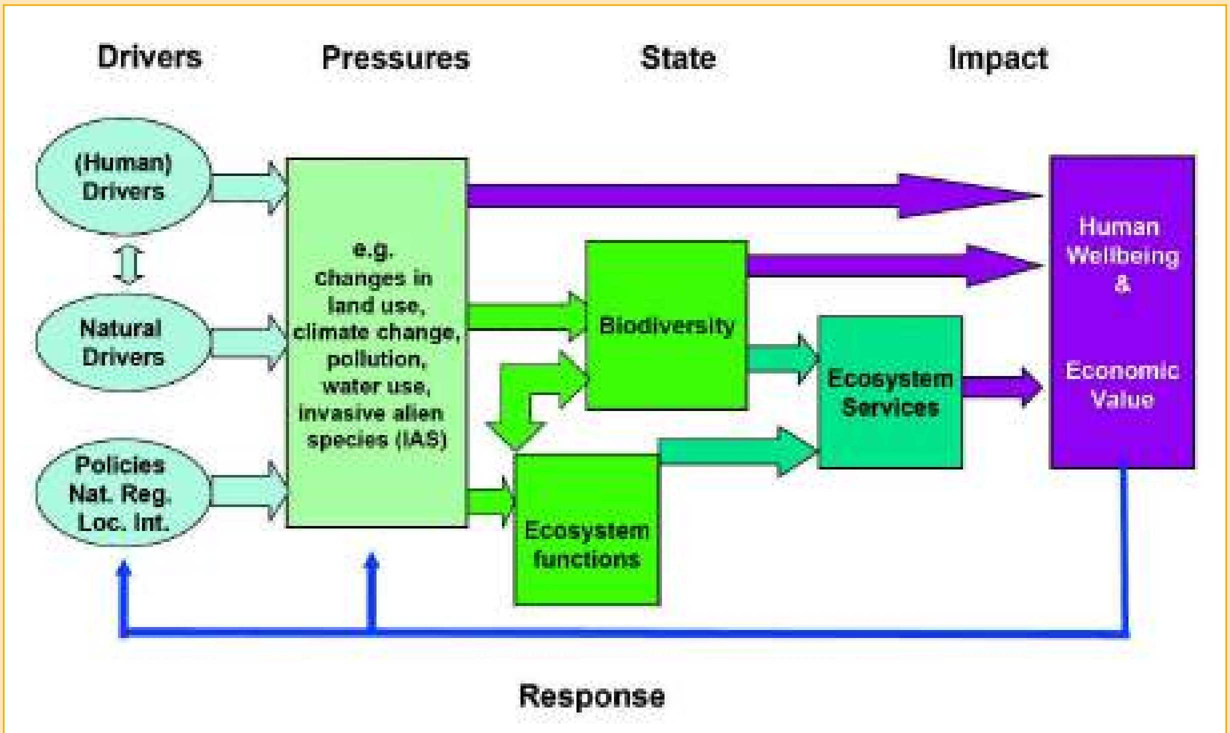
- clarifying the consequences of action or inaction for human well-being by measuring our progress and the efficiency of measures we take (e.g. whether a subsidy actually helps fish stocks to recover; and
- benchmarking and monitoring performance in relation to defined targets and communicating whether, when and by whom targets are met (e.g. whether deforestation rates are slowed by the use of the instrument REDD, see Chapter 5).

Biodiversity and ecosystem service indicators can be useful for these purposes across different sectors and at different stages of the policy cycle. They can be applied to: problem recognition (e.g. endangered habitats and loss of ecosystem services); identification of solutions (e.g. favourable conservation status and necessary management activities); assessing and identifying linkages between policy options (e.g. investment in protected areas, green infrastructure); the implementation process (e.g. reforming subsidies, payment for ecosystem services); and ongoing monitoring and evaluation (e.g. status and trends). Figure 3.1 shows how indicators feed into the iterative policy cycle.

To make full use of their potential, indicators need to be part of an analysis framework that addresses functional relationships between nature and human well-being. The DPSIR approach (see Figure 3.2 below) can be a useful basis for such a framework, making it possible to characterise/measure driving forces (e.g. population growth, consumption and production patterns), pressures (e.g. intensive agriculture, climate change) on biodiversity state and ecosystem functions, their impact on the delivery of related ecosystem services and subsequently on human well-being and, finally, the (policy) response.

We also need indicators to consider 'tipping points' or 'critical thresholds' i.e. the point at which a habitat or a species is lost and the provision of an ecosystem service is therefore compromised. Used in this way, indicators can function as an early warning system to effectively communicate the urgency of targeted action. Table 3.1 demonstrates how indicators can be applied to the fisheries sector to reveal the link between sustainable catch, stock resilience and minimum viable stock thresholds.

Figure 3.2: Drivers, Pressures, Status, Impact and Responses (DPSIR)



Source: adapted by Chapter 3 authors from Braat and ten Brink 2008

Table 3.1: Thresholds and responses in the fisheries sector

Thresholds	Examples
Natural critical thresholds	• Minimum population levels for stock viability (e.g. fish) • Salination of water bodies (freshwaters becoming salty) • Minimum oxygen levels in water for species viability • Minimum habitat area for species survival • Ocean acidity levels and species viability • Absorptive capacity of ecosystem (beyond which damage occurs)
Scientifically-established critical thresholds	*Scientific assessment of the above, and* • Maximum sustainable yield (MSY) • Maximum fleet capacity
Responses	**Examples**
Political responses	• Commitment to significantly reducing the rate of biodiversity loss • Commitment to sustainable use of marine ecosystems • Commitment to achieving good ecological status of ecosystem
Legal responses *(creating legal thresholds) Stakeholder responses*	• Catch quotas, catch sizes e.g. Total Allowable Catch (TAC) • Emission limit values: Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), SO_2 • Designation of marine protected areas and no-take zones
Stakeholder responses	• Protection of the value of the marine environment i.e. natural and cultural resource protection • Agreed management practices to work within sustainable take levels

Source: adapted from ten Brink et al. 2008

The effectiveness of indicators is influenced by the presentation of the information they generate. Maps can be critical tools – not only for communication with the public but also to identify problems and solutions. They provide a powerful instrument to communicate information spatially and can thus form the basis for targeting policy measures. For example, information contained in and shared through a map can help identify:

- who creates benefits associated with biodiversity and should therefore be eligible to receive a Payment for Ecosystem Services;
- who benefits from these ecosystem services and should therefore contribute to payments to secure the future provision of such services (see Chapter 5 on PES).

However, indicators are not a panacea – whether for biodiversity and ecosystem services or in any other field. They have to be used bearing in mind their limitations and risks (see Box 3.1). These include the risk of misinterpretation due to condensing of information, the challenge of data quality and limitations in clearly capturing causality.

Box 3.1: Keeping indicators in perspective

"Indicators only indicate; they do not explain. Determining that change has occurred does not [always] tell the story of why it has occurred. Indicators constitute only one part of the logical and substantive analysis needed […]. The use of indicators can be made into an elaborate science. Using a large number of different indicators, however, has no merit in itself. The key to good indicators is credibility – not volume of data or precision in measurement. A quantitative observation is no more inherently objective than a qualitative observation. Large volumes of data can confuse rather than bring focus. It is more helpful to have approximate answers to a few important questions than to have exact answers to many unimportant questions."

Source: UNDP 2002

3.2.2 WHAT SHOULD BIODIVERSITY INDICATORS MEASURE?

It is becoming obvious that we urgently need to better understand what is happening to biodiversity in order to conserve and manage ecosystem services effectively. All ecosystem services are underpinned by biodiversity and there is good evidence that biodiversity losses can have substantial impacts on such services. For example, the loss of functional groups of species can negatively affect overall ecosystem resilience (see also TEEB D0 Chapter 2, Folke et al. 2004), restoration of biodiversity can greatly enhance ecosystem productivity (Worm et al. 2008) and regions of high priority for biodiversity conservation can also provide valuable ecosystem services (Turner et al. 2007).

More comprehensive and representative measures and monitoring are needed for biodiversity as a whole, without prejudice to current efforts to develop and monitor specific ecosystem service indicators (see 3.2.4 and TEEB D0 Chapter 3). It is critical that these cover the three principal components of biodiversity (genes, species and ecosystems) in terms of their quantity, diversity and ecological condition ('quality'). Concentrating only on selected components that we currently consider to be of particular value is risky: ecological processes are too complex and interlinked and present too many unknowns for us to do this without risking grave damage to ecosystem services and wider aspects of biodiversity. The big picture is vital to keeping future options open – and this clearly depends on maintaining the full range of biodiversity. "To keep every cog and wheel", wrote Aldo Leopold, "is the first precaution of intelligent tinkering" (Leopold 1953).

In practice, even if the importance of measuring and monitoring biodiversity has been long recognised, most effort has focused on species of high conservation concern to provide evidence of ongoing losses and thereby prompt actions by politicians and wider society. This approach has produced enough data to provide status assessments of some of the better-known taxa groups and led to regular publication of lists of globally threatened species according to standardised IUCN Red List criteria (IUCN 2001). It has also supported assessments of some species and habitats threatened at regional and national levels. However, we still have only an incomplete picture of the status of many taxa groups across the world.

Through various multilateral environmental agreements, including the Ramsar Convention on Wetlands, the CBD and the Convention on Migratory Species, targets have been agreed for conserving biodiversity. Most notably, CBD Parties committed themselves in April 2002 to achieve by 2010 a significant reduction in the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth. This target was endorsed by the World Summit on Sustainable Development (WSSD) and the United Nations General Assembly and incorporated within the Millennium Development Goals. Similar targets were adopted in other regions: the EU adopted a more ambitious target of halting the decline of biodiversity in the EU by 2010 and restoring habitats and natural systems.

Setting targets has been a bold and extremely important step towards halting biodiversity loss, but it is now clear that the CBD and EU targets will not be met (for the latter, see European Commission 2008a). These failures may be partly because the targets did not explicitly define measures of biodiversity by which they could be monitored, undermining their usefulness in terms of accountability. More broadly, biodiversity monitoring is insufficient in most parts of the world and for most taxa groups to reliably measure progress towards targets (or key pressures or effectiveness of responses). In practice, assessing biodiversity trends presents significant challenges as it needs to cover a wide variety of features. Given the complexity of biodiversity, targets need to relate to a set of inter-related indicators rather than individual indicators.

In 2004, the CBD Conference of the Parties agreed on a provisional list of global headline indicators to assess progress at the global level towards the 2010 target (Decision VII/30) and to effectively communicate trends in biodiversity related to the Convention's three objectives (see Table 3.2). The more recent Decision VIII/15 (2006) distinguished between indicators considered ready for immediate testing and use and those requiring more work. A similar and linked process of indicator development has also been undertaken in the EU (EEA 2007).

For reasons of necessity and practicality, the CBD indicators tend to rely on existing datasets rather than identifying future needs and devising appropriate monitoring programmes. This approach of adopting, adapting and supplementing existing data brings inevitable compromises (Balmford et al. 2005; Dobson 2005; Mace and Baillie 2007). As a result of these data constraints, and in the interests of balance, most indicators identified in the CBD process relate to pressures rather than to the actual status of biodiversity.

In July 2009, an International Expert Workshop on the 2010 Biodiversity Indicators and Post-2010 Indicator Development[2] concluded that "the current indicator set is incomplete in a number of areas; e.g. wild genetic resources, ecosystem quality, ecosystem services, sustainable use, human well-being, access and benefit sharing and indigenous local knowledge, and both threats and responses more broadly" (UNEP-WCMC 2009). Similar conclusions were reached in a review of the EU biodiversity indicator set (Mace and Baillie 2007).

From a TEEB perspective, the gaps relating to genetic diversity, the quality of ecosystems (i.e. their ecological condition) and ecosystem services are of particular concern (see also TEEB D0 Chapter 3). We outline requirements for the first two below and consider ecosystem service indicators in more detail in section 3.2.4.

Table 3.2: Indicators for assessing progress towards the 2010 biodiversity target

Indicators considered ready for immediate testing use **are bold**;
indicators confirmed as requiring more work are *in italic* and placed in parentheses.

Focal area	Indicator
Status and trends of the components of biological diversity	**Trends in extent of selected biomes, ecosystems, and habitats** **Trends in abundance and distribution of selected species** **Coverage of protected areas** **Change in status of threatened species** **Trends in genetic diversity of domesticated animals, cultivated plants and fish species of major socio-economic importance**
Sustainable use	**Area of forest, agricultural and aquaculture ecosystems under sustainable management** *(Proportion of products derived from sustainable sources)* *(Ecological footprint and related concepts)*
Threats to biodiversity	**Nitrogen deposition** **Trends in invasive alien species**
Ecosystem integrity and ecosystem goods and services	**Marine Trophic Index** **Water quality of freshwater ecosystems** *(Trophic integrity of other ecosystems)* **Connectivity/fragmentation of ecosystems** (Incidence of human-induced ecosystem failure) (Health and well-being of communities who depend directly on local ecosystem goods and services) (Biodiversity for food and medicine)
Status of traditional knowledge, innovations and Practices	**Status and trends of linguistic diversity and numbers of speakers of indigenous languages** *(Other indicators of status of indigenous and traditional knowledge)*
Status of access and benefit-sharing	*(Indicator of access and benefit-sharing)*
Status of resource transfers	**Official development assistance provided in support of the Convention** *(Indicator of technology transfer)*

Source: CBD 2009

Monitoring of genetic diversity in wild species would be especially valuable with respect to its linkage to ecosystem services (such as the potential provision of new drugs). As genetic material is the raw material upon which natural selection and selective breeding acts, it is fundamental to enabling adaptation to environmental change (e.g. climate change) and longer-term evolution. However, information on **genetic diversity within species** is largely confined to cultivated crops and domesticated animals at the moment and would be extremely difficult, time-consuming and costly to gather and monitor more widely. For these reasons, its direct measurement and inclusion as a headline biodiversity indicator is currently impractical. However, a useful proxy indicator would be phylogenetic diversity – i.e. the **taxonomic difference between species** (which can be measured as an index of the length of evolutionary pathways that connect a given set of taxa).

The most important gap in the CBD indicator set that needs to and actually can be filled concerns the ecological condition of ecosystems (biotopes and habitats). Although existing indicators address some attributes of some habitats (e.g. marine habitats by the Marine Trophic Index), no habitats are adequately monitored with respect to all the key attributes that define their condition. This is a significant weakness for monitoring the overall status of biodiversity because many ecosystems can be degraded with little visible impact on the species that are most typically monitored (e.g. birds, which are often less sensitive to habitat degradation than other species groups). Monitoring ecosystem condition is particularly important with regard to provision of ecosystem services as it is often the most direct indicator of likely benefits. For example, some ecosystem services, such as climate regulation or water purification, tend to be related more to biomass than to biodiversity per se (i.e. quantity not diversity). Others relate more to diversity – e.g. bioprospecting and genetic diversity (see Chapter 5). Such attributes therefore need to be considered in assessments of ecosystem condition.

Establishing a global standardised system for measuring ecosystem condition indicators would be a major challenge and probably prohibitively time-consuming and not cost-effective. A possible solution would be to create a simple assessment approach that works with and supports the establishment of national biodiversity indicators that are compatible with a global reporting framework. This framework could be established by expert working groups that first identify a minimum set of attributes to define acceptable condition for each type of ecosystem. Generic standards could then be set for each attribute against which to judge the condition of the ecosystem.

This approach is illustrated in the hypothetical examples in Table 3.3, which draw on the concepts used to monitor protected area condition in the UK based on generic standards within a Common Standards Framework[3]. Specific standards could vary between countries/regions within agreed limits appropriate to local conditions, but would be published to enable scrutiny of how each country interprets the acceptable condition standards. This approach could lead to a subset of common indicators at global level, complemented by more and varied indicators at national, regional and local levels.

Although a very large set of indicators would be used to measure the quality (condition) of all ecosystems, the results could if necessary be combined into one simple index of overall ecosystem condition e.g. x% of ecosystems in acceptable condition.

3.2.3 TOWARDS A BIODIVERSITY MONITORING FRAMEWORK

Balmford et al. (2005) noted that a global biodiversity monitoring system should not focus on a few aspects of biodiversity but cover a wide range of natural attributes, including habitat extent and condition. Similarly, the 2009 biodiversity indicators workshop (see 3.2.2) recommended that "some additional measures on threats to biodiversity, status of diversity, ecosystem extent and condition, ecosystem services and policy responses should be developed in order to provide a more complete and flexible set of indicators to monitor progress towards a post-2010 target and to clearly link actions and biodiversity outcomes to benefits for people" (UNEP-WCMC 2009).

Table 3.3 Hypothetical examples of key attributes and generic limits that define acceptable condition in two habitat types

	Temperate forest		Blanket mire	
Attribute types	**Attribute (and ecosystem service relevance)**	**Acceptable limits**	**Attribute (and ecosystem service relevance)**	**Acceptable limits**
Size	Area of habitat patch (minimum area for key species & interior habitat)	>10ha	Area of habitat patch (maintenance of hydrology)	>100ha
Physical properties			Peat depth (maintenance of carbon) Water level (vegetation requirements and peat protection)	>10cm <10cm below soil surface & <20 cm above soil surface
Vegetation structure	Height/age classes (regeneration of habitat and underpins diverse community)	>20% mature trees, 2-5% seedlings		
Species composition	Native species (supports key species of biodiversity)	>90%	Sphagnum mosses (carbon sequestration depend on these species) Dwarf shrubs	>20% cover < 10%
Biomass	Tree density (timber production)	> 10 trees per ha <100 trees per ha	Not measurable in practice	
Productivity			Forage (for livestock and wild species)	>90% potential net primary production
Specific features	Dead wood (habitat for key species)	> 10 cubic foot per ha		

On the basis of these observations and the discussions in 3.2.2, we suggest that the status of biodiversity could be (i) measured according to an expanded CBD indicator set and the above framework, and (ii) summarised into the following five headline indicators:

- taxonomic difference between species – phylogenetic trends (indicators to be developed);
- population trends (e.g. based on a modified version of the Living Planet Index (Collen et al. 2009; Hails et al. 2008; Loh et al. 2005);
- species extinction risk trends (based on the Red List index: see Baillie et al. 2008; Butchart et al. 2007; Butchart et al. 2005);
- ecosystem extent (following CBD practice, with agreement on classes and definitions);
- the condition of ecosystems according to key attributes (CBD indicators to be extended).

These five headline indicators could form the basis of SMART (specific, measurable, achievable, realistic and time-specific) targets for the status of biodiversity. Like their constituent indicators (e.g. for each habitat type), they are scalable and could therefore be used for targets and monitoring from local to global scales, subject to agreement on standards. Monitoring data could also be differentiated according to sample locations (e.g. to report on the condition and effectiveness of protected areas) or applied to the land holdings of corporations to assess their impacts on biodiversity and ecosystems.

However, as noted in 3.2.1 above, the value of indicators increases considerably if they are integrated within a DPSIR framework. Including indicators of drivers and pressures can warn of impending impacts, whilst monitoring responses can help to assess the effectiveness of conservation measures: these facilitate the adoption of adaptive management practices (Salafsky et al. 2001). Creating a framework that complements state indicators with indicators of related pressures and drivers would therefore provide a comprehensive measurement and monitoring system to enable effective management of biodiversity and many key ecosystem services at a global level. Specific ecosystem service indicators would also be required for certain circumstances and locations (see 3.2.4 below).

We already have sufficient species monitoring data to provide headline indicators of species population trends and threat status trends, although representation of some taxa groups and regions needs to be improved. We can also assess ecosystem extent through remote sensing data: existing datasets could be used more effectively by developing software to create long time series and near-real-time data on land use, land cover and landscape fragmentation in collaboration with e.g. GMES and NASA.

The main gap in available data therefore concerns ecosystem condition. This requires major investment in monitoring. Some monitoring can be done using existing and new remote sensing data (e.g. habitat fragmentation, vegetation cover and landscape diversity) but more on-the-ground sample surveys of key attributes will be needed in utilised ecosystems as well as more field data from countries with the highest levels of biodiversity and threatened biodiversity (c.f. in richer western countries as is now the case). With appropriate training and capacity building, such surveys could be carried out by local communities and other stakeholders using simple but robust and consistent participatory methods (Danielsen et al. 2005; Tucker et al. 2005). This type of monitoring approach would also engage local people in biodiversity issues and provide employment benefits. It is essential to ensure that indicator development supports local and national needs as much as top-down international institutional needs.

Biodiversity monitoring is currently inadequate mainly because funding is insufficient. Although creating a comprehensive biodiversity monitoring framework would require significant resources, this would almost certainly be a small fraction of the value of the ecosystem services currently lost through ineffective monitoring and management. Increasing funding for biodiversity monitoring would be highly cost-effective.

At present, responsibility for and funding of monitoring and measurement is not fully shared with those who use and benefit from biodiversity or with those who damage it. At the moment, a significant proportion of biodiversity monitoring costs are met by NGOs and their volunteers or from public sources. A strong case can be made for more use of approaches based on the polluter pays principle to contribute to better monitoring of biodiversity pressures and state. Shifting more responsibility for monitoring to the private sector can reduce the cost burden on public authorities.

More generally, the private sector's impacts on biodiversity need to be better monitored and reported on. Although indicators of such impacts have been developed, these tend to be too general and inconsistently applied to be of great value. We need to agree on approaches and standards that provide more meaningful and robust indicators of biodiversity impacts and are linked to SMART business targets (e.g. no net loss of biodiversity). Top-down generic indicators need to be completed by bottom-up approaches where local stakeholders report on impacts of relevance to them.

3.2.4 MEASURING ECOSYSTEM SERVICES

Policy makers need information from measurement of ecosystem services for integrated decision-making that responds to environmental, social and economic needs. If wisely used and well researched, ecosystem services (ESS) indicators can reflect the impacts of biodiversity and ecosystem loss and degradation on livelihoods and the economy. This move from measurement of biophysical capacities to measurement of benefit flows and economic values of ecosystem services can provide an effective tool that takes the whole value of our natural capital into account.

ECOSYSTEM SERVICE INDICATORS

Ecosystem service indicators make it possible to describe the flow of benefits provided by biodiversity. They contribute to better measurement and communication of the impacts that change an ecosystem's capacity to provide services supporting human well-being and development. Within the analytical DPSIR framework (see Figure 3.2 above), they can complement other indicators by focusing on the social impact of loss of natural capital and thus describe and communicate interactions between nature and society.

Compared to 'traditional' biodiversity indicators on status and trends in species diversity and richness, long recognised as important, ecosystem services indicators are a relatively new tool. The publication of the Millennium Ecosystem Assessment (MA) catalysed increased attention to ecosystem services in the political arena.

This shift also led to increased development and use of related indicators, very often derived from other sectors e.g. for timber production and the forestry sector. Because these were often available immediately, initial indicators mostly focused on provisioning services. However, the MA's final report in 2005 noted that "there are at this time no widely accepted indicators to measure trends in supporting, regulating or cultural ecosystem services, much less indicators that measure the effect of changes in these services on human well-being". Some years on, despite ongoing efforts, this statement remains largely valid. This is mostly due to the complexity of functional relationships between ecosystem components and how they affect the provision of services, and the multi-dimensional character of these services. It is essential to continue efforts to develop reliable indicators of the provision of the main types of ecosystem services, including regulating, supporting and cultural services. The technical difficulties reflect to a large extent the relatively recent focus on ecosystem services. They are no reason to stop exploring and promoting the potential use of existing indicators – what we have is already useful for policy discussions and instrument choice and design, even if much remains to be done.

VALUING WHAT ECOSYSTEM SERVICES INDICATORS MEASURE

Table 3.4 offers a useful, but far from extensive, first set of ecosystem services indicators, based on the MA framework, that are already in use or being developed. It includes a wide range of quantitative (e.g. timber, crop and fish production) and some qualitative indicators (e.g. probability of natural hazards) which well reflect the value of some ecosystem services.

However, for some services and some audiences, economic valuation is seen as essential. When considering potential trade-offs between provisioning services (usually captured by market prices) and regulating services (often non-marketed services), the absence of monetary values for regulating services can create a bias towards provisioning services. The approach, importance and examples of monetising ecosystem services indicators are explored in Chapter 4 below.

Each type of information is important. **Although qualitative indicators do not quantify and monetise benefits arising from ecosystem services, they are an important tool to underpin quantitative and monetary information and help to close gaps where no such information exists.** It is possible to develop widely-recognised qualitative indicators, if based on sound judgment, experience and knowledge. This is particularly true for supporting ecosystem services which, in the MA framework, include all natural processes that maintain other ecosystem services (e.g. nutrient cycling, soil formation, ecological interactions) and whose benefits

Table 3.4 Examples of ecosystem service indicators

Ecosystem service	Ecosystem Service Indicator
Provisioning Services	
Food Sustainably produced/harvested crops, fruit, wild berries, fungi, nuts, livestock, semi-domestic animals, game, fish and other aquatic resources etc.	• Crop production from sustainable [organic] sources in tonnes and/or hectares • Livestock from sustainable [organic] sources in tonnes and/or hectares • Fish production from sustainable [organic] sources in tonnes live weight (e.g., proportion of fish stocks caught within safe biological limits) • Number of wild species used as food • Wild animal/plant production from sustainable sources in tonnes
Water quantity	• Total freshwater resources in million m^3
Raw materials Sustainably produced/harvested wool, skins, leather, plant fibre (cotton, straw etc.), timber, cork etc; sustainably produced/ harvested firewood, biomass etc.	• Forest growing stock, increment and fallings • Industrial roundwood in million m^3 from natural and/or sustainable managed forests • Pulp and paper production in million tonnes from natural and/or sustainable managed forests • Cotton production from sustainable [organic] resources in tonnes and/or hectares • Forest biomass for bioenergy in million tonnes of oil equivalent (Mtoe) from different resources (e.g. wood, residues) from natural and/or sustainable managed forests
Genetic resources Protection of local and endemic breeds and varieties, maintenance of game species gene pool etc.	• Number of crop varieties for production • Livestock breed variety • Number of fish varieties for production
Medicinal resources Sustainably produced/harvested medical natural products (flowers, roots, leaves, seeds, sap, animal products etc.); ingredients / components of biochemical or pharmaceutical products	• Number of species from which natural medicines have been derived • Number of drugs using natural compounds
Ornamental resources Sustainably produced/harvested ornamental wild plants, wood for handcraft, seashells etc.	• Number of species used for handcraft work • Amount of ornamental plant species used for gardening from sustainable sources
Regulating services	
Air purification	• Atmospheric cleansing capacity in tonnes of pollutants removed per hectare
Climate/climate change regulation Carbon sequestration, maintaining and controlling temperature and precipitation	• Total amount of carbon sequestered / stored = sequestration / storage capacity per hectare x total area (Gt CO_2)
Moderation of extreme events Avalanche control, storm damage control, fire regulation (i.e. preventing fires and regulating fire intensity)	• Trends in number of damaging natural disasters • Probability of incident
Regulation of water flows Regulating surface water run off, aquifer recharge etc.	• Infiltration capacity/rate of an ecosystem (e.g. amount of water/ surface area) - volume through unit area/per time • Soil water storage capacity in mm/m • Floodplain water storage capacity in mm/m
Waste treatment & water purification Decomposition/capture of nutrients and contaminants, prevention of eutrophication of water bodies etc.	• Removal of nutrients by wetlands (tonnes or percentage) • Water quality in aquatic ecosystems (sediment, turbidity, phosphorous, nutrients etc)

Erosion control / prevention Maintenance of nutrients and soil cover and preventing negative effects of erosion (e.g. impoverishing of soil, increased sedimentation of water bodies)	• Soil erosion rate by land use type
Pollination Maintenance of natural pollinators and seed dispersal agents (e.g. birds and mammals)	• Abundance and species richness of wild pollinators • Range of wild pollinators (e.g. in km, regular/aggregated/random, per species)
Biological control Seed dispersal, maintenance of natural enemies of plant and animal pests, regulating the populations of plant and animal disease vectors etc., disease regulation of vectors for pathogens	• Abundance and species richness of biological control agents (e.g. predators, insects etc) • Range of biological control agents (e.g. in km, regular/aggregated/random, per species) • Changes in disease burden as a result of changing ecosystems
Cultural services	
Aesthetic information Amenities provided by the ecosystem or its components	• Number of residents benefiting from landscape amenity • Number of visitors to a site to enjoy its amenity services
Recreation & ecotourism Hiking, camping, nature walks, jogging, skiing, canoeing, rafting, diving, recreational fishing, animal watching etc.	• Number of visitors to protected sites per year • Amount of nature tourism
Cultural values and inspirational services, e.g. education, art and research	• Number of products which's branding relates to cultural identity • Number of visits to sites, specifically related to education or cultural reasons • Number of educational excursions at a site • Number of TV programmes, studies, books etc. featuring sites and the surrounding area

Sources: building on, inter alia, MA 2005; Kettunen et al. 2009; Balmford et al. 2008, TEEB D0 Chapter 3

are difficult to quantify or monetise. Due to the still significant gaps regarding the applicability of related indicators, these have not yet been listed in Table 3.4.

APPLYING ECOSYSTEM SERVICE INDICATORS

Some of the few existing and commonly agreed indicators on regulating services have been drawn up from the environment sector (e.g. climate change and carbon sequestration/storage rates, natural flood protection: see Box 3.2). Extending their application will more effectively **link biodiversity with a range of environmental policy areas and policy instruments (e.g. REDD, REDD+, flood risk management)**. This can support new synergies and better communication of environmental and economic interdependencies and potential trade-offs amongst concerned stakeholders (e.g. companies, public institutions, civil society etc).

Ecosystem services indicators can also support more efficient integration of biodiversity considerations into other sector policies (e.g. agriculture, fisheries, forestry, energy, land use planning). They can create bridges between biodiversity, economic and social indicators and measure how impacts on capacity to provide ecosystem services could affect different sectors. Such tools can usefully contribute to more 'joined-up-thinking' and policy integration (see Box 3.3).

A policy area can specifically put ecosystem services to the forefront of its agenda – as has been done with forestry and carbon storage/sequestration or could be done with urban air quality and the cleansing capacity of forests. It is crucial to be aware of the risks of trade-offs between different ecosystem services – but also to take opportunities to create synergies (e.g. direct maintenance of benefits through reforestation, or investment in green infrastructure to support their continued provision by avoiding forest degradation).

Box 3.2: Examples of ESS indicators across environmental policy areas

Climate Change – Carbon sequestration/storage rates (Total amount of carbon sequestered/stored in Gt $C0_2$ equiv. = sequestration capacity/storage per hectare x total area of ecosystem)

Tropical forests have an annual global sequestration rate of around 1.3 Gt of carbon, or about 15% of total carbon emissions resulting from human activities. Forests in Central and South America are estimated to take up around 0.6 Gt C, African forests roughly 0.4 Gt, and Asian forests around 0.25 Gt. It is estimated that tropical and subtropical forests together store nearly 550 Gt of carbon, the largest amount across all biomes. Reforestation and halting forest degradation could enhance this further (Trumper et al. 2009). The EU therefore supports a new instrument to generate significant funding to achieve the objective of halting global forest cover loss by 2030 (the Global Forest Carbon Mechanism, see EC 2008b). This approach uses carbon sequestration rates and an ecosystem's capacity to store carbon as an indicator to describe benefits arising from forest ecosystems with regard to climate change mitigation policy. This ecosystem service can also be linked to new financial incentive mechanisms such as REDD (Reducing Emissions from Deforestation and Degradation in developing countries) being proposed under the UN Framework Convention on Climate Change (UNFCCC). REDD could make explicit the value of reduced CO_2 emissions and, compared to other GHG emission reduction alternatives, is estimated to be a low-cost mitigation option (Stern 2006; IPCC 2007; Eliasch 2008). Related policy instruments are discussed in Chapter 5.

Urban Air Quality – Atmospheric cleansing capacity (e.g. tonnes of particulates removed per hectare of ecosystem)

A study by Nowak et al. (Powe 2002 and references within) found that urban trees in Philadelphia, USA, had removed over 1,000 tons of air pollutants from the atmosphere in the year 1994. According to a UK study (Powe 2002), trees can be seen to absorb large quantities of pollutants e.g. between 391,664-617,790 metric tonnes of PM10 (particulate matter) and 714,158-1,199,840 metric tonnes of SO_2 per year.

Urban planning can use this capacity of green infrastructure to achieve air pollution control targets e.g. air quality standards. Values can be attached via the avoided morbidity and mortality impacts resulting from urban green infrastructure's contribution to reduced air pollution levels. In the context of a 'bubble' policy developed for a specific area (e.g. bubble policies for air pollutants set by the US Environmental Protection Agency), the development or conservation of green infrastructure could be used to balance air emissions from sources included in this area. By enabling trading of air emission rights, an economic value can be attached to such services.

Clean Drinking Water – Removal of nutrients by wetlands (amount/percentage); water quality in aquatic ecosystems (sediment, turbidity, phosphorus etc.)

Bionade Corporation produces and distributes organically manufactured non-alcoholic drinks in Germany, with a global turnover of 40 million Euros in 2007. Clean drinking water being a main ingredient, the company has initiated a project with the German NGO Trinkwasserwald e.V. to create 130 hectares of 'drinking water forests' throughout Germany linked to their capacity to prevent pollution. The NGO indicates that each hectare of conifer monoculture converted into deciduous broadleaved forest will generate 800,000 l/year for a one-off conversion cost of 6,800 EUR/hectare. Private contracts between the NGO and the public or private forest owners are signed for a period of twenty years (Greiber et al. 2009; for further examples, see Chapter 5).

Box 3.3: Examples of ESS indicators across sector policies

Agriculture – Abundance, species richness and range of wild pollinators (e.g. insects, mammals)

The indicator can be used to identify what proportion of production depends on pollination by wild insects or mammals, linking cultivated land to criteria such as abundance, species richness and range of wild pollinators.

- wild pollinator diversity and activity can vary with distance between natural forest and crop field for example Ricketts et al. (2004) show that for coffee, those sites near the forest were visited by a greater diversity of bee species that those further away, and nearer sites were visited more frequently and had more pollen deposited than further sites. Beyond roughly 1 km from forest, wild pollination services became insufficient, and coffee produced approximately 20% less as a result;
- an early estimate for the global value of wild and domestic pollination estimated the value at US$ 120 billion per year (Costanza et al. 1997). More recently, Losey and Vaughan (2006) estimated that wild pollinators alone account for about US$ 3 billion worth of fruit and vegetables produced in the US per year. In 2008, French (at INRA and CNRS) and German (at UFZ) scientists found that the worldwide economic value of the pollination service provided by insect pollinators, bees mainly, was €153 billion in 2005 for the main crops that feed the world. This figure amounted to 9.5% of the total value of the world agricultural food production (Gallai et al. 2009).

Building on this type of indicator, agri-environment payments can be linked to the capacity of farmland to provide pollination services, with the effectiveness of actions undertaken measured against the related indicator. Subsidies to agriculture could be reformed towards extensive farming systems supporting the provision of pollination services (see further Chapters 5 and 6).

Health – Atmospheric cleansing capacity (e.g. tonnes of particulates removed per hectare of forest) related to illness/mortality rate

The UK study on air cleansing capacity (see Box 3.2) estimated the impact of higher air quality in terms of net health effects (having trees compared to another land use) at between 65-89 cases of avoided early mortality and 45-62 fewer hospital admissions per year. The estimated net reduction in costs ranged between £222,308- £11,213,276. The range is dependent on the extent of dry deposition on days with more than 1mm rain and how early the deaths occur. In terms of health effects, Hewitt (2002) also found that doubling the number of trees in the West Midlands would reduce excess deaths due to particles in the air by up to 140 per year (Powe 2002 and references within). One of the measures to meet urban air quality and health standards (e.g. as set by the World Health Organisation) can include investments in protected areas to secure provision of these services (see Chapter 8).

Further examples:

Poverty – Number of wild species used as food and/or amount of wild animal/plant products sustainably collected

Energy – Forest biomass for bioenergy in Mtoe from different resources (e.g. wood, residues) from natural and/or sustainable managed forests

Although there are no commonly known policies mandating 'no net loss' of ecosystem services at regional or national level, it is not inconceivable that such targets will be adopted in the future (see Chapter 7 for project level use of 'no net loss'). **The development of ecosystem services indicators will inevitably have to be accompanied by a clear definition of relevant policy goals to ensure the effectiveness of such indicators as an integration tool.** A widely-recognised set of indicators on the quality of ecosystems and their capacity to provide ecosystem services will be necessary to effectively measure progress towards those targets and the efficiency of approaches taken.

A streamlined or small executive set of headline indicators would arguably be sufficient for high level target setting and communication by policy makers, politicians, the press and business, supported by wider sets for measurement and monitoring. Initiatives such as Streamlining European 2010 Biodiversity Indicators (SEBI 2010) and the CBD global headline indicators have started taking into account a limited number of indicators relating to ecosystem capacity to provide services and goods (e.g. water quality of freshwater ecosystems) and to sustainable use of provisioning services (e.g. ecological footprint; area of forest, agricultural and aquaculture ecosystems under sustainable management). Table 3.2 above outlines indicators

Box 3.4: Using indicators in policy: the ecological footprint for measuring sustainable use of provisioning services

As noted in Chapter 2, ecological footprint analysis compares human demand on nature with the biosphere's ability to generate resources and provide services. It measures how much biologically productive land and water area an individual, a city, a country, a region, or humanity requires to produce the resources it consumes and to absorb the waste it generates. The following examples show how the footprint has been applied in decision-making.

SEBI 2010: The Ecological Footprint has been included in the set of 26 indicators developed by the Initiative. According to the latest SEBI 2010 review, natural resource use and waste generation within Europe is more than two times greater than the continent's natural capacity to provide these resources and absorb these wastes. This ecological deficit means that Europe cannot sustainably meet its consumption demands from within its own borders. The EU-27 on its own has a footprint of 4.7 global hectares per person, twice the size of its biocapacity.

Source: Schutyser and Condé 2009

European Union (EU): The European Commission is incorporating the footprint into its dialogue and considering how and where to integrate its measurement, notably as regards its impact outside the territory of the EU. An analysis of the potential to use the footprint and related assessment tools in the EU Thematic Strategy on the Sustainable Use of Natural Resources has been carried out. The European Commission supports the wider improvement of this tool.

Source: Ecologic et al. 2008; EC 2009

Switzerland: The government has completed a scientific review of the National Footprint Accounts. Officials are now incorporating footprint data into the nation's Sustainability Development Plan.

Source: Global Footprint Network 2009

South Australia: The state is using the Ecological Footprint as a regional target – aiming to reduce its footprint by 30% by 2050.

Source: South Australia's Strategy Plan 2007 considered by the CBD and taken up by the SEBI 2010 initiative. Box 3.4 highlights the use of the ecological footprint in policy across different countries.

Ecosystem services indicators can also be included in corporate reporting standards (e.g. Global Reporting Initiative) to communicate the impacts of lost services on company performance (e.g. paper and forestry, water quality and beverage industry) and the impacts of companies on provision of these services (e.g. metals and mining). Further details on business and ecosystem services can be found in TEEB D3.

A small set of headline indicators may be enough for communication and high-level target setting but **there is also value in having detailed ecosystem service indicators for certain policy instruments**. These include e.g. policy assessments, Environmental Impact Assessments (EIA) and national accounting as well as procedures to analyse companies' economic dependency and impacts on ecosystem services through materiality or Life Cycle Assessments (LCA). In policy and environmental impact assessments, such indicators help us to answer questions on the economic, social and environmental consequences of different policy or planning options affecting biodiversity (see Chapter 4). With regard to national accounting, indicators can be integrated into Systems of National Accounts (SNA) through the development of satellite accounts (see Box 3.5). More details on national accounting can be found in sections 3.3 and 3.4 below.

Ecosystem service indicators are not an isolated part of measurement but can effectively complement macro-economic and social indicators to further describe interactions between nature and society. Ways to move to more sustainable measurement of the wealth of nations and well-being of societies are discussed in sections 3.3.1 and 3.3.2 respectively.

Box 3.5: Using indicators in policy: the Final Ecosystem Services approach in national accounting

Switzerland commissioned a feasibility study on the use of the 'final ecosystem services' (FES) approach developed by Boyd and Banzhaf (2007) for its national income accounting. FES are defined as components of nature that are directly enjoyable, consumable or usable to yield human well-being. The schematic account matrix distinguishes between FES indicators attributable to four main benefit categories: Health, Safety, Natural Diversity and Economic Benefits. The study analyses in more detail the application of accounting indicators in the category 'health' and for the benefit of 'undisturbed sleep' (see example below).

Schematic account matrix for final ecosystem services (FES)

benefit category (FOEN Product group)	Benefit		Ecosystem Services		Relevant intermediate products, processes, functions
	Type of benefit	Description	Description	Unit	
Distinction between: • Health • Safety • Natural diversity • Factors of production	Active use value, passive use value, existence value	Benefit 1	Ecosystem Service 1	…*Persons/year…	
			Ecosystem Service 2	…*Persons/year…	
			…	…*Persons/year…	
		Benefit 2			
Example – *Health*	*Passive use value*	*Undisturbed sleep*	*Night-time sound level below limit (at place of residence)*	*# Persons/year where defined threshold is not exceeded in dB(A) between 22 – 06 hours*	*Natural sound absorbers*

Source: Ott and Staub 2009

CHALLENGES AND NEXT STEPS

The extent to which ESS indicators are ready for use varies depending on the availability of data, the capacity to summarise characteristics at multiple spatial and temporal scales and communication of the results to non-technical policy-makers (Layke 2009). There are more and better indicators for provisioning services than for regulating and cultural services, due to our clear and immediate dependency on provisioning services which are mostly incorporated into marketed commodities (e.g. wood for timber, fuel and food).

The flow of benefits from regulating and cultural services is not as visible or easily measurable: many non-market services are therefore enjoyed for free. Proxy indicators can help us estimate benefits associated with these services by referring to the capacity of an ecosystem to provide them – but these are only a short-term solution. **More widespread use of ecosystem services in decisions will require us to improve regulating and cultural service indicators** (Layke 2009). Promising ideas such as the trait concept (Layke 2009), which seeks the clear definition of characteristics required for the provision of services, are available but need further elaboration.

ESS indicators need to take account of the sustainability of provisioning and other services over time, to ensure that the long-term benefit flow of services is measured. Overexploitation of benefits arising from some provisioning services (e.g. overexploitation of fish stocks) as well as cultural services (e.g. tourism) and regulating services (e.g. reforestation activities for carbon capture) could lead to a depletion of benefits and social trade-offs. Indicators referring to those services therefore need to take sustainable productivity into account. This calls for a clear definition of what sustainability actually means with regard to those services. It is crucial to develop a baseline in order to determine where critical thresholds (e.g. population of fish stock within safe biological limits, soil critical loads) and alternative future pathways under different policy scenarios (e.g. fisheries subsidies reform, subsidies in the agriculture sector) may lie. However, settingcritical thresholds raises substantial problems linked to ignorance, uncertainties and risk associated with ecological systems. Safe minimum standards may be a way to overcome these challenges (see TEEB D0 Chapter 5).

Not all ecosystem service indicators can be quantified: there is a risk that policy makers focus more on those for which quantifiable information is available. As stated in TEEB D0 Chapter 3, "reliance on existing indicators will in all likelihood capture the value of a few species and ecosystems relevant to food and fibre production, and will miss out the role of biodiversity and ecosystems in supporting the full range of ecosystem services, as well as their resilience into the future." To avoid risks of creating a policy bias by focusing on a subset of indicators high on the political agenda or the agenda of vested interests, we need to increase efforts to find complementary non-quantified indicators.

In parallel, ESS valuations that focus on a single service should be systematically cross-checked with broader measurements to assess the capacity of ecosystems to continue delivering the full variety of other services potentially of interest. This capacity depends on ecosystem robustness, integrity and resilience, not on asset value. We therefore need to compare eco-nomic benefits from ecosystem services exploitation to the additional costs required to maintain ecosystem capital in the broadest sense (i.e. to mitigate overall degradation), rather than sticking to narrow measurement of the losses of benefits resulting from natural resource depletion.

TEEB D0 Chapter 3 discusses in more detail the lessons learned from initial application of existing indicators and highlights key opportunities and constraints arising from their use.

To better identify the beneficiaries of ecosystems services and those who guarantee their provision to society, we need more research on the link between biodiversity and ecosystem condition and on the provision of ecosystems services. This is particularly acute for indicators on regulating and cultural services: data are often insufficient and indicators inadequate to characterise the diversity and complexity of the benefits they provide (Layke 2009).

Improving measurement can be a long process but it is of fundamental importance to arrive at good solutions. In the long term, measurement is often a good investment and can be a cost-effective part of the answer – spotting risks early and addressing them efficiently can help avoid much higher damage costs later on. As sections 3.3 and 3.4 show, indicators feed directly into macro-economic aggregrates and thus form an integral part of accounting systems.

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3.3 'GREENING' OUR MACRO-ECONOMIC AND SOCIETAL INDICATORS

"Choices between promoting GDP and protecting the environment may be false choices, once environmental degradation is appropriately included in our measurement of economic performance."

Stiglitz-Sen-Fitoussi Report on the Measurement of Economic Performance and Social Progress, 2009.

3.3.1 TRADITIONAL APPROACHES TO MEASURING WEALTH AND WELL-BEING

A range of 'traditional' indicators are used to measure countries' economic performance and in policy making, These include: GDP and GDP growth, national income, final consumption, gross fixed capital formation (GFCF), net savings, international trade balance, international balance of payments, inflation, national debt, savings rates and so on. On the social side, some of the indicators most commonly used relate to unemployment, literacy, life expectancy and income inequality. A useful combined indicator that straddles more than one domain is the human development index (HDI).

These conventional aggregates feed into and are an integral part of national accounting systems (see 3.4 below). However, they only tell part of the story as they do not systematically cover the loss of biodiversity. Indicators for biodiversity and ecosystem services are already a step in the right direction towards complementing them. As section 3.2 showed, we now have a swathe of environmental indicators, from water quality to more recent measurements of CO_2 emissions. Many argue that there are in fact too many separate tools to have anywhere near as much public, press and political attention as the consolidated traditional economic indicators. CO_2 is starting to be an exception, but while helpful, does not address ecosystems and biodiversity directly.

We can illustrate the slow process of change through the example of trade deficits e.g. where imports exceed exports. These feature every week in many newspapers or magazines yet there is little mention of green trade deficits i.e. the impacts on biodiversity related to imports and exports of goods and services. The tool of ecological footprint analysis (see Box 3.4 above) can help to fill this gap by helping to **identify creditor and debtor nations** from a biodiversity perspective. 'Water footprints' can also offer useful information to consumers – to put it simply, when bananas are imported, so are the water and the nutrients from the soil.

Certain countries – notably the most developed countries – are significant environmental debtor nations. Most developing countries are creditor countries. However, there is little reflection of this debt or credit in traditional measurement and decision making or in market signals. Some countries have responded to the understanding that a continued growth in their footprints cannot go on for ever and are using the footprint as a policy target to reduce their environmental impacts or increase resource efficiency (see Box 3.4).

The next section shows how traditional approaches can be gradually adapted to support more sustainable measurement.

3.3.2 TOOLS FOR MORE SUSTAINABLE MEASUREMENT

Part of the solution is understanding that for many of the economic terms used in everyday policy making, there are already parallels that take nature into account.

Economic assets – natural assets. The concept of capital derives from economics: capital stocks (assets) provide a flow of goods and services which contributes to human well-being. This concept has traditionally been equated with manufactured goods which produce, or facilitate the production of, other goods and services.

This 'manufactured capital' is only part of the picture. We can also talk of 'human capital' (skills and knowledge, quality of the labour force), 'social capital' (universities and hospitals) and 'natural capital' – the stock of our natural resource from which ecosystem services flow. These four types of capital are defined in Box 3.6. While some do not like to equate nature to 'natural capital', the term has its use in communicating the importance of nature in the context of our economic activities.

Infrastructure and green infrastructure. Traditionally infrastructure spending focused on roads, rail, schools etc. There is now increasing appreciation of the importance of investing in 'green infrastructure' – this not only includes protected area networks (see Chapter 8) but also investments in watersheds that provide waste services (see Chapters 5 and 9), city gardens that provide amenities, and in some countries, green roof programmes to help biodiversity and adaptation to climate change.

Man-made capital depreciates, natural capital 'appreciates'. Man-made infrastructure degrades and requires continuous maintenance – e.g. flood protection levies, water pre-treatment plants – and associated costs. Natural infrastructure can often do its own maintenance e.g. mangroves or flood plains vis-à-vis flood protection. There is little talk of proactive investment in natural capital formation, yet this is a common theme running through programmes for afforestation, investment in watersheds, forest management, restoration and investment in protected areas.

Gross fixed capital formation, natural capital formation. Most governments regularly monitor the level of gross fixed capital formation (GFCF) (i.e. investment in infrastructure), but rarely the level of natural capital formation. Some elements are included but offer a very incomplete picture of natural capital. For example, when a forest is felled (e.g. to convert to agricultural use), current SNA guidelines suggest recording a positive GFCF in an agriculture land asset up to the amount of the felling works[5].

Box 3.6: Four types of capital[4]

Manufactured Capital: Manufactured (or human-made) capital is what is traditionally considered as capital: produced assets that are used to produce other goods and services. Examples include machines, tools, buildings and infrastructure.

Natural Capital: In addition to traditional natural resources, such as timber, water, and energy and mineral reserves, natural capital includes natural assets that are not easily valued monetarily, such as species diversity, endangered species and the ecosystems which perform ecological services (e.g. air and water filtration). Natural capital can be considered as the components of nature that can be linked directly or indirectly with human welfare.

Human Capital: Human capital generally refers to the health, well-being and productive potential of individual people. Types of human capital include mental and physical health, education, motivation and work skills. These elements not only contribute to a happy, healthy society but also improve the opportunities for economic development through a productive workforce.

Social Capital: Social capital, like human capital, is related to human well-being, but on a societal rather than individual level. It consists of the social networks that support an efficient, cohesive society and facilitate social and intellectual interactions among its members. Social capital refers to those stocks of social trust, norms and networks that people can draw upon to solve common problems and create social cohesion. Examples of social capital include neighbourhood associations, civic organisations and cooperatives. The political and legal structures that promote political stability, democracy, government efficiency and social justice (all of which are good for productivity as well as being desirable in themselves) are also part of social capital.

Source: GHK et al. 2005 building on Ekins 1992

National Net Savings, 'Genuine' Savings. Countries measure how much money is saved on average as the result of all positive and negative economic transactions. However, because some economic revenue comes from rent on natural capital, these should not all be considered as part of Net Savings as they currently are in the SNA. Part of these receipts should be reinvested to maintain the income flow in a sustainable way, just as companies do with regard to depreciation of other capital. In addition, human capital and ecosystem capital should be maintained like other forms of capital.

The World Bank's 'adjusted net or genuine savings' indicators measure a 'truer' level of saving in a country by not just looking at economic growth but also taking into account the depreciation of produced capital, investments in human capital (as measured by education expenditures), depletion of minerals, energy, forests and damage from local and global air pollutants (World Bank 2006). These indicators should also include the degradation of ecosystem capital which relates to maintenance of all ecological functions, instead of – as is currently attempted for forests – being limited to depletion which only relates to the maintenance of income from forest exploitation.

GDP vs National Income that takes nature into account. GDP (the sum of sectors' value added) measures only the economic transactions which have taken place during the accounting period, not the welfare, well-being or wealth of a country. Because these transactions are the basis for taxation (the main government resource) and are also closely correlated to employment, GDP has been overplayed in macroeconomic decisions and is sometimes misinterpreted as a welfare indicator by journalists and many economists. Once GDP is restored to its original status, the question of an alternate or supplementary headline aggregate comes to the fore.

The international Commission on the Measurement of Economic Performance and Social Progress (the 'Stiglitz-Sen-Fitoussi Commission') (Stiglitz et al. 2009) has addressed current limitations and flaws in GDP use (see Box 3.7).

Box 3.7: The Stiglitz-Sen-Fitoussi Commission's critique of GDP

The Commission has addressed current limitations and flaws in GDP use, insisting on the need to pay more attention to other existing aggregates, namely National Income and Households Consumption. It started by looking at the properties of the National Income. Derived from GDP, the Income aggregate aims to measure how much money we can dispose of freely for our own expenditures:

- where part of GDP is regularly sent abroad – e.g. to pay revenue to a foreign shareholder of domestic companies or to families of immigrant workers – GDP is adjusted for these transfers of revenue with the rest of the world, leading to the so-called 'Gross National Income';
- a second adjustment is made to take into account the normal degradation of productive capital and the need to repair or replace it, to produce a Net National Income (National Income).

The Commission examined which elements of this Income are not disposable (e.g. income tax for the Households sector) and which other imputations should be considered e.g. non-market services supplied by the government sector. It concluded by proposing the compilation of a Net Disposable National Income, mostly targeted at improving households' well-being.

If we take a step further in this direction and consider that the Consumption of Natural Capital still needs to be taken into account, we can propose the calculation of an Adjusted Net Disposable National Income. Being linked to production processes, this imputation will mostly draw upon business accounts.

Source: building on Stiglitz et al. 2009

Correcting the prices for consumption, imports and exports. Some talk of 'greening GDP' when they actually mean 'greening the economy' – i.e. reducing the impact on nature. One way to do this is to change market signals to encourage activities that take nature into account – e.g. getting the prices right through full cost recovery charges, resource costing, subsidy reform and the polluter pays principle (taxes, liability, regulation). The development and greening of markets and supply chains e.g. via green public procurement, can also help (see generally Chapters 5 to 7).

National accounts currently record household final consumption as well as imports and exports at purchasers' prices. Normal market prices cover production and distribution costs (intermediate consumption, labour, taxes and financial costs), the entrepreneur's profit plus an allowance for compensating fixed capital depreciation resulting from wear and tear (as noted above). In national accounts, no such element is recorded for the depreciation of the ecosystem capital. This means that purchasers' prices are underestimated in cases where commodities originate from degrading ecosystems.

If we set the target of maintaining ecosystem capacity in a good state (e.g. 'halt biodiversity loss', "ensure sustainable development" or the many equivalent regional or national objectives), the implicit value of ecosystem degradation potentially attached to each commodity unit needs to be considered as a concealed negative transfer to future generations and/or – in the case of international trade – from suppliers to consumers.

Measuring and valuing these concealed transfers is important to assess the reality of each country's economic performance. From a well-being perspective, this sheds light on the sustainability of consumption patterns and on distributional effects resulting from distorted international trade. Systematic implementation of product traceability – starting to be done though fair trade or for organic products (see Chapter 5) – and printing the full price on the product would help the many consumers keen to act responsibly to make informed choices. It would also be a measure to help protect sustainably-managed industries against arguably unfair competition from ecosystem-degrading competitors who do not pay for their degradation and thus receive an implicit subsidy (see Chapters 6 on subsidies and 7 on full cost recovery and polluter pays principle).

This type of measurement approach would also help in policy design and lead to future GDP statistics being less out of step with nature.

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3.4 INTEGRATING ECOSYSTEMS INTO NATIONAL INCOME ACCOUNTING

"A country could cut down all its forests and deplete its natural resources and this would show only as a positive gain to GDP despite of the loss of [natural] capital".

Robert Repetto (1987) in
Millennium Ecosystem Assessment (MA) 2005

3.4.1 THE RATIONALE FOR ECOSYSTEM ACCOUNTING

Ecosystems are badly – and even equivocally – recorded in national economic accounts, at best as an economic resource able to generate monetary benefit for their owners i.e. they feature only in proportion to this private benefit. A range of ecosystem services supporting production are merely considered as externalities. Free amenities and regulating services supplied by thriving ecosystems are absent from the picture.

The TEEB project has always acknowledged accounting as an essential component because the protection of public goods (e.g. the life-support functions provided by ecosystem services and the sustainable use of these services) goes to the heart of sustainable development and how it can accommodate economic growth. Proper accounting is necessary to support properly informed decisions. The indicators discussed in sections 3.2 and 3.3 above need to feed directly into such accounting systems.

At present, the actual value of ecosystem services is only accounted for either when they are incorporated into the price of products or when the services are (at risk of being) lost and the cost of alternatives becomes evident. When their market price is zero, however, as is often the case, services are effectively taken not to exist and can thus be appropriated for production or simply degraded without any recording. These free ecosystem services need in some way to be measured, valued and added to existing measures such as GDP to provide more inclusive aggregates to guide decisions by policy makers, businesses and consumers.

The need for change is widely acknowledged, not just in TEEB but also in processes like 'Beyond GDP'[6], the OECD's Global Project on Measuring the Progress of Societies'[7] and the Stiglitz-Sen-Fitoussi Commission (see Box 3.7). Economic commentators also recognise the increasing urgency for action, given the unsustainable externalities resulting from over-consumption of ecosystem services, most visible in climate change and loss of biodiversity. Add in growing demography, the emergence of big economic players and chaotic economic development in general and it becomes obvious that accounting for the real value of what we produce and consume is essential for taking personal and collective decisions.

Today's unparalleled multiple systemic crises – economic/financial, climate/energy and ecosystems/biodiversity – have jointly spawned **crises of governance and trust**. Citizens, business and government are increasingly concerned about accumulating debts, the exposure of concealed debts and the ability of huge untested rescue packages to work. Social crisis could be exacerbated. These three crises share common features, all relating to shortcomings in societal accounting mechanisms: over-destruction of financial, human and natural capital, over-consumption fuelled by often hidden debt and the shifting of risks and debts from the strongest to the weakest (the ever-increasing North-South debt) or to future generations.

Underlying this lack of complete accounting are factors that include:

- lack of transparency in consumer transactions of financial, food, fibre and energy products;

- misleading market price signals that did not cover all costs and risks;
- neglect of public goods such as the built and natural infrastructure, security, cooperation, equity, nature, clean air and water.

Yet early signals could have been recognised in advance of these crises: financial transactions accounting for more than 90% of the world's total transactions; two digit profit rates raised as an accounting standard for companies; pension liabilities putting pressure on public budgets/debts (which will increase markedly in coming decades of aging population); the average very low progress towards the Millennium Development Goals (MDGs) and even increases in malnutrition in many countries; the melting of ice caps and glaciers; and a rate of ecosystem degradation and species extinction unprecedented in the Earth's history.

These crises highlight the need for governance that maintains capital, meets the needs of today's and future generations and enhances citizen participation. Fair, transparent and robust accounts are an important support for any such governance model. Robustness relates to the completeness of recording and the elimination of double counting – such properties are essential when calculating the true results of economic activity (profit of companies, taxable revenue of households or Nation's product, income and savings). Fairness relates to distributional equity considerations between rich and poor within countries, between rich and poor parts of the world and between present and future generations. Transparency concerns full disclosure of the use of different types of capital, the positive and negative impacts (externalities) on them from such uses and how their costs/benefits vary between today's needs and those of future generations.

3.4.2 LIMITATIONS OF CONVENTIONAL ACCOUNTING SYSTEMS

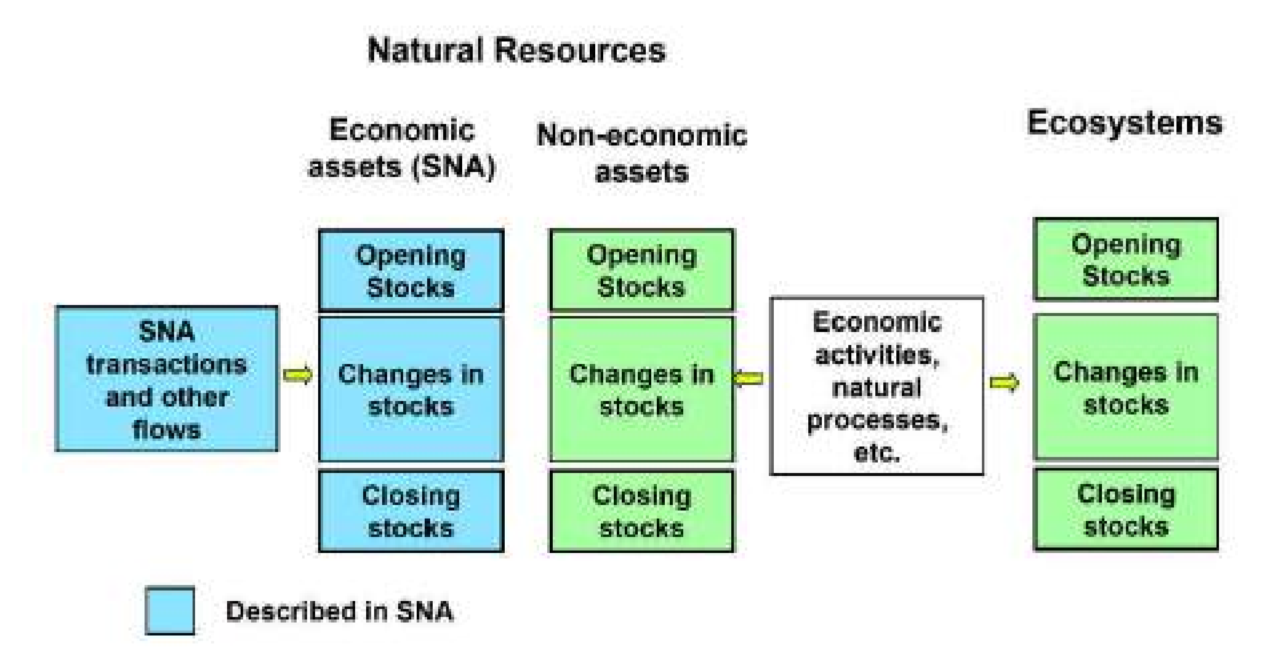
The UN System of National Accounts (UN SNA), is the globally recognised accounting framework that brings coherence to hundreds of mainly economic (but also some social and environmental) statistics sources available in countries. SNA is the framework from which variables such as GDP, production, investment and consumption are produced annually, quarterly and sometimes even monthly.

Historically the impetus for such accounts has always come from the need to mobilise resources in times of crisis. From the first sets of accounts developed in the 17th and 18th century in England[8] and France[9], the material balance of the USSR economy of 1925[10], to the first official national income statistics produced for the USA[11] in 1934, the UK[12] in 1941 and several European countries after 1945, the common purpose was either to mobilise resources to fight wars and/or to pay for peacetime reconstruction. After the Second World War, the Marshall Plan for post-war construction in Europe spawned the development of a first Standardised System of National Accounts published in 1952[13]. The following year the United Nations published a revised version for global use known as the 1953 SNA.

This backdrop of reconstruction and re-industrialisation strongly influenced the SNA's almost exclusive focus on the economic factors of production and consumption. Its creators were well aware of the SNA's limitations. In his Nobel Memorial lecture in 1984, the 'father' of the SNA, Richard Stone, stated that accounts for society ought to rest on three pillars: economic, socio-demographic and environmental. He highlighted that issues such as pollution, land use and non-renewable resources offered plenty of scope for accounting and that GDP should in effect be complemented by other variables when considering overall societal welfare. Since then, there has been only limited progress with including natural capital in SNA revisions: the 2008 revision still does not record subsoil assets depletion in the same way as fixed capital consumption (United Nations et al. 2008).

The intrinsic limitations of SNA when analysing the social functions of the economy led to the introduction of 'satellite' accounts in the 1993 SNA revision, one of which was developed as the System of Economic Environmental Accounting (SEEA) (United Nations et al. 2003: see Figure 3.3 below). However, the SEEA of 1993 failed because it did not recognise the need for asset accounts in physical units or acknowledge the concept of ecosystem.

Figure 3.3: SNA and Environmental-Economic Accounting



Source: Hassan 2005

A few countries developed satellite accounts for environmental protection expenditures, for natural assets (sub-soil, water, forest), for pollution (emissions accounts) or for other material flow accounts (see also TEEB Climate Issues Update 2009). However, too little use was generally made of these satellite accounts. This led to the creation of the London Group on Environmental Accounting – a group of national and environmental accountants from various OECD and developing countries – and to the revision of the SEEA in 2003 to present a better balance between monetary and physical accounts.

The 2003 SEEA now offers best accounting practices for physical units for natural assets, such as land ecosystems and water systems. With respect to valuation issues, however, it still artificially divides ecosystems into a resource component (timber, fish stocks, water in reservoirs…) where depletion is calculated according to conventional economic rules and where valuation remains uncertain for 'environmental degradation'. Addressing these shortcomings in ecosystem accounting is a key challenge for the SEEA 2012/2013 revision. Ecosystem accounts and valuation issues are planned to be part of a specific volume.

3.4.3 PRACTICAL STEPS TOWARDS ECOSYSTEM ACCOUNTING

Against this background, elements of a framework for ecosystem accounting have been developed and are being tested by the European Environment Agency with many partners. Several analyses and methodological approaches have been developed and presented in papers (Weber 2007, 2009). Land accounting has been established on the basis of land-cover change detection for Europe (EEA 2006) and can be applied to the global level using similar methodologies developed with ESA, FAO, UNEP, IGBP and other relevant bodies.

Under the auspices of TEEB, the European Environment Agency has been working on Ecosystem Accounting for the Mediterranean Wetlands. This methodological case study is being carried out to illuminate the possible contribution of environmental accounting in general, and ecosystem accounting in particular, to the economics of ecosystems and biodiversity. It has come to findings and confirmations of the following points on ecosystem accounting methodologies (see Box 3.8).

Box 3.8: Practical elements for ecosystem accounting, based on EEA Mediterranean Wetlands case study

1. **Ecosystem accounts can be implemented across the three geographical scales most relevant to prevailing governance models and societal welfare considerations.** The basic scales are the Global/Continental, the National/Regional and the Local. Each scale corresponds to a different governance framework. The Global/Continental scale is the one of general objectives, stated by international conventions, requiring simplified accounts that monitor main trends and distortions for all countries. The National/Regional scale is where the enforcement of environmental policies and regulations prevails, through environmental agencies, and ministries of economy, statistical offices and courts. The Local scale is the action level: local government, site level, management, projects, case studies, and business. This is the scale where assessing and valuing ecosystem services is essential and feasible because informed actors can express their real preferences.

2. **From a policy and data point of view, ecosystem accounting should be prioritised from a top-down perspective, not bottom-up[14].** Each of the three governance scales addressed above can be assigned a mission, an access to data and a time frame. If there is any chance of integrating the environment in economic decision-making, the strategy should consider the three interconnected tiers and their feasibility.

3. **Simplified global-scale ecosystem accounts** annually updated for assessing losses (gains) in total ecological potential in physical units and the costs of restoring the ecosystem for maintaining their functions and consequently their capacity of delivering their services from one year to the next. This maintenance cost is the ecosystem capital consumption which can be used in two ways: 1/ calculation of the value of domestic and imported products at their full cost in addition to their purchase price and 2/ subtraction from the Gross National Product (altogether with fixed capital consumption) for calculating a new headline aggregate, the Adjusted Disposable National Income (ADNI). Simplified global-scale ecosystem accounts can be produced at short notice on the basis of global monitoring programmes and international statistics.

4. **Integrated national economic-environmental accounts with ecosystem accounts.** The first task is to compute ecosystem capital consumption and use this to derive ADNI on the basis of national socio-economic statistics and monitoring systems. The second task is to integrate such ecosystem accounts with the national accounting matrixes and the monetary and physical indicators used for policy making. The process for implementing these national accounts is the revision of the UN SEEA by 2012/2013.

5. **Local/private actors** are increasingly demanding guidance for taking into account the environment in their everyday decisions on development projects of various types. As the Mediterranean Wetlands case study shows, ecosystem accounts would be very helpful for planning departments and environmental protection agencies to fully internalise environmental considerations when considering e.g. the costs-benefits of development proposals. Businesses are also interested as shown by their response to carbon accounting and recent interest in biodiversity considerations. Progress at this scale could be by developing guidelines based on the general principles but adapted at needs of the various communities of users.

6. **Socio-ecological systems are the appropriate analytical units for such accounting.** They reflect higher levels of interaction between ecosystem and people. Stocks and flows of land cover, water, biomass/carbon, and species/biodiversity are the priority accounts to be established in view of calculating the ecological potential[15] of many terrestrial socio-ecosystems. A simplified formula as well as a more

sophisticated one can be used depending on operational targets, scales and data availability. Ecosystem services are the outcomes of ecosystem functions which are directly or indirectly used by people. UNEP and EEA have taken steps in order to come to an international standard ecosystem services classification to use in environmental accounting and ecosystem assessments more generally.

7. **Asset valuation is both very feasible and very useful in the context of cost benefits assessments of impacts of projects.** It helps policy makers achieve trade-offs between possible future benefits from new developments and the total present benefits from economic natural resources and main non-market ecosystem services, and to see if benefits compensate losses. In the case of regular national accounting, the method contains several risks. The main one relates to the non-use values – often of a public good nature – which tend to be ignored or inadequately valued because of the problems mentioned previously. For renewable assets the valuation of the stocks is not even necessary. What matters first is that the ecosystems are renewing, that their multiple functions can be maintained over time, whatever the present preference for one or other service they deliver. The degradation of ecological potential can be observed and measured in physical units. It is then possible to calculate a restoration cost in reference either to the average cost of maintenance works or to the benefit losses of reducing extraction or harvesting down to a level compatible with the resilience of the socio-ecological systems.

8. **Maintenance of the ecosystem capital is the other approach of valuation.** It considers in a holistic way the capacity of ecosystems to deliver services in the present and future. Two elements are to be considered, 1/ actual expenditures for environmental protection and resource management and 2/ additional costs potentially needed to mitigate ecosystem degradation. When the actual expenditures are not sufficient to maintain the ecosystem, additional costs may be necessary and an allowance made accordingly. This is what is done by business and national accounts under the expressions 'cost of capital maintenance' or 'fixed capital consumption'. 'Ecosystem capital consumption should be calculated in the same way as fixed capital consumption' and added to it. This would result in an adjustment in the calculation of company profit or national income. As for the fixed capital, this adjustment measures what should be reinvested to maintain an equivalent productive (and in the case of ecosystems, reproductive) capacity of the asset. This is what should be set aside at the end of the accounting period and be made available at the beginning of the following one for restoring capacities. This is an important accounting number which can support actions such as reduced distribution of dividends and accordingly reduced taxes on benefits.

3.4.4 USING AVAILABLE INFORMATION TO MEET POLICY MAKERS' DEMANDS

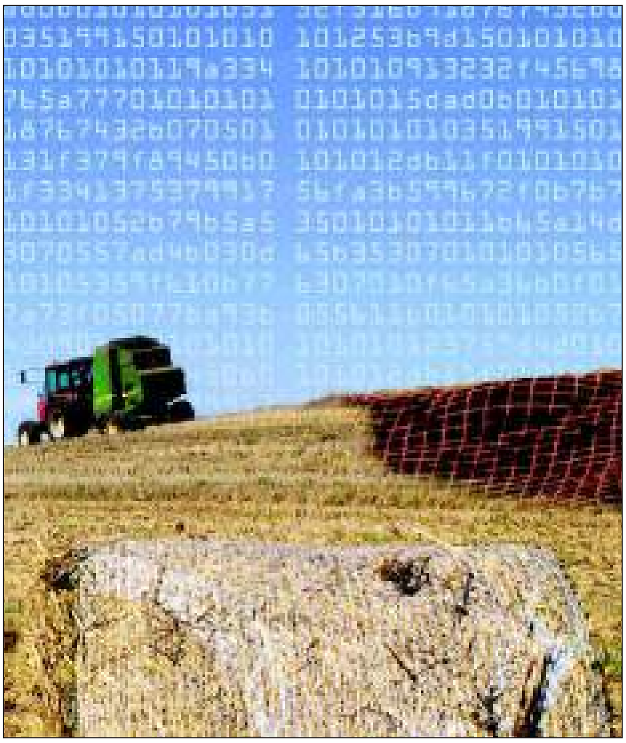
The data issue requires a strategic response. On the bright side, we have made tremendous progress with data collection in the last 30 years. Earth observation satellites, ground positioning systems, *in situ* real time monitoring, data bases, geographical information systems and internet are shorthand for a well known story. Public and private organisations have developed capacities and networks which make it possible today to take the first steps towards ecosystem accounting. The dark side has two aspects. The first concerns the lack of guidelines for accounting for ecosystem benefits and costs, especially at local government/agency and business levels. The Mediterranean case study (see Box 3.8) shows that data are regularly collected by the natural park bodies yet compiling them into an integrated framework is a huge effort. We need to make progress on drafting such guidelines at the local level, starting from the needs of local actors for information on physical state, costs and benefits in relation to their mandate.

The second difficulty relates to restrictions to data access imposed by some public organisations. This situation should stop, at least for public data paid by the public's money, In practice, it is already being addressed by the new data policies of the major space agencies, the open access policy of most environmental agencies and initiatives to facilitate access to scientific knowledge and data. Statistical offices have also considerably improved access to their databases and developed local statistics. However, more progress is still needed e.g. to merge further statistical and GIS data and develop grid data bases.

Data collection will develop if and only if it meets the needs of policy makers, companies and the public. A new product results from iterations between the supply and demand sides. The supply side brings together intuition of a need and technical capacities to meet it, draws sketches, designs models, prototypes etc. The demand side expresses needs, preferences and finally validates the supplied product by using it. Environmental accounting methodologies have been designed proficiently over the past three decades, and tested in various contexts but have not yet met the demand side requirements.

All the initiatives launched before the present financial and economic crises (see 3.4.1) note that physical indicators are part of the response to better reflect the social and environmental interactions of economic development, and all request new monetary indicators. The current crises amplify this need. It is therefore essential for the supply side to start sketching new products on the basis of existing data. These products will be coarse and simple at the start but will give users preliminary elements for better assessing trade-offs and decisions based on accounts of the past and derived outlooks.

For example, the 2007 Beyond GDP Conference[16] has created an interim follow up 'basket of four' indicators (Ecological Footprint, Human Appropriation of Net Primary Production (HANPP), Landscape Ecological Potential and Environmentally Weighted Material Consumption). The EEA proposes an ecosystem diagnosis to support ecosystem accounting based on a 'Cube' of six indicators, the main additions relating to water and biodiversity. The 2010 biodiversity target



process, guided by CBD headline indicators and followed by regions across the world provides a much higher quality and consistent basis to support decision makers than was the case only five years ago.

Decision makers need tools such as indicators to feed into accounting systems and guide their decision processes e.g. do international and national policies that govern land use and management provide the correct response to the biodiversity decline? What is the current status of biodiversity? What are the key pressures likely to affect it now and in the future? Good indicators should be policy relevant, scientifically sound, easily understood, practical and affordable and sensitive to relevant changes (CBD 2003; see also TEEB D0 Chapter 3).

Discussions on possible new targets beyond 2010 have started at both the policy and scientific levels. Regardless of their outcome, most indicators discussed here will still be relevant for any new target. The proposal in section 3.2 for five biodiversity/ecosystem indicators (aligned with the Beyond GDP, CBD headline indicators and EEA Cube that looks at elements of ecological potential) could also provide a useful starting point for a post-2010 baseline discussion.

3.5 BUILDING A FULLER PICTURE: THE NEED FOR 'GDP OF THE POOR'

"Progress measured by a single measuring rod, the GNP, has contributed significantly to exacerbate the inequalities of income distribution"

Robert McNamara, President of the World Bank, 1973

The tools described above – adjusting national income (GDP) for ecosystem services (flows) and natural capital (stock) losses – are necessary adjustments but insufficient if a significant set of beneficiaries are poor farming and pastoral communities.

In such cases, we need a more encompassing measure of societal well-being that better reflects the position of society's poorest – those who are most at risk from the consequences of mismeasurement and the loss of ecosystem services. The right income aggregate to measure and adjust is the 'GDP of the Poor'.

3.5.1 A TALE OF TWO TRAGEDIES: THE MEASUREMENT GAP AROUND THE RURAL POOR

Traditional measures of national income, like GDP which measures the flow of goods and services, can be misleading as indicators of societal progress in mixed economies because they do not adequately represent natural resource flows. This flaw materially misrepresents the state of weaker sections of society, especially in rural areas.

To move beyond paradigms focused on income, human development indices (HDI) have been developed to provide a broader-based measure of development. However, HDI also fails to take account of the contribution of natural resources to livelihoods. The World Bank has published total wealth estimates (Dixon, Hamilton and Kunte 1997) which seek to account for the contribution of natural capital, but this is a stock concept. Clearly, there is also a need for a flow variable which can adequately capture the value of natural resource flows, even though these are mainly in the nature of public goods.

Developing 'green accounts', with corresponding adjustments in traditional GDP to account for the depletion of natural capital, is a step in this direction b Genuine Savings Indicator (Pearce and Atkinson 1993) does not indicate the real costs of degradation of natural resources at the micro level. Yet real and often acute costs are felt at the micro level, mainly by the poorest and most vulnerable sections of society (see 3.5.3 below), though these are not usually recorded systematically or brought to the attention of policy makers.

Particularly for developing countries, where many poor people are dependent on natural resources for employment and subsistence, the result is often a tale of two tragedies:

- the first is that the exclusion of ecosystem service flows from society's accounting systems results in a lack of policy attention and public investment in ecosystem and biodiversity conservation. This carries attendant risks of triggering the well-documented **'tragedy of the commons'** – in other words, an *unsustainable* future for generations to come;
- the second tragedy is intra-generational rather than inter-generational. It concerns the **'tyranny of the average'** i.e. the implicit assumption that an increase in any measure of average progress (e.g. GDP Growth) can reflect progress in the *distribution* of well-being within society at large.

A 'beneficiary focus' helps us to better recognise the human significance of observed losses of ecosystems and biodiversity. Moving beyond broad measures of income such as GDP to target the well-being of the poor is particularly relevant tor transitional economies as the key beneficiaries of forest biodiversity and ecosystem services are the rural poor and forest-dwellers.

In this section, we advocate the need for an adapted measure of GDP – the 'GDP of the Poor' that can show the dependence of poor people on natural resources and the links between ecosystems and poverty (section 3.5.2). This takes the form of a three dimensional metric which integrates the economic, environmental and social aspects, thereby indicating the vulnerability of these sections of the population if valuable natural resources are lost (section 3.5.3). Once adjusted for equity, the real cost of loss of biodiversity is different – so this indicator could reflect the impact of loss in biodiversity to the 'real income' and well-being of the poor.

3.5.2 POVERTY AND BIODIVERSITY: FROM VICIOUS TO VIRTUOUS CIRCLE

The links between poverty and biodiversity can be examined through the lenses of livelihoods, distribution, vulnerability and causality.

From a livelihood perspective, abundant biodiversity and healthy ecosystems are important for food security, health, energy security, provision of clean water, social relations, freedom of choice and action. They provide the basic material for good life and sustainable livelihoods and guard against vulnerability (MA 2005). Treating these flows of value to society as externalities results in understating GDP as a measure of total income. In particular, this omission from national accounts of many ecosystem services and biodiversity values misstates the GDP of the Poor who are the key beneficiaries of such services (e.g. direct harvesting of food, fuelwood and non-timber forest products; indirect flows such as the flow of freshwater and nutrients from forests to aquifers and streams to their fields). The predominant economic impact of loss or denial of such inputs from nature is on the income security and well-being of the poor.

An analysis of vulnerability leads to similar conclusions. Natural resources are of course used not only by the poor but by society at large – countries, companies and local communities. However, the vulnerability of different user groups to changes in biodiversity varies according to their income diversity, geographical location and cultural background, among other factors. Table 3.5 illustrates this by reference to end users of forest ecosystems in the state of Para, Brazil, showing their respective vulnerability to climate change and natural hazards. The highest vulnerability is found at the level of local communities in and near forests, largely due to their lack of mobility and access to resources.

Poverty-environment linkages are multi-dimensional and context-specific, reflecting geographic location, scale and the economic, social and cultural characteristics of individuals, households and social groups (Duriappah 1997). "Poverty can be due to a range of lack of the various assets (and income flows derived from them): (a) natural resource assets; (b) human resource assets; (c) on-farm physical and financial assets; (d) off-farm physical and financial assets. A household might be well endowed in one asset but poor in another, and the type of poverty can influence the environment-poverty links" (Reardon and Vosti 1995).

Duriappah (1997) identifies two kinds of poverty: exogenous (external to the group) and endogenous (internal to the community) when he notes that the root cause of environmental degradation is not only poverty but several other factors. Exogenous poverty – factors like greed, institutional and policy failures – leads to environmental degradation which in turn leads to endogenous poverty (e.g. due to degradation of natural assets). Services commonly affected by such degradation include depletion or degradation of water availability, water quality, forest biomass, soil fertility and topsoil as well as inclement micro-climates.

The two types of poverty thus reinforce each other. **Poverty, where it leads to degradation of natural capital to support needs, reduces the services generated by ecosystems which – with lack of investment resources – leads to more poverty and thus creates a vicious circle.**

An example of these linkages (see Box 3.5) is from Haiti, the poorest country in the Western Hemisphere with 65% of its people surviving on less than US$1 a day. Deforestation was shown to have led to much higher vulnerability and loss of life (compared to the neighbouring Dominican Republic) as a result of a cyclone which affected both countries.

Natural resource degradation can thus aggravate loss of natural resources because of the poverty trap. It is essential to break the vicious circle and create a virtuous circle. A proactive strategy of investment in natural capital is needed to help increase the generation of ecosystem services.

Table 3.5: Illustration of differences in forest dependence, vulnerability to climate change impacts and factors affecting the vulnerability of different forest user groups for the State of Para, Brazil

User group	Main goods and services	Level of vulnerability	Factors affecting: Exposure	Factors affecting: Sensitivity	Factors affecting: Adaptive capacity
Federation	Biological diversity; timber and non-timber products; emission reductions; hydro-electric energy	Low for some goods and services, high for others	Geographic location; GHG emissions	Deforestation and un-controlled logging increases sensitivity	Mobility of resources; accessibility to technology, human and financial resources; diversity of land uses; biological diversity
State government (e.g. Pará)	Biological diversity; timber and non-timber products; emission reductions	Medium to high	Geographic location; GHG emissions	Deforestation and un-controlled logging increases sensitivity	Limited mobility; limited access to technology and resources; limited diversity of land uses
Logging companies	Timber	High	Geographic location; GHG emissions	Demand for timber; unauthorized forest conversion; forest degradation	Limited mobility and access resources; SFM and diversification of species harvested may increase adaptive capacity and reduce sensitivity
Forest communities in Pará	Timber and non-timber forest products; drinking water; soil restoration	High to very high	Geographic location; GHG emissions	High dependence on forest products and services in an area of high potential exposure	Diversity of uses; maintenance of biodiversity; very limited mobility and access to resources
Communities outside forests in Pará	Some timber and non-timber forest products; energy from wood	High to very high	Geographic location; GHG emissions	Market demand for agriculture products; poor soil management	Very limited mobility and access to resources; limited diversity

Source: Louman et al. 2009

Box 3.5: Environmental degradation and vulnerability: Haiti and the Dominican Republic

The relationship between environmental degradation and impacts on vulnerable populations is evidenced through the contrasting impacts of Hurricane Jeanne felt in Haiti and the Dominican Republic (DR). Haiti was originally fully forested but from 1950-1990 the amount of arable land almost halved due to soil erosion: deforestation reduced the evaporation back into the atmosphere and total rainfall in many locations has declined by as much as 40%, reducing stream flow and irrigation capacity.

By 2004 only 3.8% of Haiti was under forest cover compared to 28.4% of DR. Floods and Jeanne killed approximately 5,400 people in Haiti due to a loss of green cover, destruction of storm-protecting mangroves and a loss of soil-stabilising vegetation, causing landslides that led to most casualties. In DR, which is much greener and still has 69,600 hectares of mangroves, Jeanne claimed less than 20 lives (Peduzzi 2005).

This stark difference reflects the impacts that deforestation and resource degradation have on the resilience of poor people in the face of environmental hazards. It also demonstrates the higher risks experienced by vulnerable populations that do not have enough disposable income, insurance or assets to recover from disasters. With an average income of 30.5 US$/month, Haitians are not only more vulnerable but are also deeply affected by the worsening status of the environment. This has translated into political turmoil, overexploitation of resources that perpetuates the poverty-ecosystem degradation trap, health concerns and an emergence of environmental refugees that has implications for bordering countries' stability and natural resources.

Source: Peduzzi 2005

3.5.3 PRACTICAL STEPS TOWARDS MEASURING THE GDP OF THE POOR

Tackling poverty and biodiversity loss requires us to ensure efficient and sustainable utilisation of natural resources. The development paradigm should take into account the nexus between growth, poverty and environment.

The first step for economies where rural and forest-dweller poverty is a significant social problem is to use a sectoral GDP measure which is focused on and adapted to their livelihoods. **At a micro-level, the inclusion of ecosystems and biodiversity as a source of economic value increases the estimate of effective income and well-being of the rural and the forest-dwelling poor, if all services are systematically captured.** Initially, adding the income from ecosystem services to the formal income registered in the economy will appear to reduce the relative inequality between the rural poor and other groups, insofar as urban populations (rich and poor) are less dependent on free flows from nature. However, if natural capital losses – which affect the rural poor much more – are factored in, the picture of inequality changes again: it is clear that where natural capital is being lost, the rural poor are even less well off.

Moving towards this kind of measurement has useful potential for policy making. The examples below illustrate by how much income would change if all services were systematically quantified (for details, see Annex). The methodology used considers the sectors in national accounts that are directly dependent on availability of natural capital i.e. agriculture and animal husbandry, forestry and fishing. If these three sectors are properly accounted for, the significant losses of natural capital observed have huge impacts on their respective productivity and risks. We collectively identify these sectors as the GDP of the [rural] poor that is registered in the economy. To get the full GDP of the Poor, however, non-market benefits in these sectors (including non-market forestry products) and ecosystem services also need to be added.

We should emphasise that degradation of ecosystems and loss of biodiversity has different impacts at the macro and micro level. At the micro level, it leads to the erosion of the resource base and environmental services. **Viewed from an 'equity' perspective, the poverty of their beneficiaries makes these ecosystem service losses even more acute as a proportion of their incomes and livelihoods.**

Three case studies were conducted for India, Brazil and Indonesia to test this emerging methodology for country analysis purposes. The results are synthesised in Table 3.6 below and presented in the Annex (see Boxes 3.A1 to 3.A3 and Table 3.A1).

For India, the main natural resource-dependent sectors – agriculture, forestry and fisheries – contribute around 16.5% to the GDP. When the value of ecosystem services provided by forests and the value of products not recorded in GDP statistics are added, **this increases the adjusted contribution of agriculture, forestry and fishing to GDP from 16.5% to 19.6%**. For the rural poor, the per capita value from the agricultural, forest and fisheries sectors combined was 138.8 US$/capita (average for the rural poor). When non-market goods are included as well as the value of ecosystem services, per capita effective income goes up to 260 US$/capita. This is a much larger increase than for the average across the economy as a whole.

A similar pattern is also observed in the Brazilian and Indonesian case studies, where the increase is even more significant. The role of ecosystem services and non-market priced goods, including forest products, also play a predominant role in the income of the rural poor in Brazil and Indonesia.

These figures are a first estimate useful not only to test the indicator, but to illustrate the importance of the information that can be obtained. Though only a few of the ecosystem services could be added and generally conservative estimates have been used, the results underline the potential for further development of this indicator.

The analysis also emphasises that even with the partial evidence available, the issue of the rural poor's dependency on income from non-market products and services is a critical one to factor into policymaking. Their dependency and their increasing loss of livelihood from the erosion of natural capital, underlines the need for a strategy for investing in the natural capital stocks that support the GDP of the Poor.

Table 3.6: GDP of the Poor and share of GDP

Natural-resource dependent sectors and ESS (2005)	Brazil	Indonesia	India
Original share of GDP (%) – agriculture, forestry, fisheries	6.1%	11.4%	16.5%
Adjusted share of GDP (%) + non market + ESS	17.4%	14.5%	19.6%
Original per capita unadjusted 'GDP of the poor' (US$/capita)	51	37	139
Adjusted GDP of the poor per capita (US$/capita)	453	147	260
Additional GDP of the poor from ESS and non market goods (US$/capita)	402	110	121
Share of ESS and non market goods of total income of the poor (%)	89.9%	74.6%	46.6%

Chapter 3 has looked at the range of issues of measuring to manage our natural capital – from scientific, biodiversity and ecosystem service indicators to economic and other macro indicators. This underlines the fact that insufficient use is made of nature-related indicators. It has shown that national accounting frameworks and the associated GDP indicator integrate only part of what we need to measure – with natural capital accounts not yet generally developed, they only present part of the picture of the wealth of nations, well-being of societies and progress. Lastly, the Chapter looked at the social dimension and at the experimental indicator of GDP of the Poor, highlighting the higher dependency and vulnerability of the rural poor to the provision of services from natural capital and changes to the underlying natural capital stock.

Chapter 4 will look at how the values of ecosystems and biodiversity can be calculated, how they are used in policymaking and **how such values (both monetary and non-monetary appreciation) can be integrated into policy assessments**.

Endnotes

[1] 'Measures' are actual measurements of a state, quantity or process derived from observations or monitoring. 'Indicators' serve to indicate or give a suggestion of something of interest and are derived from measures. An 'index' is comprised of a number of measures in order to increase their sensitivity, reliability or ease of communication (see TEEB D0 Chapter 3 for further definitions used in TEEB).

[2] International workshop in Reading, UK, organised by sCBD and UNEP-WCMC: http://www.cbd.int/doc/?meeting=EMIND-02)

[3] http://www.jncc.gov.uk/page-2199

[4] In addition, immaterial capital (e.g. patents, licences, brands) plays a core role in modern economic development.

[5] See 2008 SNA, 10.44, http://unstats.un.org/unsd/nationalaccount/SNA2008.pdf;

[6] In November 2007, the European Commission, European Parliament, Club of Rome, OECD and WWF hosted the high-level conference "Beyond GDP" with the objectives of clarifying which indices are most appropriate to measure progress, and how these can best be integrated into the decision-making process and taken up by public debate. A direct outcome of the conference was the publication in 2009 of the Communication "GDP and beyond: Measuring progress in a changing world" by the European Commission, which includes an EU roadmap. http://www.beyond-gdp.eu/index.html

[7] The project exists to foster the development of sets of key economic, social and environmental indicators to provide a comprehensive picture of how the well-being of a society is evolving. It also seeks to encourage the use of indicator sets to inform and promote evidence-based decision-making, within and across the public, private and citizen sectors. http://www.oecd.org/pages/0,3417,en_40033426_40033828_1_1_1_1_1,00.html

[8] Known as Verbium Sapienta (1665). Produced by William Petty for resource mobilisation during the 2nd Anglo-Dutch war 1664-1667

[9] Known as La dime royale (1707). Published by Sebastien le Prestre de Vauban, and based on his experience of mobilising resources for the construction of military forts on French borders.

[10] Published by Wassily Leontief, Nobel Prize winner 1973, as "The balance of the economy of the USSR, A methodological analysis of the work of the Central Statistical Administration" (1925)

[11] Published by Simon Kuznets, Nobel Prize winner 1971.

[12] Published by Richard Stone, Nobel Prize winner 1984.

[13] Published by OEEC (precursor to OECD)

[14] The difficulties of Accounting for Ecosystems, starting from cases studies and the valuation of ecosystem services, were considered in a recent article (Mäler 2009). The authors state in the conclusion that "When we deal with ecosystem services, we the analysts and we the accountants must figure out the accounting prices from knowledge of the working of every ecosystem. It is therefore—at least for now—impossible to design a standardised model for building a wealth based accounting system for ecosystems. We have to develop such an accounting system by following a step by step path, going from one ecosystem to another."

[15] The ecological potential is measured from multi-criteria diagnosis (rating) based on these accounts, possibly completed on indicators related to populations' health and to external exchanges.

[16] See http://www.beyond-gdp.eu/

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ANNEX: COUNTRY-BASED CALCULATIONS OF GDP OF THE POOR

Box 3.A1: Country GDP of the Poor Calculations – India

Agriculture and allied activities contribute around 16.5% to the GDP, with per capita income of US$ 2,220 (adjusted for purchasing power parity). A large proportion of timber, fuelwood and non-timber forest products are not recorded in the official GDP, so these were added as adjustments. To these tangible benefits we have also included the contribution of ecotourism and biodiversity values and ecological services provided by forest ecosystems, based on estimates from the Green Accounting for Indian States Project (GAISP). The adjusted contribution of agriculture, forestry and fishing to GDP has increased from 16.5% to 19.6%.

More specifically:

- not all of the contribution of agriculture, forestry and fishing can be attributed to poor people;
- we assumed that fuelwood and NTFPs are totally consumed by the poor;
- for ecotourism, we assumed that with international tourists, there is a leakage of around 40% out of India and only the remaining 60% is captured by the host country. Of this 60%, part of the income accrues to the government, tour operators, hotels and restaurants (we assumed 50%) and only the remainder goes to the local people. For domestic tourists, we also assume that officially recorded revenue is captured by the formal sector and only the rest accrues to local people;
- for bioprospecting, from a strict 'equity' perspective, it can be argued that the entire revenue should be captured by locals. However, we assume that locals get a royalty of only 25% and that the rest goes to the bioprospector or to the relevant government and agency. This is a very rough approximation: in practice, local people may often get considerably less than this (see also the section on Access and Benefit Sharing in Chapter 5);
- the other ecological services considered are carbon sequestration, flood control, nutrient recycling and water recharge for which the locals directly benefit (except for carbon).

Based on this, **the per capita GDP accruing to the poor (whom we define as population holding less than 1 hectare of agricultural land, people dependent on forests and the small fishing community) is 260 US$/year.** If this income is deducted from GDP, the per capita income available for the rest of the community is 435 US$/year. However, if ecosystems are degraded, the cost may not be equal to the benefits forgone for the following reasons:

- the costs can be higher because if local people try to get the same benefits elsewhere, it costs them much more (marginal utility of income generated is always lower than marginal disutility from spending the money);
- the marginal utility of a dollar obtained by a poor person is always higher than that of a rich person;
- the poor do not have any buffer from degradation of ecosystem services in the form of institutions and financial resources, unlike the rich.

For these reasons, a loss of a dollar would hurt poor people more than a dollar to the rich. We therefore need to use equity weighting. We have used the ratio of mean per capita expenditure on food of households at the top of the pyramid to that of the households at the bottom of the pyramid as the equity weight. This data has been taken from a survey by the World Resources Institute (Hammond et al. 2007).

Box 3.A2: Country GDP of the Poor Calculations – Brazil

In Brazil, agriculture and allied activities contribute only around 6.1% to the GDP, with per capita income of US$ 8151 (adjusted for purchasing power parity). After accounting for unrecorded goods and unaccounted services from forests in the national accounts, based on a study by Torras (2000) adjusted for inflation, the adjusted contribution of agriculture, forestry and fishing to GDP has increased to 17.4%. This is not surprising given that forests cover 87% of Brazil's land area (of which primary forests cover 50% of the land area). Brazil has an active market for environmental services, the benefits of which are shared by several stakeholders.

We assumed that climate regulation services provided by forests are captured by global populations and the rest of the ecological services will accrue to Brazilians. Of this we assumed that only 10% of the benefits (except ecological services) and 2% of ecological services (assumed in proportion to the area held by the poor) accrue to the rural poor (Brazil has only 14% rural population). Based on this, the per capita GDP accruing to the poor (whom we define as population holding less than 4 hectares of agricultural land, people dependent on forests and the small fishing community) is 453 US$/year and that available for the rest of the community is 1,416 US$/year. After adjusting for the equity weighting (ratio of mean per capita expenditure on food of households occupying the top of the pyramid to that of the bottom of the pyramid), the inequality-adjusted cost per person for the poor community is US$ 642.

Box 3.A3: Country GDP of the Poor Calculations – Indonesia

Agriculture and allied activities contribute around 11.4% to the GDP, with per capita income of US $ 2931 (adjusted for purchasing power parity). After accounting for unaccounted timber, fuelwood and non-timber forest products, ecotourism, biodiversity values and ecological values that are not recorded in the GDP, the adjusted contribution of agriculture, forestry and fishing to GDP has increased to 14.5%. These values were taken initially from a study by Beukering et al. (2003). However, based on expert opinion in Indonesia*, these values seem to be a little higher for the country as a whole: we have therefore revised the estimates upwards to reflect the reality.

As valuation is context and area specific, it is better to consider a range of values across the country rather than transferring one estimate for the entire region. The following conservative range of estimates seem to be an appropriate lower band, based on various studies conducted in Indonesia:

- unrecorded timber and fuelwood used directly by forest-dependent poor communities: 40–60 US$/hectare/year;
- non-timber forest products: 22–30 US$/hectare/year;
- ecotourism and biodiversity: 12-20 US$/hectare/year;
- ecological services: 40–60 US$/hectare/year*.

The same study was used to calculate the proportion of benefits shared by poor people. The different groups of stakeholders identified as benefiting from forest ecosystems include: 1) local communities (households, small-scale farmers and entrepreneurs); (2) local government (the body responsible for maintaining infrastructure and collecting local taxes); (3) the elite logging and plantation industry (owners of concessions); (4) national government (law enforcement); and (5) the international community (representing global concerns for poverty, climate change and biodiversity loss).

If the forests are harvested selectively, the share of benefits received by the local community is estimated to be 53%, by local governments 10%, by elite industries 14%, by national governments 5% and by the international community 18%. In this study, we have assumed that poor people get 53% of the total benefits. Based on this, the per capita GDP accruing to the poor (whom we define as population holding less than 4 hectares of agricultural land, people dependent on forests and the small fishing community) is 147 US$/year and that available for the rest of the community is 425 US$/year.

As the loss of one dollar of benefits derived from ESS to the rich is not same as one dollar to the poor, we should use equity-adjusted income (equity weights were derived by dividing the mean per capita expenditure on food of households in the top of the pyramid to that of the bottom of the pyramid). Based on this, the inequality-adjusted cost per person for the poor community is US $ 327.

**Source: Ahmad, Mubariq (2009), Mimeo based on experts discussion in reference to various segmented forest valuation studies known in the circle of Forestry Department, Bogor Agriculture University*

Table 3.A1: Equity-adjusted income of the poor (adjusted for purchasing power parity, 2005)

		Brazil	Indonesia	India
Gross domestic product (US$ millions)	(1)	1517040	670840	2427390
Contribution of agriculture, forestry, livestock and fishing (US$ millions)	(2)	92397	76715	401523
Of which contribution by the poor (per hectare value multiplied with area of small holdings less than 1 ha) (US$ millions)	(3)	993	3708	48867
Percentage contribution of agriculture, forestry and fishing to GDP	(4)	**6.1 %**	**11.4 %**	**16.5 %**
Total population (millions)	(5)	186	229	1094
Of which poor (millions)	(6)	19.6	99	352
Per capita agricultural GDP of the poor	(7=3/6)	**50.7**	**37.4**	**138.8**
Per capita GDP for the rest of the population (less GDP of the poor and rest of the population) (8 = (1 - 3)/(6 - 7)		9104,6	5138,9	3208,0
Adjustments for unrecorded timber and fuel wood from forestry GDP (US$ millions)	(9)	5870	6660	16477
Adjustments for contribution of NTFPs to the economy (US$ millions)	(10)	57158	5230	11691
Adjustments for ecotourism and biodiversity values (US$ millions)	(11)	28866	1823	17285
Adjustments for other ecological services (US$ millions)	(12)	79193	6800	28282,6
Adjusted contribution of agriculture, forestry and fishing to GDP	(13 = 9+10 +11+12+2)	263484	97227	475258
Adjusted contribution of agriculture, forestry and fishing to the poor	(14)	8870	14579	91580
Per capita adjusted agricultural GDP for the dependent population	(15=14/6)	**452.6**	**147**	**260.1**
Per capita adjusted GDP for the entire population	(16=13/5)	1416	425	435
Equity adjusted cost per person for agriculture dependent community	(17 = equity weight*15)	***641.9***	***327***	***307.0***
Contribution of Ecological services to classical GDP (in US$ millions)	(18= 13-2)	171807	20512	73735
Additional contribution to GDP	(19=18/1)	11.0%	3.1%	3.1%
Total Share of GDP	(20-19+5)	**17.4%**	**14.5%**	**19.6%**
Contribution to the poor (in US$ millions)	(21 = 14-3)	7877	10872	42713

For figures see country notes below:

1) Brazil: Brazil has a population of 20 million dependent on forests including 350,000 indigenous people. The figures also include population with less than one hectare agricultural land and fishing population. The equity weights are based on the ratio of consumption expenditures on food of the top expenditure group to the bottom expenditure groups based on survey by the world resources institute.

2) Indonesia: Indonesia has 80 to 95 million people who are directly dependent on forests (based on a publication on forest dependent population by FAO). The figures also include population with less

than one hectare agricultural land and fishing population. Of the 40 million households who are dependent on agriculture, 14% have less than 1 ha of land holdings in Indonesia. The equity weights are based on the ratio of consumption expenditures on food of the household occupying the top of the pyramid to those in the bottom of the pyramid based on a survey by the world resources institute.

3) India: The values for forests are based on the Green Accounting for Indian States Project (GAISP) floor values adjusted for the year 2005. For timber, fuelwood only open forests are considered. For the rest very dense and dense forests are considered. For the forest dependent population, based on the publication forest dependent population, India has 200 million people who are directly dependent on forests. To this are included, population with less than one hectare agricultural land and fishing population. The equity weights are based on the ratio of consumption expenditures on food of the agricultural households with more than 4 hectares agricultural land to the households having less than 1 ha land.

4) Note: the services to agriculture, fishery and livestock can be captured through the productivity approach method, i.e. any decrease or deterioration in services is already reflected in the value added in agriculture, livestock and fishing sectors. So these values were not calculated separately').

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 4: Integrating ecosystem and biodiversity values into policy assessment

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Chapter 4

Integrating ecosystem and biodiversity values into policy assessment

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Key Messages of Chapter 4

The main cause of the biodiversity crisis is unsustainable growth in consumption and production, exacerbated by a tendency to undervalue biodiversity and the ecosystem services it supports.

Current decision-making is biased towards short-term economic benefits because the long-term value of ecosystem services is poorly understood. Recognising the value of ecosystem services can lead to better more cost-efficient decisions and avoid inappropriate trade-offs. It is also an important step towards refocusing economic and financial incentives to achieve sustainability goals. Tools and techniques already exist for this purpose and are being constantly improved.

Understanding the value of ecosystem services

Decision-makers need to understand what ecosystem services are generated by natural capital in their zone of influence, what ecosystem services are (at risk of) being lost, the economic costs of losing them, who faces these costs, where and when. Valuation can help develop the necessary evidence base and should address spatial relationships between sources and beneficiaries of impacts and services. Countries should therefore cooperate to develop and integrate robust valuation procedures within their broader decision support systems.

Valuation procedures should, as a minimum, be based on a qualitative understanding of environmental and social impacts of changes to natural capital and associated ecosystem services. Building capacity to quantify and monetise such impacts is an essential step to make trade-offs explicit and increase transparency.

Expanding monetary valuation of ecosystem services

Quantitative and monetary valuation needs to strengthen the focus on long-term impacts (positive and negative) of resource use decisions and compare them using an discount rate appropriate for ecosystem services.

Existing expertise should be maximised by building on past practice, undertaking more primary analysis and promoting benefits transfer of existing studies in accordance with available guidance.

Integrating economic thinking into policy assessment

Valuation is a tool to guide decisions, not a precondition for acting to protect biodiversity. Decision-makers across all levels and sectors need to commit to systematic and timely analysis of proposed projects, programmes and policies through impact assessments, strategic environmental assessments and environmental impact assessments. The aim should be to have a fuller evidence base available at the right time to take the whole picture into account.

The precautionary principle should be applied in decision-making affecting biodiversity and ecosystem services where impacts cannot be predicted with confidence and/or where there is uncertainty about the effectiveness of mitigation measures.

Each country needs to develop and institutionalise a culture of analysis, consistent with recognised best practices. This can be done by developing capacity and having an accepted, functional and supported policy assessment system in place.

4 Integrating ecosystem and biodiversity values into policy assessment

"All decisions have costs and hence all decisions to incur that cost imply that benefits exceed costs. All decisions not to incur the costs imply that costs exceed benefits. Economic valuation is always implicit or explicit; it cannot fail to happen at all."

David W. Pearce (1941-2005)
OBE, Professor at the Department of Economics, University College London

Chapter 4 focuses on methods for valuing biodiversity and ecosystem services and ways to feed better information more effectively into national and international policy formation. **4.1** provides an overview of **different ways to analyse value** and how these can be linked through a Total System Value approach. **4.2** outlines **methodologies for monetary valuation** and demonstrates their practical application, before identifying certain limitations that need to be addressed. **4.3** shows how structured **assessment frameworks** can support more informed and balanced policy-making and sets out eight **best practices** to improve current practices. **4.4** considers **next steps** and the critical need to build valuation and assessment capacity.

4.1 UNDERSTANDING THE VALUE OF ECOSYSTEM SERVICES

Earlier chapters of this Report explained how current losses of biodiversity and associated ecosystem services, driven by unsustainable patterns of production and consumption, have significant economic costs for local, national and international communities. This begs an important question: if biodiversity loss is so detrimental, then why do we allow it?

Part of the answer lies in our failure to understand and incorporate the long-term value of ecosystem services when we make policy decisions that build in assessments of trade-offs. A much more robust approach is needed to correct the current bias in decision-making towards short-term narrowly-focused economic benefits.

4.1.1 THE NATURE OF VALUE AND VALUING NATURE

What do we mean by the 'value' of ecosystem services? When people think of value, they consider an item's usefulness and importance. This **value is rarely the price we actually pay for ecosystem services: on the contrary, these are often free to the 'user' or cost much less than their value to society as a whole**. Many ecosystem services tend to be outside traditional markets and so do not have a market price.

In a few cases, such as provision of timber or seafood, some output from an ecosystem does have a market price. This reflects the fact that those outputs are bought and sold on an open market where the price reflects what people are willing to pay for them. Even in this situation, the price charged does not necessarily reflect their true value as it will only be partial. More specifically, there are likely to be impacts on the wider ecosystem beyond those considered in the market transaction.

The absence of markets for most ecosystem services arises for a number of reasons, including the lack of clear property rights attached to such services (see Chapter 2). In many cases, ecosystem services have a 'public good' characteristic which would not be priced accurately by markets even if property rights were defined (e.g. genetic diversity of crops that has insurance value for future food security).

Difficulties in obtaining monetary estimates of ecosystem services mean that decisions tend to be based on incomplete cost-benefit assessments and, as noted, are biased towards short-term economic benefits. Because we underestimate the economic and social importance of such services, we have few incentives to safeguard them and society as a whole loses out.

4.1.2 THREE WAYS TO ANALYSE VALUE: QUALITATIVE, QUANTITATIVE AND MONETARY

To put an economic value on changes to ecosystem services, we first need to understand what those changes are. Figure 4.1 illustrates the series of steps that have to be considered in turn. Valuation usually comes at the end of the process and has to build on scientific information collected in the earlier stages.

Figure 4.1: Understanding ecosystem changes

Source: Own representation, Stephen White

Analysis of ecosystem services can be done at three levels - qualitative, quantitative and monetary. Qualitative analysis generally focuses on non-numerical information, quantitative analysis focuses on numerical data and monetary analysis focuses on translating this data into a particular currency.

All three types of analysis are useful, but they provide different levels of information to a decision-maker. We can illustrate this through the example of a scheme to increase agricultural production by converting grazing land to intensive cropping. If the financial benefits of intensification outweigh the financial cost of land clearance, this may seem appealing at first sight. However, this would only be a partial analysis as it only considers costs and benefits of the market transactions associated with the change of land use. To determine whether the policy would be beneficial at a societal level, we also need to consider non-market impacts, including impacts on untraded ecosystem services and biodiversity. For example, land conversion could release significant emissions of greenhouse gases and also reduce the land's capacity to absorb flood waters.

What would the different types of analysis deliver in this type of case?

- **Qualitative analysis** would simply describe the potential scale of these impacts (e.g. increased flood risk): the decision-maker would have to make a judgement as to their importance relative to any financial costs and benefits.

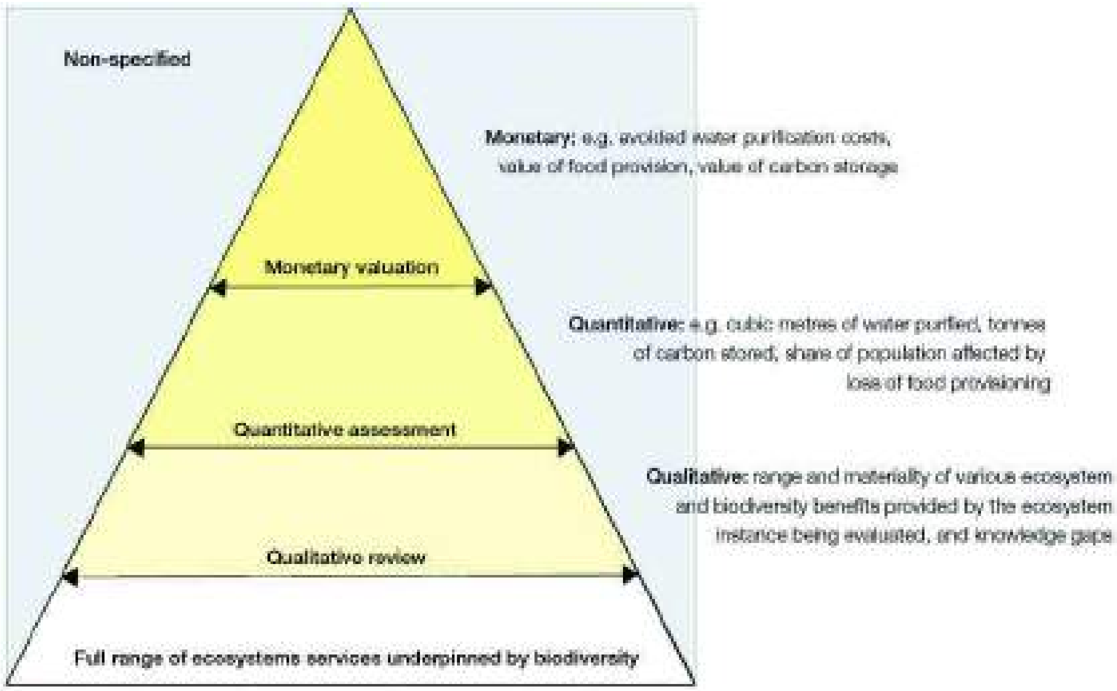
- **Quantitative analysis** would directly measure the change in ecosystem services resulting from the change in land use (e.g. frequency/volume of estimated increase in flood risk/carbon dioxide emissions). The decision-maker would then have a scientific measure of impacts to weigh up against financial costs and benefits.

- **Monetary analysis** attaches monetary values to the change in the flow of ecosystem services, to give an impression as to whether a policy is likely to have a net benefit to society as a whole. It usually builds on quantitative analysis.

Which type of analysis to adopt will largely depend on the type of benefit being measured, the time and resources available and the significance of the decision. Qualitative analyses are usually easier and less expensive to conduct than quantitative analyses. Likewise, quantitative analyses usually require fewer resources than monetary analyses.

Source: Getty Images.

Figure 4.2: The benefits pyramid



Source: P. ten Brink: presentation at March 2008 workshop Review of Economics of Biodiversity Loss, Brussels

Figure 4.2 illustrates the different levels of resources required for each type of analysis. As one goes up the pyramid, there are fewer ecosystem services that can be assessed without increasing time and resources. This insight is relevant because it may not always be practical to quantify changes in ecosystem services. In many cases, a qualitative assessment may be preferable: more resource-intensive analysis will inevitably be focused on the issues of most concern and potential value.

This highlights that valuation is only one input into the decision-making process but one that can be central. **A pragmatic approach to valuation can be summed up as follows: "always identify impacts qualitatively, then quantify what you can, then monetise (where possible)".**

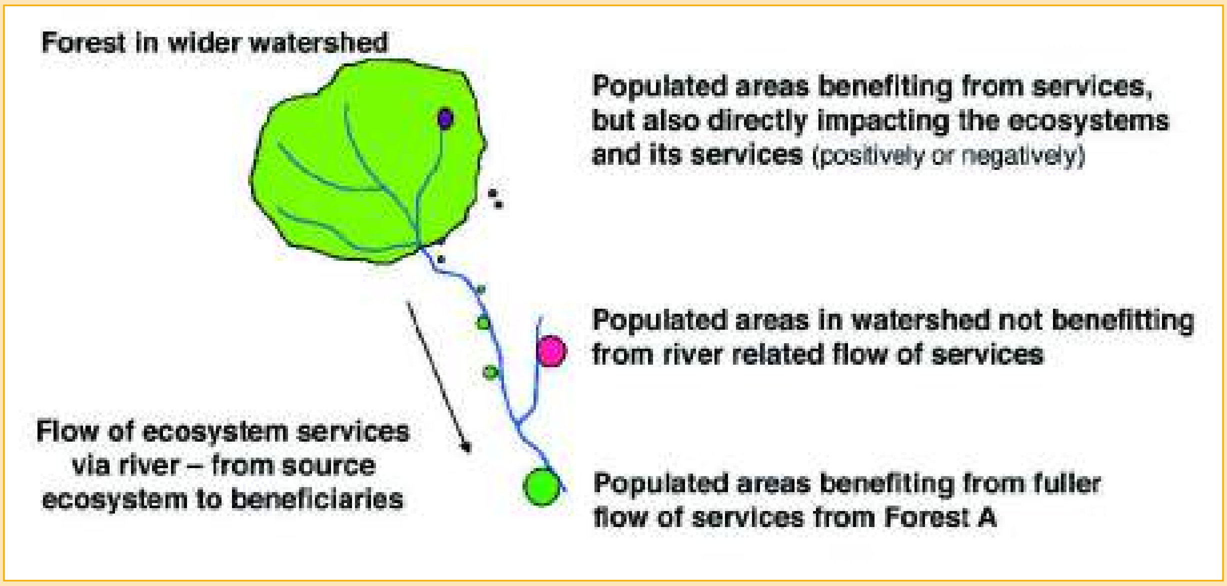
In any type of analysis, it is important to understand the spatial relationship linking the source supplying the ecosystem service to the various beneficiaries. This helps to identify impacts to be taken into account during the valuation and which stakeholders are likely to be winners or losers from any decision (or trend) (see Box 4.1).

Despite the importance of qualitative analysis, the main challenge for policy-makers is to promote more robust frameworks and capacity for quantitative and monetary analysis to reveal economic value of ecosystem services. This is the focus of the rest of this Chapter.

Box 4.1: Mapping links between supply of ecosystem services and beneficiaries

The diagram below shows how a partially forested watershed provides different services to different populations in the vicinity Some benefit downstream from the services it provides; others are in the area but do not benefit; and others not only benefit from those services but also influence them through activities that degrade or enhance the natural capital.

This type of information is useful to understand which stakeholders need to be involved or taken into account when designing ecosystem management approaches and choosing instruments to reward benefits (see Chapter 5), or avoid impacts (see Chapter 7).



Source: Adapted from Balmford et al. 2008

4.1.3 APPLYING TOTAL ECONOMIC VALUE FRAMEWORKS TO ECOSYSTEMS

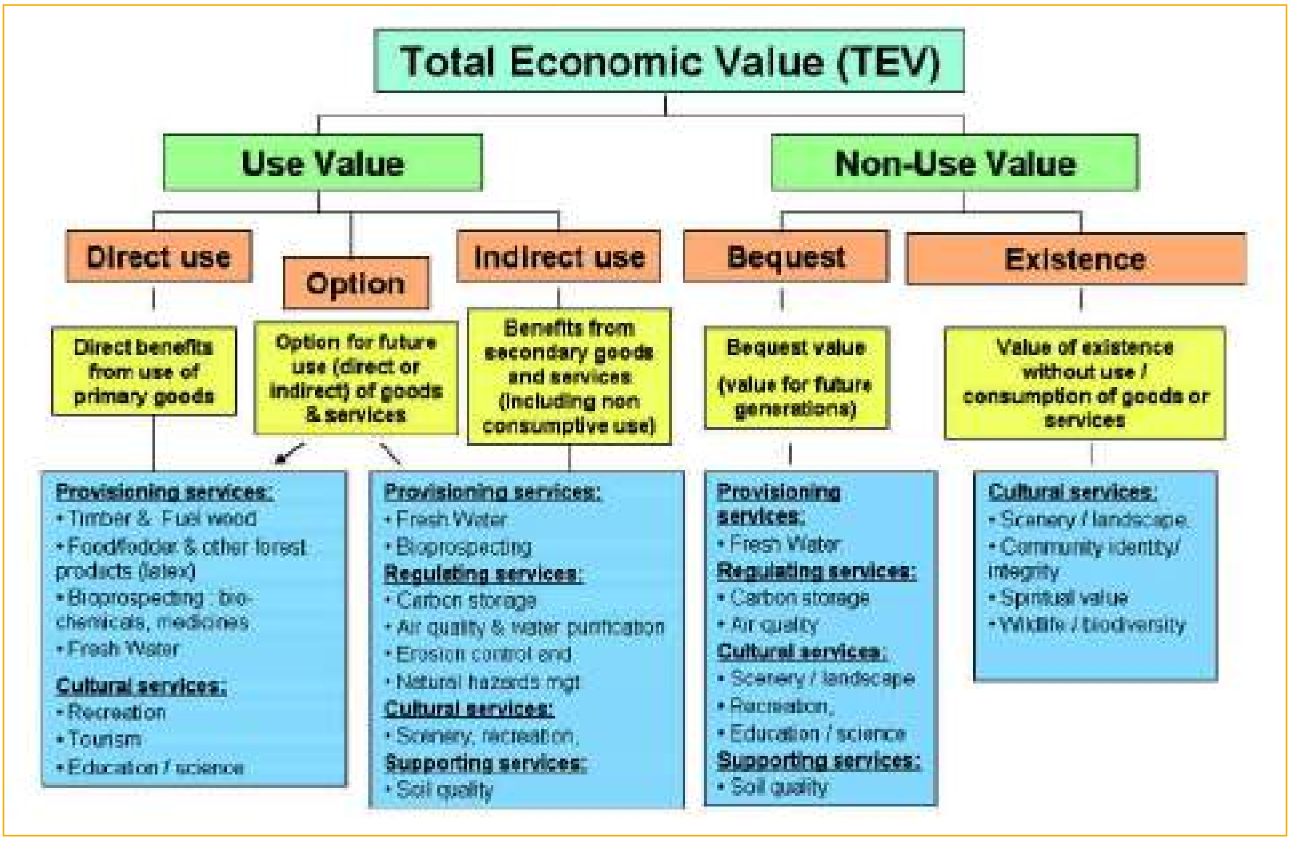
To correct the current distortion in policy trade-offs, valuation is a critical step towards ensuring that ecosystem services are given the right weight in decisions.

The Total Economic Value (TEV) framework is a well structured way to consider all of the values that an ecosystem provides. Figure 4.3 presents key elements of TEV, well known to some, and gives links to different ecosystem services)[1]. It is based on two broad categories of value:

- **'Use values'** include direct and indirect use of ecosystems and options for future use. ***Direct use value*** arises from the direct use of an ecosystem good or service and can include consumptive use (e.g. timber production) and non-consumptive use (e.g. wildlife viewing). ***Indirect use value*** refers to benefits derived not from direct consumption but from effects on other goods and services which people value (e.g. regulating services for water are valued because they protect people and property against flooding; pollination is important for food production). ***Option use values*** represent the value of having the option of using (both directly and indirectly) the ecosystem good or service in the future.

- **Non-use values** exist because people derive pleasure from simply knowing that nature and its elements (e.g. a rare species) exist, or because they wish to bequest it to future generations.

Figure 4.3: Application of a Total Economic Value framework to ecosystem services



Source: Kettunen et al. 2009

Although TEV in theory covers all benefits, in practice several benefits are still understood only in a partial way and some values have yet to be understood. In such cases, we can more usefully refer to **Total System Value (TSV) that combines all benefits, whether monetised, quantified or simply understood qualitatively.**

4.2 EXPANDING MONETARY VALUATION OF ECOSYSTEM SERVICES

4.2.1 HOW DO COMMON VALUATION METHODS WORK?

There are three main methods for determining the monetary value of ecosystem services, all linked to **'willingness to pay' (WTP)**. More details are provided in Annex 1 which shows how techniques can be applied to different ecosystem services.

Market analysis (i.e. revealed willingness to pay) is valuable for measuring a range of benefits and costs. Examples include explicit revenues generated from services (e.g. forest products), avoided expenditure needs (e.g. avoided cost of water purification and provision), replacement costs (e.g. artificial pollination), insurance costs (e.g. from natural hazards) and damage costs (e.g. damage from flooding).

Where market values are not directly available or usable, we can use two well-recognised groups of **non-market valuation techniques**:

- **'revealed preference methods'** (i.e. imputed willingness to pay) is demonstrated through e.g. increased house prices near parks, forest and beaches. These can lead to increased local government receipts);

- **'stated preference methods'** (e.g. expressed willingness to pay) can be used in relation to e.g. improving water quality (linked to water pricing) or protecting charismatic species (linked to funding or park entrance fees).

Box 4.2 shows how different valuation techniques can be combined to provide the fullest possible picture of an ecosystem's total value.

The above methods provide primary analysis for specific cases. The next section considers ways to adapt case-specific information for wider application.

Source: Getty Images.

Box 4.2: Valuing ecosystem services to inform land use choices: example of Opuntia scrubland in Peru

Opuntia scrublands in Ayacucho host cochineal insects, the source of carminic acid (a natural dye used in food, textile, and pharmaceutical industries) and are used by local farmers for animal grazing and food provision. They also perform a major environmental role protecting slopes against erosion and flooding and rehabilitating marginal lands by improving the levels of humidity and soil retention capability.

A mix of techniques from demand- and supply-side toolkits can be used to assess values associated with different ecological functions:

- ***Valuation of provisioning services.*** Direct use values of Opuntia (production of food, fruit, cochineal exports, manufactured dyes, fodder, fuel and ornamental goods) can be derived using **direct market prices** and, if necessary, the value of the closest substitute goods. For scrubland products (e.g. cochineal and fruit), once the yearly quantity and quality of yields and the size of the collection area are calculated, market prices can be used to derive the direct use value of the products collected in a given year. Scrubland use value as a source of fuel can be quantified considering the wage rate as a broad approximation of the opportunity cost of time employed by households in periodic working hours that generate supply of fuel.

- ***Value of regulating services.*** The value of the cash-crop depends on a parasitic insect living on Opuntia plants: farmers collect the cochineal by removing the insect from host plants. Insects not harvested are used to repopulate the scrubs for later harvests. The value of these nursery and refugium services can be quantified using a supply-side approach (based on the costs avoided by farmers if the host plants should be infested by hand at the prevailing labourers' wages that represent the opportunity cost of time).

- ***Value of supporting services.*** Indirect use values attach to erosion control services critical for farmers in the high-sloped Andean area. Soil loss affects crop productivity but changes only become apparent after many years of severe soil loss. Farmers' interest in soil erosion is mainly concerned with on-farm impacts e.g. increased production costs, decreased profitability owing to soil fertility decline, cost of implementing soil conservation measures. One way to quantify such benefits is to use a **Contingent Valuation method** e.g. stated preference techniques to obtain a broad monetary idea of households' WTP for erosion control services provided by the scrubland.

The valuation found that even if only some of the intangible benefits are considered, the value of ecosystem services provided by Opuntia scrubland is higher than computable direct financial revenues from agriculture. The proportion of farmers' income attributable to direct use value of scrubland products is as high as 36%. When indirect use values (regulation of soil erosion) are included, the value of scrubland for farmers rises to over 55% of income.

Source: Adapted from Rodríguez et al 2006

4.2.2 SCOPE FOR EXTENDING BENEFITS TRANSFER METHODS

'Benefits transfer' is a method of estimating economic values for ecosystem services by using values already developed in other studies of a similar ecosystem. It is a pragmatic way of dealing with information gaps and resource (time and money) constraints. This is important as there are rarely enough resources available to conduct a primary (or site specific) valuation study for every site, ecosystem or service being assessed.

Box 4.3: Use of benefits transfer of values for non-timber forest products (NTFP)

An analysis of studies undertaken suggests a clustering of NTFP values of a few dollars per hectare/year up to about $100/year. Suggested 'default' values have included $50-70/hectare/year. While it is useful to respond to the 'default values' by seeing if local natural capital has the same value, it would be a serious error to simply extrapolate these benchmark values to all forests. Typically, higher values relate to readily accessible forests whereas values for non-accessible forests would be close to zero in net terms due to cost of access and extraction. The key questions to consider are whether there are sufficient commonalities to allow a benefit transfer and also what 'weighting factor' may need to be applied, in the light of any differences, to make the benefits transfer sufficiently robust.

Source: SCBD 2001

Benefits transfer is not a new concept but can be considered as a practical solution to resource constraints. The basic rationale is that there may be sufficient commonalities between ecosystem services in different areas to allow values from one area to be transferred to another. However, this needs to be done with care as values can vary widely even amongst similar ecosystems (see Box 4.3).

Conditions under which benefits transfer can provide valid and reliable estimates include: i) that the commodity or service being valued is very similar at the site where the estimates were made and the site where they are applied; ii) that the populations affected have very similar characteristics; and iii) that the original estimates being transferred must themselves be reliable (CBD Decision VIII/26).

Benefits transfer is still a developing subject. Specific actions that need to be undertaken to make such methods more widely applicable include:

- **development of more primary valuation studies.** The more studies we have, the greater the statistical confidence with which a transfer can be undertaken - and the greater the policy-makers' confidence in the underlying techniques;
- **increased development and access to valuation study databases.** Some databases have been developed to make the technique of benefits transfer easier but existing databases tend either to be incomplete in their coverage of studies or are not freely available[2];
- **development of benefits transfer guidance.** Guidance on accounting for differences between the subject and object ecosystems and their beneficiaries should be developed to show best practice and indicate where benefits transfer can give a reasonable value of ecosystem services.

TEEB D0 (The Science and Ecological Foundations) has collated over a thousand valuation studies and is developing them into a matrix of ecosystem services values across ecosystems to help offer a publicly valuable tool (see Box 4.4 and TEEB D0, Chapter 7). This matrix will be completed in 2010.

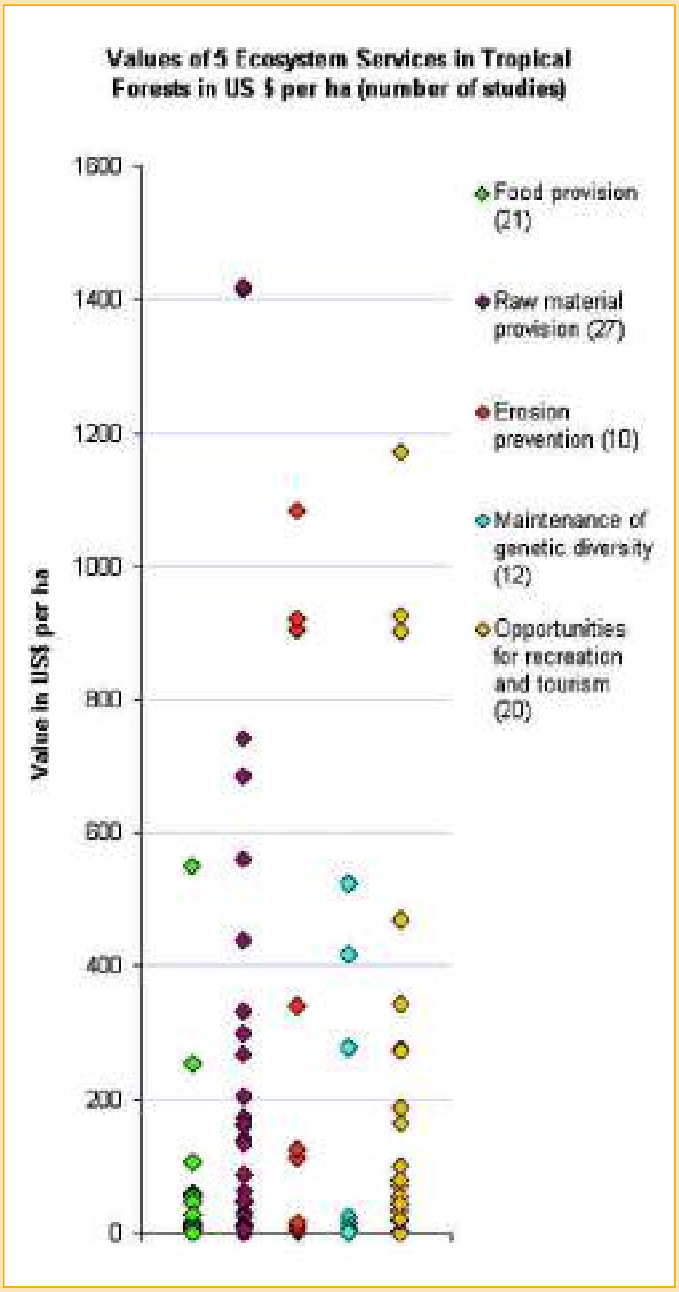
Box 4.4: Collected evidence on the values of ecosystem services

Over 1100 values have been collected to date, covering 10 biomes and 22 ecosystem services. Values are organised based on geographical and socio-economic criteria and are also influenced by the context of the valuation study.

The analysis so far shows that there are no easy answers. For most ecosystem services, it is not possible to 'plug and play' values from elsewhere without first considering the local characteristics. This was highlighted in Chapter 1 for tourism from coral reefs; figure 4.4 shows values for different ecosystem services in tropical forests.

In practice, the 'default assumption' is often that the value of forests is the timber, and that there is no value attached to the wide range of other ecosystem services. The reality is that the value of other services can be high. This shows the need to consider how an ecosystem serves people and the impacts of its loss. Understanding the services lost is an easy first step towards understanding the value at risk. Understanding the value is the basis for due commitment to and design of instruments that then turn the some of the 'valuation values' into 'real values' and hence change the practical incentives on the ground.

Figure 4.4: Ecosystem Services values from forests – working insights from TEEB D0



Source: TEEB D0, Chapter 7

4.2.3 EXAMPLES OF VALUATION IN PRACTICE

Perhaps the best way to demonstrate the 'value of valuation' is to show some of the many ways in which it is already used:

- to underline the value of natural assets and **help determine where ecosystem services can be provided at lower cost than man-made technological alternatives** e.g. water purification and provision, carbon storage, flood control (see Box 4.5 and also Chapters 1, 5, 8 and 9 of this report);

Box 4.5: New Zealand: Values of Water Provision

A 2006 study commissioned by the Department of Conservation found that Te Papanui Conservation Park (Lammermoor Range) provided the Otago region with water that would cost $136 million to get from elsewhere.

The 22,000 hectare tussock grass area acts as a natural water catchment, supplying water flows valued at $31 million for hydroelectricity, $93 million for the city of Dunedin's water supply and a further $12 million for irrigating 60,000 hectares of Taieri farmland. The $136 million corresponds to a one-off sum describing the avoided cost of having to suddenly get water currently provided free of charge by Te Papanui from somewhere else.

Source: New Zealand Department of Conservation 2006

- to **communicate the need for and influence the size of payments for ecosystem services (PES)**. Valuation can be useful for municipalities setting up PES for activities leading to clean water provision and at international/national level in discussions on design and future implementation of REDD (Reducing Emissions from Deforestation and Degradation) and REDD+ (see Chapter 5);

- to **evaluate damage to natural resources to determine appropriate compensation**, using non-market valuation techniques e.g. under liability regimes in the US and the EU this has proved of particular value for court decisions on liability (see Box 4.6);

Box 4.6: Using valuation to assess levels of compensation

In 1989, response to the Exxon Valdez oil spill:

- boosted efforts to evaluate environmental damage and helped to speed up development and use of new methodologies for capturing the value of biodiversity and ecosystems;
- spurred the introduction of policy responses consistent with the polluter pays principle i.e. compensation payments based on values of the biodiversity and ecosystem services that had been damaged;
- led to enactment of the US Oil Pollution Act 1990 and international maritime regulations;
- based on economic analysis, led to regulatory prescriptions for double-hull ship building measures. 79% of all oil tankers criss-crossing the globe are now of double-hull design.

Indian Supreme Court and Forest Conversion Payments

In 2006, the Indian Supreme Court set compensatory payments for the conversion of different types of forested land to non-forest use. The Court drew on an economic valuation study of Indian forests by the Green Indian States Trust (GIST 2006), to determine the rates. The study estimated the value of timber, fuel-wood, non-timber forest products and eco-tourism, bio-prospecting, ecological services of forests and non-use values for the conservation of some charismatic species (e.g. Royal Bengal tiger, Asian lion) for six different classes of forests. The compensatory payments are directed towards an afforestation fund to improve the country's forest cover. In 2009 the Supreme Court directed that Rs.10 billion (around 143 million EUR) be released every year towards afforestation, wildlife conservation and for creating rural jobs (see full analysis in Chapter 7).

- to **create political support for designing new fiscal instruments** e.g. to help set taxes at the level equivalent to the cost of environmental impacts of certain activities. One example is the UK landfill tax: the value of damage caused by using landfills for waste disposal (instead of incineration) was an element in setting the tax rate;

- to **set entry fees** for national parks, using the Travel Cost Method in particular (see Box 4.7 and also Chapter 8);

Box 4.7: Entry Fees for Parks

Countries that face difficulties in mobilising public money for nature conservation often resort to entrance fees to national parks, which are important revenue sources (e.g. case of entry fees to the Biebrza National Park, Poland (OECD, 1999)). Charging special fees for specific activities in protected areas is quite common e.g. fees added to diving costs in marine reserves in the Philippines (Arin and Kramer 2002). Evaluation exercises help to identify the range of prices that a visitor will be willing to pay for access to a natural area and recreation or other activities there. Tourists are interested in preserving the sites they visit and a small increase in the fees they pay only amounts to a small fraction of the total cost of their trip.

- to **inform impact assessment of proposed legislation and policies**. Examples include the EU Water Framework Directive and new marine legislation in the UK which provides for the establishment of Marine Conservation Zones on the basis of the ecosystem service benefits they provide;

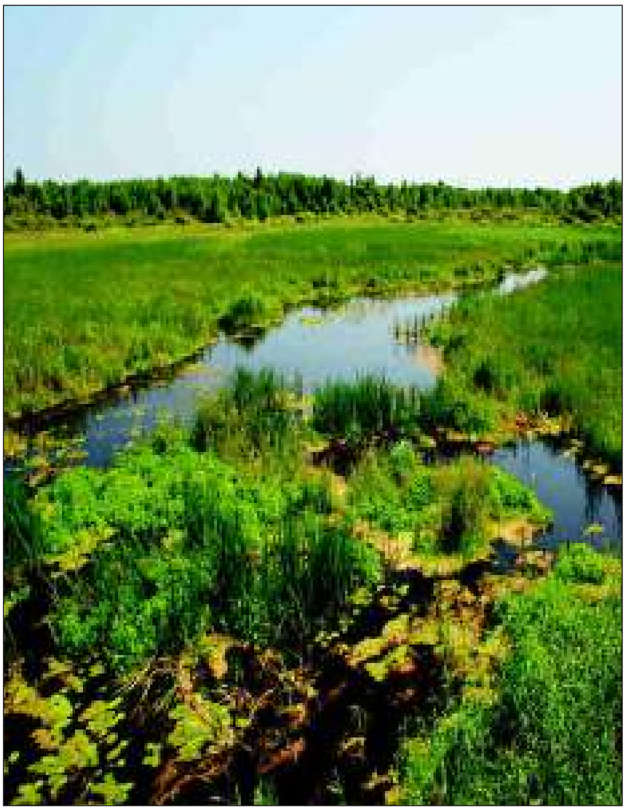
- to **reveal the relative importance of different ecosystem products**, especially those not traded in conventional markets (see Box 4.8).

Box 4.8: Valuing ecosystem services at the country and regional level

Mediterranean region: A 2005 regional study valued the potential of non-timber forest products (NTFPs) as a source of livelihood and sustainable development. It estimated benefits for six major groups of NTFPs: firewood, cork, fodder, mushrooms, honey and other products. Valuation was based on a variety of techniques, drawing on official statistics, and supplemented by local surveys.

At the regional level, NTFPs were found to provide annual benefits of about €39/ha of forests i.e. about 25% of the total economic value of forests. The average estimate for southern countries (€54/ha) is considerably higher than for northern (€41/ha) or eastern countries (€20/ha). The study thus reveals the importance of NTFP benefits both for specific countries and for the region as a whole.

Source: Croitoru 2005



Source: Przykuta, licensed under http://creativecommons.org/licenses/by-sa/3.0/

Biebrza National Park, Poland

4.2.4 LIMITS TO MONETARY VALUATION

When used according to best practice, valuation tools can provide useful and reliable information on changes in the value of non-marketed ecosystem services that would result from human activities. However, monetary valuation has its limits and to rely solely on this would be contentious and incorrect. Some of the main factors to be borne in mind are outlined below:

- **costs and required expertise can be significant**. Most assessment frameworks recognise this by recommending that scoping studies are prepared for 'light' analysis and that in-depth analysis is done later only if provides added value;
- valuation provides an essentially **static picture of value** i.e. what something is worth today. As ecosystem services become scarcer or support more marketed goods, then their value changes over time;
- it is only appropriate for **small changes**. Meaningful evaluation of the total value of global services is not feasible: particular care needs to be taken where threshold effects are possible;
- expertise in monetary valuation is concentrated in developed countries. It is less practiced in developing countries, which may also face other cultural or socio-economic challenges that require techniques to be adapted before application (see Box 4.9).

Overall, **there are clearly reasons for optimism about using non-market valuation techniques for the valuation of ecosystem services**. The thousands of studies already undertaken have led to considerable practical progress. However, **valuation needs to be used judiciously. It is only one of many inputs into decision-making**, given the complexity of the underlying ecosystem services that are being valued. In view of current constraints on quantification and valuation, we need to see **economic assessment as a tool to guide biodiversity protection, not as a precondition for taking action**.

Box 4.9: Adapting valuation techniques to country-specific contexts

A 2008 study considered economic and non-economic techniques for assessing the importance of biodiversity to people in developing countries. It found that standard approaches to valuation were unlikely to effectively reveal local preferences because it could be difficult for certain groups to express their value for natural resources via such methods.

Concrete recommendations to enable more effective valuation included:

- further research to develop appropriate best practice guidelines;
- further research on how to incorporate participatory and action-focused approaches into economic valuation;
- building local research capacity for all stages of design, administration and analysis of valuation studies.

Source: Christie et al. 2008

The TEEB D0 report will discuss these issues in more detail and provide recommendations on how to develop capacity and improve the use of valuation to decision-makers.

4.3 INTEGRATING ECONOMIC THINKING INTO POLICY ASSESSMENT

The role of all policy assessments[3] – including cost-benefit analysis – is to organise information in such a way that decision-makers can consider trade-offs and take better informed decisions. Valuation is an input to decision-making, but does not by itself provide the decision. It has a particular role for biodiversity, as the provision of ecosystem services is currently often not factored into decisions affecting ecosystems. The policy assessment techniques described in this chapter are feasible, practical and road-tested ways to correct this distortion.

Source: André Künzelmann, UFZ

4.3.1 WHAT CAN POLICY ASSESSMENTS CONTRIBUTE?

A Policy Assessment Framework is a way to improve the quality and coherence of the policy development process, and better integrate biodiversity concerns.

It is hard to measure their pay-off because, by definition, we do not know what would have happened in their absence. However, where properly conducted, assessments are generally found to be a worthwhile and often low-cost investment. The European Commission estimates that they change around two-thirds of its policies for the better and this finding is supported by broader analysis of Regulatory Impact Assessment (Evaluation Partnership 2007, Jacobs 2006).

Policy assessments come in many forms, from formal to informal, from up-front to reactive (to justify decisions already taken or at least check that there are no major negative impacts). They are in place for different levels of decision-making: local, regional and national. Box 4.10 describes the best-known formal procedures[4] .

Box 4.10: The main Policy Assessment processes: EIA and SEA

Environmental Impact Assessment (EIA) has a project focus. It is the process of evaluating the likely environmental impacts, including impacts on biodiversity, of a proposed project prior to decision-making. EIA is intended to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision-makers. However, existing EIA tools often do not perform their full job as they are not applied early or thoroughly enough in the decision-making process, and their insights not always fully taken on board in subsequent project decisions.

Strategic Environmental Assessment (SEA)[5] has a broader sustainable development (economic, social and environmental) focus. It is a systematic and comprehensive process of identifying and evaluating the environmental consequences of proposed policies, plans or programmes to ensure that they are fully included and addressed early on in decision-making, along with economic and social considerations. SEA covers a wide range of activities, often over a longer time span. It may be applied to an entire sector (e.g. a national energy policy) or geographical area (e.g. a regional development scheme).

These two frameworks should complement each other. EIA is undertaken 'down-stream' whereas SEA takes place 'up-stream'. SEA does not usually reduce the need for project-level EIA but it can help to streamline incorporation of environmental concerns (including biodiversity) into the decision-making process, often making project-level EIA a more effective process.

EIA and SEA are familiar terms, but variants of SEA can be found in several contexts:

- UNEP - Integrated Assessment and Policymaking for Sustainable Development;
- Regulatory Impact Analysis (RIA) to examine and measure the likely benefits, costs and effects of proposals or amendments to policies and regulations;
- Trade Impact Assessment (sometimes referred to as Integrated Assessments (IA) or Sustainability Impact Assessment (SIA)) covers trade both in goods that can affect biodiversity and in commodities provided by biodiversity that are traded internationally.

Biodiversity and ecosystem services are also addressed in other policy fields such as social impact assessment and health impact assessments.

Although this range may seem wide, the processes are closely related. For example, Regulatory Impact Assessment, Impact Assessment and Integrated Assessments can all be seen as forms of SEA applied to specific institutional contexts.

Assessment frameworks ask common questions, tailored to the needs of the specific policymaking process. This commonality is no surprise because the broad questions that need to be asked to inform decisions are always the same, whether it is a decision on biodiversity or finance or at local or national level. What is the problem? What do we want to achieve? What are the options for addressing the problem? What are the impacts of different options?

This **commonality offers opportunities for learning from others and sharing best practice** in order to understand how a wide range of policies can impact biodiversity and ecosystem services. Box 4.11 outlines ways in which SEA has found to be useful in one region of the world.

Box 4.11: Has SEA helped? Lessons learnt in the European Union

A review of the way the 27 EU Member States implement the SEA Directive shows that application varies from country to country, reflecting different institutional and legal arrangements. Reported SEA costs vary widely, according to the type of plan or programme being assessed, ranging between EUR 3,000 and EUR 100,000.

Member States identify a large number of benefits of SEA, the main ones being that:

- SEA integrates environmental considerations into decision-making and makes plans and programmes 'greener';
- SEA supports participation and consultation of relevant public authorities and strengthens cooperation between different (planning and environmental/health) authorities;
- SEA increases transparency in decision-making through better stakeholder involvement;
- SEA makes it easier to comply with specific requirements of the policy concerned and check coherence with other environmental policies;
- SEA helps to identify relevant issues and knowledge of an area's environmental context and to share this knowledge between different actors.

Source: COWI 2009

All decision-making relies on information, even where no formal EIA or SEA has been undertaken. In the area of biodiversity and ecosystem services, information demands are complex. Common difficulties relate to measurement, data availability, lack of scientific certainty, the unidentified value of biodiversity and uncertainty over the relationship between biodiversity and ecosystem services. Moreover, impacts are often felt in the future or in distant places, and even expert knowledge can be uncertain or conflicting.

In practice, the question often boils down to a choice between uncertain value (biodiversity and ecosystem services) and the relative certainty of an alternative land use. This choice will almost always be weighted towards the alternative land use.

The need to better incorporate biodiversity into mainstream sectoral policy assessments is now receiving high-level attention. Box 4.12 provides an example of work being carried out at the agriculture-trade-biodiversity interface. Annex 2 sets out detailed advice on ways to ensure that biodiversity is covered in such assessments.

Fair trade Coffee growers in Tacuba in the Parque Nacional El Imposible, El Salvador

Box 4.12: Making a case for biodiversity in mainstream policy assessment

A synthesis of assessment frameworks used to identify the impact of trade liberalisation on agricultural biodiversity revealed several common challenges with respect to the integration of biodiversity into trade-related assessments[6].

The frameworks analysed offer entry points to explicitly integrate biodiversity into assessments as a way to move the issue up the policy agenda. However, practical application show that final recommendations tend to focus on wider environmental issues (deforestation, soil degradation, pesticide use or water quality) where impacts are obvious and information more easily available.

Particular challenges for the integration of biodiversity into the assessment, include:

- difficulties in establishing cause-effect chains of trade liberalisation on agricultural biodiversity;
- the multi-dimensional concept of biodiversity makes it harder to develop aggregated indicators that could be included in economic models;
- insufficient data availability and comparability;
- insufficient methodologies to measure biodiversity impacts;
- shortage of reliable scientific information.

Building on its earlier work on integrated assessment of trade-related policies (UNEP 2009a), UNEP has developed step-by-step guidance for incorporating biodiversity-related issues and actions at each stage of the assessment process (see Annex 2). This guide is accompanied by a reference manual describing the complex linkages that exist between trade in the agricultural sector and biodiversity.

Source: UNEP 2009b, in progress

4.3.2 HOW CAN WE MAKE BETTER USE OF AVAILABLE INFORMATION?

Good progress is now being made to develop the information base for biodiversity and ecosystem services (see Chapter 3). However, we also know that information needed is often available but not accessed. Involving stakeholders who do have information to hand is fundamental – not least because they may ultimately be the people most affected.

Decisions are always taken in the absence of perfect information. In practice, this is a question of degree. The reality in both developing and developed countries is that there are data gaps and a need for more systematic collection of biodiversity data. However, this lack of information should not be taken as an argument to delay action to protect ecosystem services, rather the opposite. A small amount of analysis can often allow decision-makers to protect biodiversity and ecosystem services in ways that can benefit the majority.

The strength of a policy assessment process is to provide a structured framework for systematically asking standard questions and requiring collection of necessary information. Table 4.1 shows some of the biodiversity-specific dimensions to these standard questions.

Table 4.1: Adapting standard questions to cover biodiversity & ecosystem services

What is the problem?	- *how do we measure biodiversity?* - *how do we measure biodiversity loss?* - *how does loss of biodiversity translate into lost ecosystem services?* - *are there threshold effects including critical thresholds that might be breached?* - *what are the relationships between biodiversity in this site and elsewhere?*
What are the objectives?	- *are there national biodiversity objectives?* - *is there a national biodiversity strategy?*
What are the main policy options?	- *how could biodiversity loss be mitigated against?*
What are the economic, social and environmental impacts of those options?	- *how much biodiversity would be lost or gained with a particular action?* - *what is the value of ecosystem services?* - *how do we account for loss of biodiversity far into the future?* - *how do we take account of distributional impacts?* - *how do we account for the fact that biodiversity loss may affect people in other areas or countries?* - *how do we value ecosystem services that are either 'options' or even unidentified so far?*
What is the most favourable option?	- *how do we ensure decisions take into account the lack of certainty over biodiversity?* - *how do we balance potential biodiversity impacts against other potential impacts (balancing various policy options)?*
How will it be monitored and evaluation in the future?	- *how do we monitor and ensure implementation of 'preservation area' or rules?*

4.3.3 BEST PRACTICES FOR MORE EFFECTIVE ASSESSMENT FRAMEWORKS

This section sets out 'building blocks' to improve assessment frameworks and shows how and when information on the economics of ecosystems and biodiversity can be fed into the process.

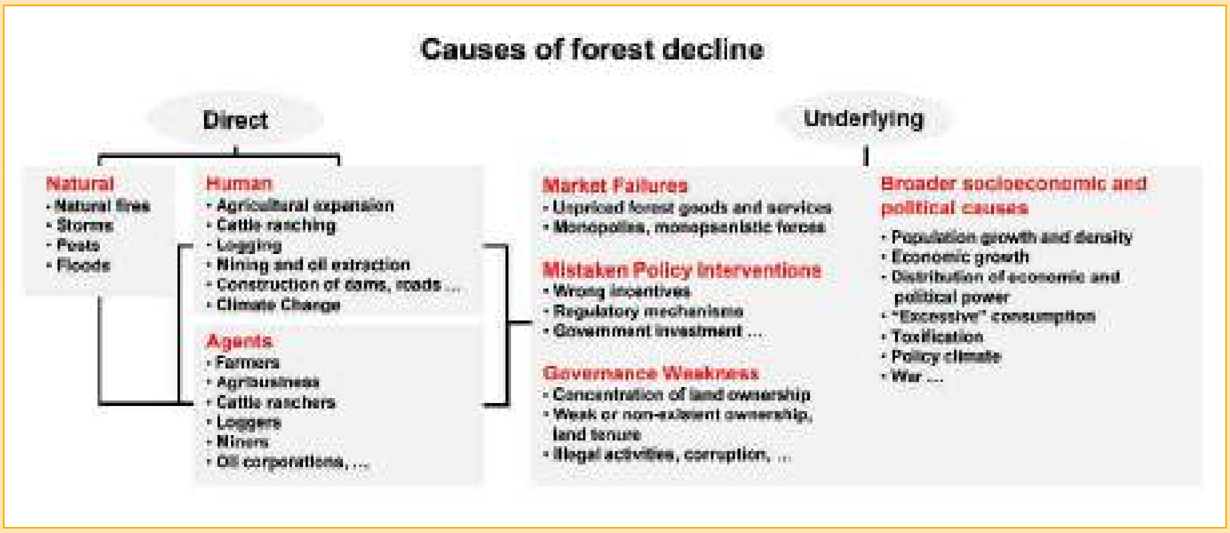
BEST PRACTICE 1 - UNDERSTAND CHANGES IN ECOSYSTEM SERVICES

There is a need to understand **what is currently happening** (sometimes called the problem definition). This means understanding the state of existing biodiversity and the ecosystem services that it provides. There is also a need to understand **what is driving current trends**, including the degradation or loss of biodiversity (see Box 4.13).

For any policy, there is ultimately a need to understand what ecosystem services will be lost and what this means for different stakeholders and what actions will tackle the problem.

Box 4.13: Example of drivers of biodiversity loss analysis

Understanding the combination of direct and indirect factors leading to biodiversity loss allows for better targeted and more cost-efficient policies to be put in place. In this example, a mixture of economic, institutional, political, natural and social factors constitute the drivers of deforestation and degradation. Understanding that the reasons for continued conversion of tropical forest land are interrelated, and their relative importance in a specific country, is the first step in designing a policy response.



Source: Contreras–Hermosilla 2000

BEST PRACTICE 2 – UNDERTAKE AN INTEGRATED ANALYSIS

Information is of little use if it does not influence decisions. In the same way, having information on biodiversity and ecosystem services impacts is of little use if it is not considered with information on other economic, social and environmental impacts (see Box 4.14). The best approach is always **a fully integrated assessment**. EIA and SEA are the best-known processes for delivering such integration, They can be extremely effective but current EIA implementation is often weak which leads to problems on the ground.

For assessment processes focused on other types of impact, one way to force biodiversity impacts to be considered is to **require environmental assessment** (or more specifically biodiversity assessment).

Box 4.14: Improving rural livelihoods and biodiversity conservation through an integrated landscape approach in India

Social and environmental issues are addressed together through the Biodiversity Conservation and Rural Livelihood Improvements Project, currently being implemented by the Government of India with the support of the Global Environment Facility.

The project is designed at a landscape level which encompasses Protected Areas (PA), non-PA forests and other land uses. It signals a shift from PA-based conservation approaches, which largely managed PAs as 'islands' surrounded by other land uses, which were often not compatible with conservation goals and outcomes. Through its integrated approach, the project influences development and conservation in lands surrounding the PAs by promoting rural livelihoods and addressing biodiversity concerns, This strengthens the management and viability of core PAs, thus expanding conservation efforts to the landscape level. See also Chapter 8.

Source: BCRLIP 2009

BEST PRACTICE 3 – QUANTIFY AND MONETISE ECOSYSTEM SERVICE IMPACTS WHERE POSSIBLE

Decision-making is always based on a broad comparison of costs and benefits, even in cases where costs and benefits are not all monetised (i.e. balancing pros and cons). **Biodiversity and ecosystem services are too often left out of the decision when they cannot be quantified or monetised.**

We therefore need a framework that begins by identifying all costs and benefits. This can then be developed by including qualitative information on their nature and scale, then through quantification and valuation. Where only partial quantification and valuation is possible, this still helps to highlight which relevant costs and benefits have been included and which omitted.

Once we have quantification and valuation in monetary terms (see 4.2), we usually have to **compare costs and benefits both now and over time by using a discount rate**. 'Discounting' is the practice of attaching a lower weight to future costs and benefits than to present costs and benefits (e.g. a social discount rate of 4 per cent means that society values €1 today as equivalent to €1.04 in a year's time[7]). It essentially reflects society's preference to enjoy a positive experience today and postpone any pain to the future.

There are different views over what the discount rate should be: even if there is a right number, it probably varies between countries (see Box 4.15). A useful way forward may be to set out a relative order of importance: do an analysis - quantify as far as possible - have a discount rate - choose a discount rate.

Box 4.15: The choice of the discount rate

Discounting is important to the analysis of long-term projects. For instance, a 100-year project, yielding benefits of €22,000 on completion, is worth around €8,000 today at a 1 per cent discount rate but only €1 at a 10 per cent discount rate.

In general, a lower discount rate will favour ecosystem services as they are expected to continue into the far future, and this increases the weighting placed on them. However, this is not always the case as a low discount rate will favour any project with large upfront costs and benefits further in the future, including schemes such as road building that might compete with projects to preserve biodiversity and ecosystem services.

Practice varies considerably. An OECD survey of its Member Countries found that the social discount rate used was usually around 4-5% but varied from 3% in Denmark to 10% in Australia. Some countries allowed for declining rates (usually after 30 years). In practice, what is most surprising is **how infrequently the benefits of ecosystem services are recognised, quantified and monetised**. This – rather than the choice of discount rate – may well be the biggest analytical bias against the preservation of ecosystem services.

Some argue that the social discount rate should be lower. Most notably, the Stern Review on the Economics of Climate Change argued for a discount rate lower than any of those used currently used by a government, though this is challenged by the mainstream economics position. TEEB D0 will provide further advice on this issue.

What is clear is that we need to better understand the benefits of ecosystem services for the future – which means not forgetting or neglecting them when taking decisions now. Doing so biases decisions towards short-term actions and often away from preserving biodiversity.

Source: OECD 2006a

BEST PRACTICE 4 - COMPARE PROS AND CONS (OR COSTS AND BENEFITS)

When considering an option, we need **to consider all the relevant positive and negative impacts together**. What are the trade-offs? What ecosystem services might be lost and what would we gain in their place?

Comparing trade-offs is simple enough when there is a full financial cost-benefit analysis: all economic, social and environmental impacts are expressed in monetary terms and can be easily added up or subtracted. However, this is rarely possible. In practice, we have to consider positive and negative impacts, only some of which will be quantified.

As discussed above, there is a strong case for quantifying and valuing in monetary terms more often than we do now. Even where this happens, there will still be questions about the impact on different groups and on distributional impacts. This reminds us that policy assessment serves to inform decision-makers and help them weigh up the pros and cons of different options, but not to take decisions for them.

Analysis may often take the form of a partial cost-benefit analysis where some elements are quantified and monetised. The identified net benefits can then be compared with the qualitative assessment of remaining costs and benefits. Several analytical frameworks can help in such cases, including Multi-Criteria Analysis. All methods are designed to ensure that the main impacts have been identified and then compare their pros and cons.

BEST PRACTICE 5 – IDENTIFY WHO WINS AND WHO LOSES FROM CHANGES IN ECOSYSTEM SERVICES

Knowing what the impacts are is not enough: we also need to understand who is affected and when. If the loss of ecosystem services affects one group disproportionately, this needs to be taken into account: it might lead to measures to protect that group or the biodiversity they depend on. Different actions could leave existing inequalities unchanged, aggravate them or help to reduce them.

Table 4.2 uses the example of forestry to show how different elements of Total Economic Value may vary in their importance to different groups.

Table 4.2: Distributing Total Economic Value from forestry between stakeholders

Stake-holders	Extractive direct use values	Non-extractive direct use values	Indirect use values	Preservation values
Land forest users	Forest and agricultural products (sale, subsistence and inputs into the farming system, e.g. fodder, litter etc.	Cultural and spiritual values	Microclimate, hydrological, soil conservation and nutrient cycling	Preserving use values for descendants
Commercial interests	Timber, commercial NTFPs, genetic material for pharma-ceutical development	Tourism	Downstream irrigation/water benefits to commercial farmers, water and electricity companies, and other businesses	Undiscovered commercial potential of biodiversity
National and forestry department interests	Forest revenue and foreign exchange	Recreation, tourism, education, science	A range of watershed protection services	Future biodiversity values
Global society interests	Globally traded products	Science (especially medical, education)	Global environmental services, e.g. carbon sinks	Existence values, future medicinal discoveries

Distributional analysis can reveal areas where we need to **align local decisions with social benefits at the national or even international level, using mechanisms such as REDD**. Under current systems, incentives for different groups are often incompatible. For example, deforestation may be in the interests of a regional community, but against those of an indigenous community and the international community.

Box 4.16: Identifying the three different levels of stakeholders

Beneficiaries: target groups that make use of or put value on known ecosystem services which will be deliberately enhanced by the policy, plan or programme under consideration;

Affected (groups of) people: people that experience intended or unintended changes in ecosystem services they value as a result of the policy, plan or programme;

General stakeholders:

- national or local government institutions having *formal responsibility* for management of defined areas (town and country planning departments, etc.) or ecosystem services (fisheries, forestry, water supply, coastal defence, etc.);
- formal and informal institutions *representing affected people* (water boards, trade unions, consumer organizations, civil rights movements, ad hoc citizens committees, etc.);
- formal and informal institutions *representing (the intrinsic value of) biodiversity* (non-governmental nature conservation organisations, park management committees, scientific panels, etc.);
- the *general public* that wants to be informed on new developments in their direct or indirect environment (linked to transparency of democratic processes); and
- stakeholders of *future generations* who may rely on the biodiversity under consideration.

Source: CBD and NCEA 2006

BEST PRACTICE 6 – INVOLVE AND ENGAGE STAKEHOLDERS

One of the best ways to understand who wins and loses is to **involve all potentially affected groups in the appraisal process** (see Box 4.16). As highlighted in Chapter 2, stakeholders are a source of expertise, data and opinions. The indigenous knowledge of people who are the stewards of biodiversity is immensely rich and an essential complement to technology-based data generation (GIS, remote sensing etc).

Developing stakeholders' sense of ownership and building trust in the people undertaking the policy assessment makes it easier to feed their perceptions and knowledge into the decision-making process. This has many advantages, particularly because biodiversity issues are often 'hidden' to all but a few expert or local stakeholders.

Chapter 3 has already emphasised that it is often the poorest in society who depend most on biodiversity and ecosystem services and are most vulnerable to changes in such services (e.g. availability of fuel or water for private use). Consulting such groups presents challenges but neglecting them in decision-making can undermine the effectiveness of adopted policies (e.g. resistance, weak implementation and/or adverse social side-effects).

The need for better participatory practices and more transparency is now widely acknowledged (see Box 4.17) and there are many examples of good practice in both developing and developed countries (see Chapters 5 to 9). Where done well, these are a relatively easy way to improve decision-making processes and improve understanding of the final policy choices.

Box 4.17: International backing for public participation in environmental decision-making: the Aarhus Convention (1998)

The UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters establishes legally-binding rights and obligations with regard to governmental decision-making processes on matters concerning the local, national and transboundary environment. It has so far been signed by around 40 (primarily European and Central Asian) countries and the European Community and been described as "the most ambitious venture in the area of environmental democracy so far undertaken under the auspices of the United Nations".

Quote: Kofi A. Annan, former Secretary-General of the United Nations (1997-2006)

Stakeholder consultation and transparency, alongside good governance (see Chapter 2), **are essential to limit abuse or non-use of available information** (e.g. in cases where decision-makers benefit from a situation that has negative impacts for the majority). Well-designed processes can promote effective public participation provided that they specifically address common constraints such as:

- **poverty:** involvement means time spent away from income-producing tasks;
- **rural settings:** distance make communication more difficult and expensive;
- **illiteracy or lack of command of non-local languages** can inhibit representative involvement if print media are used;
- **local behavioural norms or cultural practice** can inhibit involvement of groups who may not feel free to disagree publicly with dominant groups (e.g. women versus men);
- **languages:** in some areas a number of different languages or dialects may be spoken, making communication difficult;
- **legal systems** may be in conflict with traditional systems and cause confusion about rights and responsibilities for resources;
- **interest groups** may have conflicting or divergent views and vested interests;
- **confidentiality:** can be important for the proponent, who may be against early involvement and consideration of alternatives (CBD and NCEA 2006).

BEST PRACTICE 7 – IMPLEMENT THE ECOSYSTEM APPROACH

Assessment processes can be linked to the ecosystem approach, a paradigm for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The ecosystem approach can be applied to a specific sector (e.g. by the FAO for fisheries) or in a more generic way as under the Convention on Biological Diversity[8].

The ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organisation which encompass the essential processes, functions and interactions among organisms and their environment. Box 4.18 provides an example of how human uses, cultural diversity and established economic practices can be recognised through an ecosystem-based approach to assessment.

Box 4.18: Applying SEA at the ecosystem level through the Sperrgebiet land use plan, Namibia

The Sperrgebiet is a biodiversity-rich desert wilderness in southwest Namibia which includes a diamond mining area. In 1994, recognising conflicting demands on the fragile ecosystem, an agreement was reached between the government, Namdeb (the mining licence holder) and NGOs to formulate an integrated land use plan to safeguard the region's long term economic and ecological potential. An SEA-type approach was used, involving several steps:

- a thorough literature review with gaps filled through consultations with specialists;
- development of sensitivity maps for various biophysical and archaeological parameters;
- extensive public consultation (public workshops, information leaflets, feedback forms, land use questionnaires);
- identification of different land use options for the area and their evaluation in terms of environmental opportunities and constraints;
- formulation of a vision (declaration of the entire Sperrgebiet as a protected area);
- development of an interim zoning plan to guide immediate decisions, followed by a technical specialist workshop to refine the final zoning plan;
- a preliminary economic analysis of the main land use options;
- development of an administrative framework covering land proclamation, management advisory committee, ecotourism models, zoning, future access control and integration into the surrounding political and economic structures;
- for each potential land use, guidelines were prepared outlining what needs to be included in a project-specific EIA and the Environmental Management Plan.

The Land Use Plan was finalised in 2001 and the Sperrgebiet proclaimed a National Park in 2004, after the Plan's recommendations were accepted.

Source: OECD 2006b

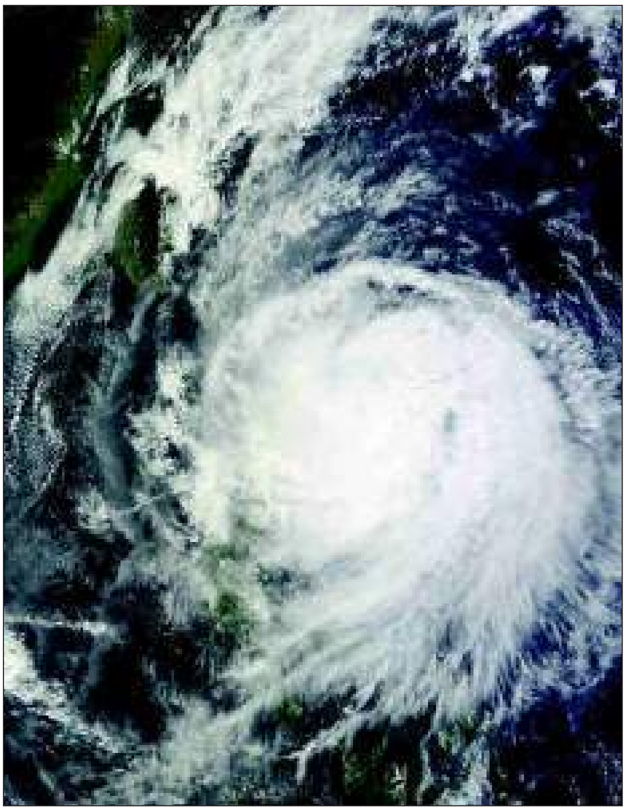
BEST PRACTICE 8 - ACCOUNT FOR RISKS AND UNCERTAINTY

Risks to biodiversity: Since we know relatively little about biodiversity, there are often significant risks attached to policies that impact on it. It is important to **identify these risks, their likelihood, and the probable consequences** (i.e. the impact, extent of the damage, and costs), generally using different risk scenarios. Risks can rarely be reduced to zero without incurring large costs, but there are often **measures to reduce them in an efficient way**.

The **'precautionary principle'**[9] requires decision-makers to take a cautious approach where impacts on biodiversity cannot be predicted with confidence and/or where there is uncertainty about the effectiveness of mitigation measures. This obviously presents major challenges e.g. for risks of invasive alien species impacts (species displacement, predation, lost output from agriculture), of fish stock collapse from overfishing or of loss of entire ecosystems (e.g. from coral reef loss due to pollution or climate change) (see Chapter 1). The biggest potential costs of biodiversity loss come from ecosystem collapse (see TEEB Climate Issues Update with regard to coral reefs), but it is extremely difficult to estimate the probability of this happening. Even at a local level, critical thresholds can mean change is unpredictable - ecosystems could be resilient but after a threshold become vulnerable to even small changes.

Risks from natural hazards, on the other hand, are well known - e.g. risks of flooding, storm surges on coasts, fires, drought, spread of disease via animal vectors – and there is also fairly good understanding, based on historical precedents, of where the areas at risk are. Much less well understood is the exact timing and scale of these impacts and, when it comes to diseases or invasive alien species spread, the exact pathway or pathogen involved.

It is increasingly clear that natural capital can significantly reduce the risk and scale of impact and damage (see Chapters 8 and 9). A valuable tool to manage the risk involves creating 'risk maps' to identify at-risk zones (e.g. for flooding). Looking to the future, identifying where natural capital (e.g. wetlands, mangroves, protected areas) can play a role in mitigating risks will be a critical part of risk maps and risk mitigation strategies. This can also contribute directly to strategies to adapt to climate change and reduce the risk of impacts. Links to spatial planning tools and policies will be of critical importance to help reduce the risks.



Source: NASA Earth Observatory. URL: http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=40869

Typhoon Lupit hitting the coast of Philippine island Luzon in October 2009

4.4 NEXT STEPS: THE NEED TO BUILD ASSESSMENT CAPACITY

Throughout the world, policy-making processes are closely tied to social structures, cultures and established political, legal, and administrative systems. These all have their own built-in rigidities. The priority now is to **establish a culture of analysis and data collection and institutionalise it**. This is challenging but it is possible and is already happening in several countries.

The best way forward often involves **step-by-step improvements**. Even though the most detailed policy assessment frameworks can seem daunting in terms of effort, there are often 'low hanging fruit' i.e. a small amount of analysis can quickly pay dividends. We already have good examples that can be replicated and frameworks that can be adopted – most importantly some form of SEA.

A successful assessment process needs support and resources. Capacity-building programmes need to be country-specific and tailored to cultural, socio-economic and legal characteristics on the ground (see example in Box 4.19).

Capacity is most likely to develop if there is an **accepted, functional and supported policy assessment framework** that creates a demand for it. Ad-hoc assessments may be good some of the time, but are unlikely to be systematically good or to allow for institutional learning.

Source: Melanie Hartwig, UFZ

Box 4.19: Capacity-building for integrated assessment by UNEP

UNEP guidance for integrating assessment of trade-related policies and biodiversity in the agricultural sector (see Box 4.8) is built on the practical experiences of six African, Pacific and Caribbean (ACP) countries (Cameroon, Jamaica, Madagascar, Mauritius, Uganda and Papua New Guinea).

Between 2005-2009, these countries received support to design and undertake an integrated assessment of a trade policy affecting the agricultural sector and, based on the results, to implement policy recommendations and adjust tools and techniques to country-specific contexts. Pilot projects were designed and led through national institutions (a core team of researchers and decision makers, supported by national steering committees and stakeholders invited for consultations and review). In-country learning was complemented by international workshops for core team members (acting as multipliers) and by expert input at key stages.

The main project focus was on (i) understanding trade and biodiversity linkages (ii) conceptualising trade policy impacts based on the Millennium Ecosystem Assessment Framework (iii) incorporating biodiversity into integrated assessment tools and techniques and (iv) developing and implementing policy responses. Positive results of the initiative can be seen at different levels:

- collection of baseline data, development of biodiversity indicators, identification of data gaps and commitment to fill these gaps;
- establishment of government-research partnerships and a formalised process for stakeholder consultation, including those that represent biodiversity;
- commitment to more systematic screening of policies, degrees, laws and existing assessment procedures to better incorporate biodiversity considerations;
- enhanced promotion of farming systems that support conservation and/or sustainable use of biodiversity (e.g. through training in sustainable management practices, development of strategic sectoral plans, land-use plans and/or sustainability standards);
- initiation of further training in integrated assessment for policy makers at national level;
- expressed interest to apply the integrated assessment to other policies and sectors.

Efforts to monetise biodiversity and ecosystem services through the UNEP programme fell short of initial expectations, due to lack of easily accessible data and insufficient resources under the projects to fill the gap. However, the benefits of valuation as a way to better communicate the importance of biodiversity and ecosystem services to decision makers were well understood and the countries expressed interest to extend capacity in this specific area.

Source: UNEP 2009b

Chapter 4 has shown how and why knowledge gaps can create a systematic bias in decision-making against biodiversity and ecosystem services. The techniques, frameworks and tools described above provide a starting point for countries to **develop and strengthen a robust culture of valuation and assessment** tailored to national needs and characteristics. This needs to become embedded within the policy-making process.

Chapters 5 to 9 shift the focus to the **range of solutions available to policy-makers** and consider how to create markets for ecosystem services to fully integrate them within the economy.

Endnotes

[1] Even with such a structured analysis, there is a risk of undervaluing the benefits of biodiversity. For example, there is a question as to whether secondary benefits of an ecosystem that favour another ecosystem are always properly covered.

[2] Three of the best known databases for ecosystem valuation are: EVRI database http://www.evri.ca/; RED database http://www.red-externalities.net/; and Ecosystem Services Database or ARIES database http://esd.uvm.edu/.

[3] Policy assessment is a participatory process of combining, interpreting and communicating knowledge. It usually involves setting out a cause-effect chain – involving environmental, social, and economic factors -- associated with a proposed public policy to inform decision-making. Including information on biodiversity and ecosystem services in this process means it is considered in decisions. Source: http://www.unep.ch/etb/publications/AI%20guidance%202009/UNEP%20IA%20final.pdf p.5

[4] This is not meant to be a full list. There are other tools (e.g. life cycle analysis which compares the environmental and social impacts of products and services) that are not mentioned but are also a form of policy assessment targeted at a particular need.

[5] See e.g. UNECE protocol for SEA at http://www.unece.org/env/eia/sea_protocol.htm.

[6] http://www.cbd.int/doc/meetings/cop/cop-07/information/cop-07-inf-15-en.pdf. The Synthesis included the assessment frameworks used by the OECD, UNEP, The North American Commission for Environmental Cooperation and the European Commission, the Canadian National Framework for Conducting Environmental Assessments of Trade Negotiations and the US Guidelines for Environmental Review of Trade Agreements.

[7] The social discount rate is the weight placed on all estimates of costs and benefits. When environmental impacts are monetized and included in a cost benefit analysis, they are discounted using the same discount rate applied to all other costs and benefits.

[8] http://www.cbd.int/ecosystem/.

[9] As expressed in the Preamble to the CBD, this provides that "where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat."

[10] For example, the contribution of a given ecosystem service (e.g., regulating service) to the value of another service (e.g., provisioning service) or commodity which is in turn associated with a price in the marketplace.

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ANNEX 1: OVERVIEW OF METHODOLOGIES USED IN ASSESSING VALUE OF ECOSYSTEM SERVICES

This Annex provides information on the most commonly used valuation methods (economic and non-economic) used to assess the value of ecosystem services.

Market Analysis

Market valuation methods are divided into three main approaches: (a) price-based approaches; (b) cost-based approaches which are based on estimates of the costs if ecosystem service benefits had to be recreated through artificial means; and (c) production function-based approaches that value the environment as an input[10]. Their main advantage is that they are based on data associated with actual markets, thus on actual preferences or costs by individuals. Moreover such data – i.e. prices, quantities and costs - are relatively easy to obtain. Examples include where a product is traded, such as timber or fish, or where ecosystem services contribute to marketed products, such as the value of clean water that is used as an input to local companies.

Revealed Preference Methods

Revealed preference methods use data from actual (past) behaviour to derive values. They rely on the link between a market good and the ecosystem service and the fact that demand for the market good is influenced by the quality of the ecosystem service. People are 'revealing' their preferences through their choices. The two main methods are (a) the travel cost method and (b) the hedonic pricing approach.

The travel cost method is mostly used for determining the recreational values related to biodiversity and ecosystem services. It is based on the rationale that recreational experiences are associated with a cost (direct expenses and opportunity costs of time). It is most commonly used to measure the recreational value of a site, and to assess the value that might be at risk if the site were to be damaged.

Hedonic pricing uses information about the implicit demand for an environmental attribute of marketed commodities. For instance, houses or property in general consist of several attributes, some of which are environmental in nature (e.g. proximity of a house to a forest or the view of a nice landscape). It would most commonly be used to measure the prices of houses near, say, a forest, and to compare them with those further away.

Stated Preference Methods

Stated preferences techniques are based on the demand for a given ecosystem service (or a change in its provision) measured by means of a hypothetical market simulated through the use of surveys. These methods require people to rate or rank trade-offs. Typically, the responses are collected using survey questionnaires of a representative sample of people. These valuation techniques can be used in situations where use and/or non-values are to be estimated and/or when no surrogate market exists from which value can be deduced.

However, there are difficulties in constructing hypothetical markets, and so criticism of valuation techniques is greatest for stated preference techniques, where it is felt by critics that it can often be unclear exactly what people were valuing (one service, all services etc) and whether they were making strategic responses.

The main forms of stated preference techniques are:

(a) *Contingent valuation method:* This method uses questionnaires to ask people how much they would be willing to pay to protect or enhance ecosystems and the services they provide, or alternatively how much they would be willing to accept for their loss or degradation.

(b) *Choice modelling:* Individuals are faced with two or more alternatives with shared attributes of the services to be valued, but with different levels of attribute (one of the attributes being the money people would have to pay for the service).

(c) *Group valuation:* A newer and rarer form of technique that combines stated preference techniques with elements of deliberative processes, to explore value, such as value pluralism, incommensurability, non-human values, or social justice.

Box 4.A1: An example of 'stated preference': the Exxon Valdez oil spill (1989) – *further details*

This oil spill affected 200km of Alaskan coastline - one of the largest spills in United States history and one of the largest ecological disasters. The subsequent court case included a claim for both use and non-use values with the values being claimed in compensation calculated through a contingent valuation study. The survey was developed over 18 months, including field testing, work with focus groups and pilot surveys and then around 1600 people were interviewed. The statistical analysis of these responses gave a $2.8 billion lower bound willingness to pay to avoid the damages. Eventually, Exxon settled its lawsuit with the US Government for $1 billion and agreed to spend around $2 billion on clean up, and later settled a class action lawsuit for additional amounts. These costs were consistent with the estimates from the valuation study.

What makes this now rather old example stand out, is the debate it sparked on the reliability of contingent valuation. The conclusion, of a panel of eminent and neutral economists, was that the method is sound and delivers useful results when well implemented.

Table 4.3 below sets out in more detail the methods used, and their applicability to different ecosystem services.

Table 4.A1: Valuation methods in more detail (adapted from Defra 2007)

Economic valuation methods	Description	Ecosystem services valued
Revealed Preference methods		
Market prices	These can be used to capture the value of ecosystem services that are traded e.g. the market value of forest products. Even where market prices are available, however, they may need to be adjusted to take account of distortions such as subsidies. Market prices can act as proxies for direct and indirect use values but do not capture non-use values; the price will be a minimum expression of the willingness to pay.	Ecosystem services that contribute to marketed products, e.g. timber, fish, genetic information, value of clean water that is an input to local companies
Averting behaviour	This approach focuses on the price paid by individuals to mitigate against environmental impacts.	Depends on the existence of relevant markets for the ecosystem service in question. For instance, the cost of water filtration may be used as a proxy for the value of water pollution damages; or costs of buying pollution masks to protect against urban air pollution (although this will only represent part of the damage value).
Production function approach	This focuses on the relationship that may exist between a particular ecosystem service and the production of a market good. Environmental goods and services are considered as inputs to the production process and their value is inferred by considering the changes in production process of market goods that result from an environmental change.	Regulating and supporting services that serve as input to market products e.g. effects of air or water quality on agricultural production and forestry output.
Hedonic pricing	This assumes that environmental characteristics (e.g. a pleasant view or the disamenity of a nearby landfill site), as well as other property features, are reflected in property prices. The value of the environmental component can therefore be captured by modelling the impact of all possible influencing factors on the price of the property.	Ecosystem services (e.g. regulating cultural and supporting services) that contribute to air quality, visual amenity, landscape, quiet i.e. attributes that can be appreciated by potential buyers.
Travel cost method	This is a survey-based technique that uses the costs incurred by individuals taking a trip to a recreation site (e.g. travel costs, entry fees, opportunity cost of time) as a proxy for the recreational value of that site.	All ecosystems services that contribute to recreational activities.
Random utility models	This is an extension of the travel cost method and is used to test the effect of changing the quality or quantity of an environmental characteristic at a particular site.	All ecosystems services that contribute to recreational activities.
Stated Preference methods		
Contingent valuation	This is a survey-style approach that constructs a hypothetical market via a questionnaire. Respondents answer questions regarding what they are willing to pay for a particular environmental change.	All ecosystem services.
Choice modelling	This is a survey-style approach that focuses on the individual attributes of the ecosystem in question. For example, a lake may be described in terms of water quality, number of species etc. Participants are presented with different combinations of attributes and asked to choose their preferred combination or rank the alternative combinations. Each combination of attributes has a price associated with it and therefore the respondents reveal their wiliness to pay (WTP) or willingness to accept (WTA) for each attribute.	All ecosystem services.

Cost based approaches	These approaches consider the costs in relation to provision of environmental goods and services and only provide 'proxy' values. Examples of cost-based approaches are those that infer a value of a natural resource by how much it costs to replace or restore it after it has been damaged.	
Opportunity cost	This method considers the value forgone in order to protect, enhance or create a particular environmental asset (e.g. opportunity cost of agricultural production lost if land is retained as forest).	Depends on the existence of relevant markets for the ecosystem service in question. Examples include man-made defences being used as proxy for wetlands storm protection; expenditure on water filtration as proxy for value of water pollution damages.
Cost of alternatives/ substitute goods	This approach considers the cost of providing a substitute good that has a similar function to the environmental good. For example, wetlands that provide flood protection may be valued on the basis of the cost of building man-made defences of equal effectiveness. Given that wetlands provide a range of ecosystem services, this costing would be a minimum estimate of the value of a wetland.	
Replacement cost method	This technique looks at the cost of replacing or restoring a damaged asset to its original state and uses this cost as a measure of the benefit of restoration. The approach is widely used because it is often easy to find estimates of such costs.	
Non-economic valuation methods	**Description**	**Ecosystem services valued**
Focus groups, in-depth groups	Focus groups aim to discover the positions of participants regarding, and/or explore how participants interact when discussing, a predefined issue or set of related issues. In-depth groups are similar in some respects, but they may meet on several occasions, and are much less closely facilitated, with the greater emphasis being on how the group creates discourse on the topic.	All ecosystem services.
Citizens' Juries	Citizens" juries are designed to obtain carefully considered public opinion on a particular issue or set of social choices. A sample of citizens is given the opportunity to consider evidence from experts and other stakeholders and they then hold group discussion on the issue at hand	All ecosystem services.
Health-based valuation approaches	The approaches measure health-related outcomes in terms of the combined impact on the length and quality of life. For example, a quality-adjusted life year (QALY) combines two key dimensions of health outcomes: the degree of improvement/deterioration in health and the time interval over which this occurs, including any increase/ decrease in the duration of life itself.	All ecosystem services.
Q-methodology	This methodology aims to identify typical ways in which people think about environmental (or other) issues. While Q-methodology can potentially capture any kind of value, the process is not explicitly focused on 'quantifying' or distilling these values. Instead it is concerned with how individuals understand, think and feel about environmental problems and their possible solutions.	All ecosystem services.
Delphi surveys, systematic reviews	The intention of Delphi surveys and systematic reviews is to produce summaries of expert opinion or scientific evidence relating to particular questions. Delphi relies largely on expert opinion, while systematic review attempts to maximise reliance on objective data. Delphi and systematic review are not methods of valuation but, rather, means of summarising knowledge (which may be an important stage of other valuation methods).	All ecosystem services.

ANNEX 2: STAGES OF A POLICY ASSESSMENT, PROPOSED ACTIONS AND WAYS TO ADDRESS BIODIVERSITY (UNEP 2009B)

Stages	Actions proposed		How to address biodiversity and related aspects
A. Understanding the policy context	A1.	Identify the purpose of the IA	0. Define the purpose, main objectives and sectoral focus. Define objectives in terms of ex-ante assessment and influencing decision-makers to maximise positive outcomes on biodiversity and other sustainability issues.
	A2.	Review the proposed policy and context	1. Identify environmental and biodiversity oriented policy objectives, commitments or agreements relevant for the study focus (area, commodity). Understand the policy process that is being assessed.
	A3.	Identify participants and stakeholders	2. Identify relevant stakeholders and biodiversity specialists, and ensure they are involved in the study.
	A4.	Identify and review available information	3. Identify and make an overview of relevant (biodiversity and trade-related) documents for the country / region concerned.
B. Determining the focus	B1.	Develop a conceptual framework	4. Make a summary of key issues and create a conceptual framework. Include critical biodiversity components and ecosystem services, social and economic issues and cause-effect chains.
	B2.	Identify priority sustainability issues	5. Identify the main sustainability issues (related to problems and opportunities) as associated with the conceptual framework..
C. Assessing the impacts	C1-3.	Identify criteria relevant to the main issues, develop ESE indicators and determine the baseline	6. Identify objectives or criteria and associate indicators to assess baselines and trends. Assessment of trends should be done using selected indicators. Define the status and trends of the most important indicators for the focal sectors of the assessment. Scenarios can be developed for expected changes. This is followed by a causality analysis to identify specific drivers of change and explaining possible outcomes for biodiversity and ecosystem services.
	C4.	Identify policy options including most likely option	7. Identify policy options for which to assess impacts. There may be three policy options: baseline, existing policy measures (subject of the assessment) and proposed positive policy.
	C5.	Analyse impacts using appropriate tools and techniques	8. Analyse the impacts of defined policy options on biodiversity, as well as social and economic indicators. Assess the likely impacts of policy options with the baseline scenario. If possible, quantify expected (positive or negative) changes in biodiversity and ecosystem services.
D. Developing policy recommendations	D1.	Finalise assessment of trade-offs and draw conclusion	9. Draw conclusions as regards the most desirable and realistic policy options. Consider alternative trade policy options to maximise overall positive sustainability outcomes. These are preferred over policy measures for mitigation or compensation of impacts on biodiversity and ecosystem services
	D2.	Develop policy recommendations	10. Define policy recommendations in line with the assessment results. Consider the most effective mechanisms for communicating results, using stakeholder input.

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 5: Rewarding benefits through payments and markets

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Chapter 5

Rewarding benefits through payments and markets

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Key Messages of Chapter 5

As highlighted throughout this report, the value of biodiversity and ecosystem services is not (fully) recognised by markets: degradation and loss result from decision making that ignores or understates the local and global benefits provided by ecosystems. **We urgently need new policy frameworks that reward the provision of ecosystem services and promote the greening of supply chains.**

This chapter focuses on innovative tools to reward ecosystem benefits efficiently and equitably through direct payments and tax incentives or by stimulating markets for products and services that have reduced environmental impact. These tools can be combined with instruments and approaches discussed in other chapters of this report. Effective policy mixes in each country will depend on national context and priorities.

National and international payments for ecosystem services (PES)

PES schemes that compensate those who maintain or enhance the flow of ecosystem services have already demonstrated their potential. In a global context of stagnant funding for biodiversity conservation, PES offer considerable potential to raise new funds for biodiversity or to use existing funding more efficiently. Both the public and private sectors can play a role in establishing PES in different contexts. PES have proven to be a highly flexible tool, providing both direct and indirect rewards for various ecosystem services and biodiversity conservation at a range of different scales.

At an international scale, one of the most significant PES opportunities on the table is **REDD (Reducing Emissions from Deforestation and Forest Degradation** in developing countries), which is being negotiated as part of the post-2012 climate change regime under the United Nations Framework Convention on Climate Change. Recent proposals for 'REDD-Plus' would offer incentives for forest conservation, sustainable forest management and enhancement of existing forest carbon stocks. Deforestation is estimated to account for up to 17% of global greenhouse gas (GHG) emissions: an agreement on such a mechanism could make a significant contribution to addressing global climate change and also provide substantial biodiversity benefits if designed and implemented with due consideration to the wide range of values of nature.

Recommendation: Promote PES demonstration activities and capacity building to develop the knowledge base, reduce transaction costs and scale up successful initiatives. Further efforts are needed to confirm where, in what form, and under what conditions PES work best for biodiversity, and to improve their targeting, monitoring and governance. PES should be designed to ensure additionality (i.e. going beyond 'business as usual') and to minimise leakage (i.e. displacement of damaging activities elsewhere). Spatial analysis – including data on economic costs and benefits – can help to map areas that are most important for providing ecosystem services, as well as the distribution of providers and beneficiaries, in order to identify synergies and priorities for both policy makers and private investors. Due engagement of local populations in the design and implementation of PES can be a critical factor in the success of the instrument.

Recommendation: Support an international agreement on a REDD-Plus mechanism as part of the global climate regime, while ensuring that other ecosystem services besides climate mitigation are taken into account. Depending on how REDD-Plus is designed and implemented, it could not only provide incentives for reducing emissions from deforestation and degradation but also secure biodiversity and other benefits at international, national and local levels. Appropriate safeguards should be formulated to reduce potential adverse impacts on biodiversity and to respect the rights and needs of indigenous and local communities, without making the rules so onerous that investors are unduly discouraged.

Recommendation: Contribute to emerging international initiatives to support direct investment in biodiversity public goods and natural capital across a wider array of ecosystems, such as the proposed Green Development Mechanism.

Access and benefit sharing for genetic resources (ABS)

ABS-related activities straddle payment schemes and market-based rewards. Historically, host countries have benefited little from the development and commercialisation of products based on genetic resources sourced from their territory. A fairer and more efficient regime is needed that can establish clear rights for local people, encourage the conservation of genetic resources in situ and facilitate discoveries and their application across a range of sectors.

Recommendation: Successfully conclude negotiations under the CBD on the international regime for more efficient and equitable sharing of the benefits arising out of the utilisation of genetic resources. A premium is needed for traditional local knowledge that leads to successful commercialisation based on genetic resources, together with better screening, contractual and dispute resolution procedures to minimise transaction costs. Investing in local capacity for documenting and assessing the state and value of biodiversity will be critical to successful initiatives.

Tax-based mechanisms and public compensation mechanism

Private and public efforts at a local level to conserve nature lead to national benefits that merit due incentive and payment schemes. The use of tax breaks and other compensation mechanisms offer an important 'thanks' and incentives for efforts. Similarly, transfers of tax revenues across regions can help give additional support to regions in recognition of biodiversity-rich areas or pro-biodiversity activities that create national public goods.

Recommendation: Make more systematic use of opportunities to provide tax exemptions for activities that integrate ecological concerns and promote conservation. Tax breaks can provide powerful incentives for private actors to donate land or to engage in long-term stewardship agreements. Intergovernmental fiscal transfers can likewise provide positive incentives to public agencies at various levels: ecological (e.g. protected area) criteria can be used when allocating tax revenues to lower government levels and hence address financing gaps and needs on the ground.

Recommendation: Damage caused by protected wildlife to local people needs to be recognised as a significant and legitimate concern. Public compensation programmes that account for such damage are necessary but should also aim to promote a more positive perspective that rewards the presence and protection of wildlife.

Green markets and fiscal incentives

The recent expansion of markets for biodiversity-friendly products and services – including forestry, fisheries and agriculture, tourism and other sectors – reflects a combination of market push (supply-side) initiatives by producers and market pull (demand-side) changes in the preferences of consumers, business and governments, expressed via their purchasing decisions. Markets that take ecosystems into account can stimulate the adoption of new production and processing methods that are cleaner, greener and more equitable, while helping to ensure the continued provision of scarce ecosystem services. Governments play an important role by providing an enabling framework that can incentivise these markets, including innovative tax and fiscal policies.

Recommendation: Help producers prepare for new market opportunities as consumers and public procurement policies stimulate demand for biodiversity-friendly products and services. Policy makers can support the development of robust process and performance standards and verification systems that explicitly include biodiversity conservation, including both mandatory and voluntary schemes. Public business advisory and support programmes should be geared to help companies meet the needs of new markets for green products and services.

Recommendation: Cooperative measures should be put in place to support developing countries' production and export sectors, to enable them to participate effectively in the development and implementation of new market standards. Targeted support of this kind can be an important part of international development aid, offering synergies between biodiversity, development and poverty reduction, particularly if local rights, traditions and livelihoods are taken into account.

5 Rewarding benefits through payments and markets

"We never know the worth of water 'til the well is dry".

English proverb

Biodiversity provides a range of ecosystem services[1] that benefit people locally, nationally and internationally. The provision of these services stems directly from natural processes, although management interventions are often required to maintain, develop or protect them. Many are not priced or are underpriced in the markets which means that existing economic signals may not reflect the true value of natural capital.

Chapter 5 focuses on payment and market-based tools to reward private and public actors who maintain the flow of services that benefit society. **5.1** explains how schemes delivering payments for ecosystem services (PES) actually work, drawing on lessons learnt from existing programmes and setting out indicators for improved design and implementation. **5.2** focuses on international PES, in particular the proposed REDD (Reducing Emissions from Deforestation and Forest Degradation) mechanism being developed under the UN Framework Convention on Climate Change, and also considers emerging initiatives to reward a wider range of biodiversity-related services across all ecosystems.

5.3 assesses the strengths and weaknesses of current reward structures for Access and Benefit Sharing for genetic resources (ABS) that are being addressed through negotiations for an international ABS regime within the Convention on Biological Diversity. **5.4** discusses how land, property and income tax regimes could be used more systematically to encourage private and public actors to commit to long-term conservation and how compensation payments can be shifted towards a more positive focus.

Lastly, the scope to stimulate and better target market supply and demand for goods and services produced with lower environmental impact are discussed in **5.5** (eco-labelling and certification schemes) and **5.6** (Green Public Procurement (GPP) policies).

5.1 PAYMENTS FOR ECOSYSTEM SERVICES (PES)

"Men do not value a good deed unless it brings a reward"

Ovid, B.C. 43 – 18 A.D., Roman Poet

This section describes how governments or private entities can provide payments to resource owners and users to protect natural ecosystems or to adapt production practices that ensure the continued provision of ecosystem services (5.1.1). It explains the basic principles and architecture of PES schemes (5.1.2) and provides concrete examples with lessons learnt to date (5.1.3). Remaining constraints and new opportunities are assessed (5.1.4) before setting out practical steps for improving PES design and implementation (5.1.5).

5.1.1 WHAT DO WE MEAN BY PES?

PES is a **generic name for a variety of arrangements through which the beneficiaries of ecosystem services pay the providers of those services** (Gutman 2006). The term covers payments for sustainable management of water resources and/or agricultural land, biodiversity conservation and storage and/or sequestration of carbon in biomass. This section outlines their role and scope: case examples are explored in more detail in Section 5.1.3.

PES typically involve payments to ensure the provision of a specific service. They are used for managing forest and agricultural land to ensure water quality for nearby cities, such as New York (Catskills-Delaware watershed) and Saltillo city, Mexico (Zapalinamé mountains), to cleanse coastal waters in Sweden (Zanderson et al. 2009) and to protect groundwaters in many European countries and parts of Japan (see Box 5.3 and, for other examples, Porras et al. 2008). Carbon sequestration via farm management is rewarded in New Zealand and via forest management in Costa Rica and Uganda. Farming practices that maintain other ecosystem services are rewarded through agri-environment payments in the EU and the US (Wunder et al. 2009; Baylis et al. 2004; Zanderson et al. 2009; see also Chapter 6). PES are also used to tackle external threats that could undermine service provision e.g. for removal of invasive alien species through South Africa's Working for Water Programme (see Box 5.6).

Other PES schemes focus on the provision of multiple services from a given area. Costa Rica's well-known programme (Pagos por Servicios Ambientales) supports a bundle of four services (see Box 5.2; Pagiola 2008; Wunder and Wertz-Kanounnikoff 2009). PES schemes to combine improved groundwater quality with increased biodiversity are found in e.g. Germany (see Box 5.5) and Bolivia (Los Negros watershed, see Asquith et al. 2008). PES schemes primarily for biodiversity conservation include the Bushtender programme (Victoria, Australia[2]) and the US Conservation Reserve Programme[3].

PES are **highly flexible and can be established by different actors**. Some schemes are managed by

Box 5.1: Definition of PES

PES can be defined as *voluntary* transactions where a *well-defined* ecosystem service (ES) (or land-use likely to secure that service) is 'bought' by at least one ES *buyer* from at least one ES *provider*, if and only if the ES provider secures ES provision (*conditionality*).

Source: adapted from Wunder 2005

national governments, as in Costa Rica, Ecuador, Mexico, China, EU Member States and the US. Others are established by water companies or water-user associations, as in the Catskills where PES is used to meet federal water quality standards for New York City and in Bolivia, Ecuador and Mexico. PES can also be purely private arrangements, whereby companies that rely on specific ecosystem services pay the relevant providers (e.g. payments to farmers by Perrier-Vittel in France: see Box 5.4). NGOs can also play an important role in PES e.g. by collaborating with the municipal water company in Quito (Wunder et al. 2009).

PES can be **applied at different scales**, ranging from the very local (e.g. 496 hectares in an upper watershed in northern Ecuador) to much larger scales (e.g. 4.9 million hectares of sloping farmland reforested in China (Bennett 2008; see also Chapter 9).

5.1.2 PRINCIPLES AND ARCHITECTURE OF PES

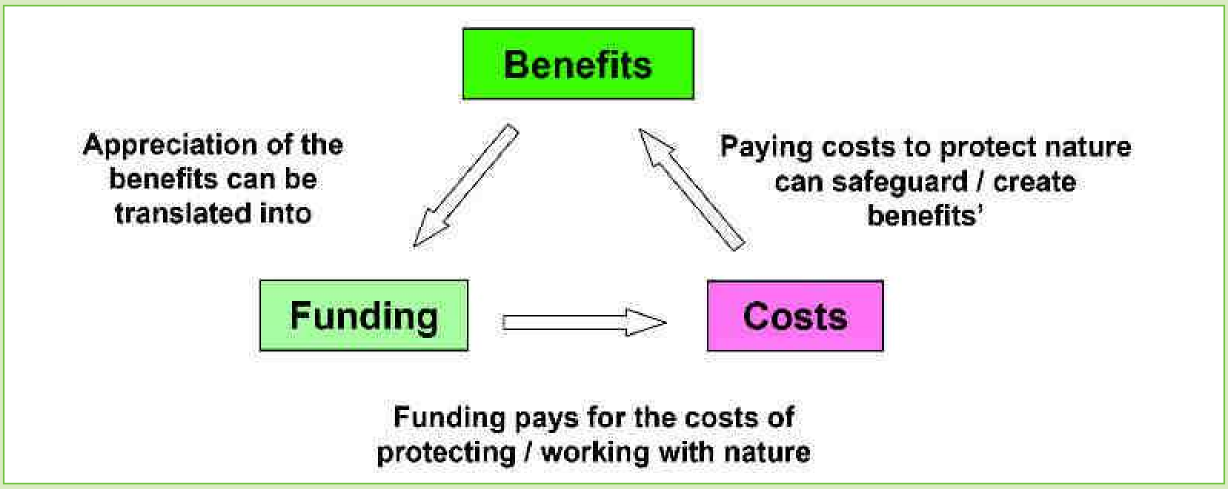
RATIONALE FOR INVESTING IN PES

The overarching principle of PES is to ensure that people who benefit from a particular ecosystem service compensate those who provide the service, giving the latter group an incentive to continue doing so (see Figure 5.1). As noted, policy makers are not the only ones concerned. Other beneficiaries of ecosystem services – such as hydroelectric power companies, irrigation authorities, water companies or aquaculture operations – may also be willing to pay to secure services that underpin their businesses. Private beneficiaries who make PES contracts with providers can thus internalise (some) environmental externalities on a purely voluntary basis.

PES are intended to **change the economics of ecosystem management and can support biodiversity-friendly practices that benefit society as a whole** (see Figure 5.2). In a situation where trade-offs exist between private and societal benefits from land uses, PES can tip the balance and render conservation-focused land uses more privately profitable with benefits for both the private land user and for society. In the absence of PES, the landowner would not choose the social optimum – unless other instruments such as regulation or incentives are in place (e.g. tax concessions, see Section 5.4) or social and cultural norms, customs or considerations lead to a social optimum without the need for payment. Care is needed to ensure that the instrument is socially compatible.

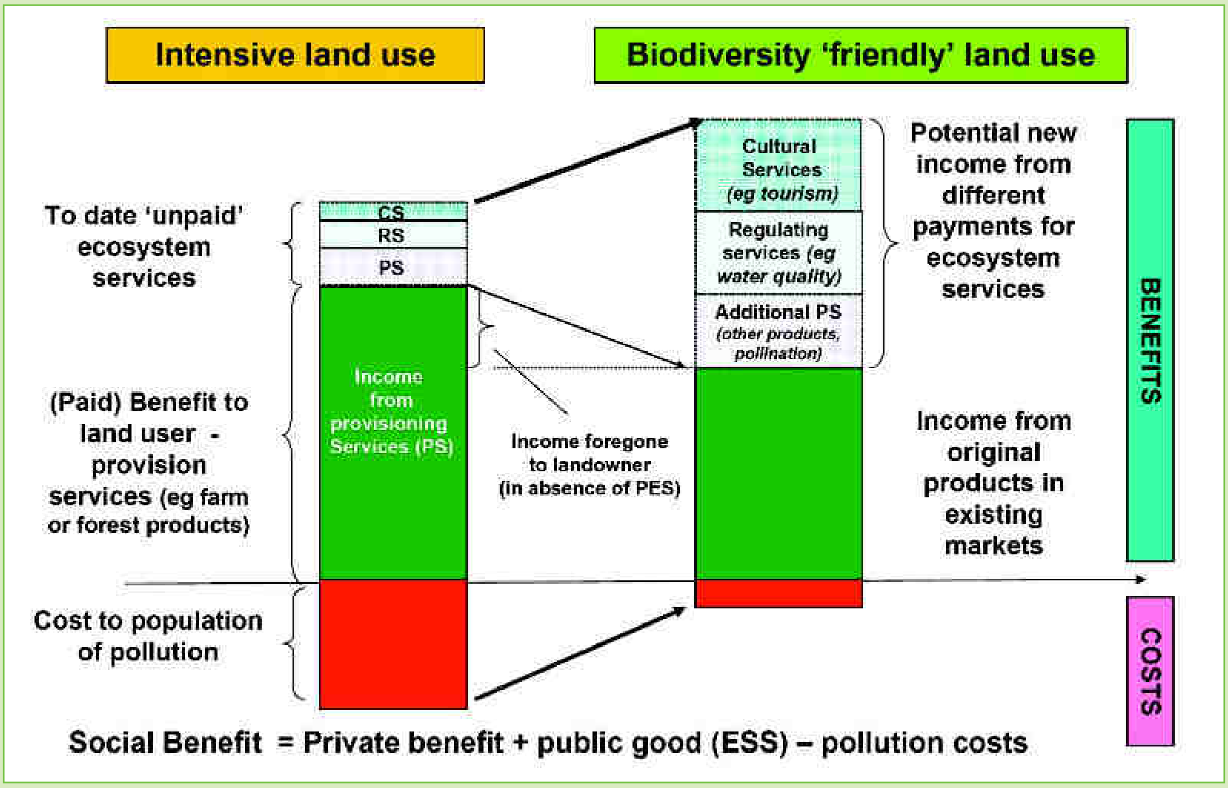
Care is also needed in their design as not all PES protect or conserve biodiversity. A focus on maximising the provision of just one service may have negative impacts on the provision of other ecosystem services if trade-offs are involved e.g. PES that promote exotic species plantations for rapid carbon sequestration at the expense of more diverse natural grasslands, which foster higher biodiversity.

Figure 5.1: Funding the provision of ecosystem services



Source: Patrick ten Brink, own representation

Figure 5.2: Increasing rewards for ecosystem services provision through PES



Source: Bassi and ten Brink, own representation adapted from Bassi et al. 2008

REGULATORY BASELINES AND ADDITIONALITY

Most PES schemes are founded on the idea that a resource owner will select uses and management practices that maximise private net benefits under existing regulations and market incentives. Privately optimal choices of land use will also evolve in line with changes to legal requirements or social norms (e.g. to reduce pollution or meet certain standards), especially where these requirements are properly enforced. The situation may be different in developing countries where systematic enforcement of environmental regulation remains a widespread challenge. There will therefore be different 'baselines' of behaviour or land use with different consequences (e.g. baselines of deforestation are a critical element of REDD discussions, see Section 5.2).

Management practices are generally adapted in response to new regulations or even because of changes in social norms. The practices assumed to be standard under existing regulation and social norms are the point of departure for PES i.e. such payments are intended to reward services that go beyond what is legally compulsory. However, the extent to which regulations are enforced can differ widely between countries, sometimes leading to a situation in which widespread management practices fall well below minimal regulatory levels. In this type of case, a PES system might have an additional effect as it involves a reward instead of an obligation, but at the same time it will undermine enforcement of environmental regulations.

PES should ideally be used to **reward good resource management practices that go beyond legal requirements or customary norms** (i.e. beyond the 'reference level' in Figure 5.3 below: this is equivalent to the above-mentioned baseline where all legal requirements are met). At this stage there may still be scope to gain further environmental benefits at a reasonable cost by paying the resource owner to undertake specified actions. Governments may find that it is less expensive or more consistent with other policy objectives (e.g. poverty reduction) to offer incentives rather than imposing management obligations. Other beneficiaries of ecosystem services may find that the reference level of service provision does not meet their needs and therefore make voluntary payments to resource owners.

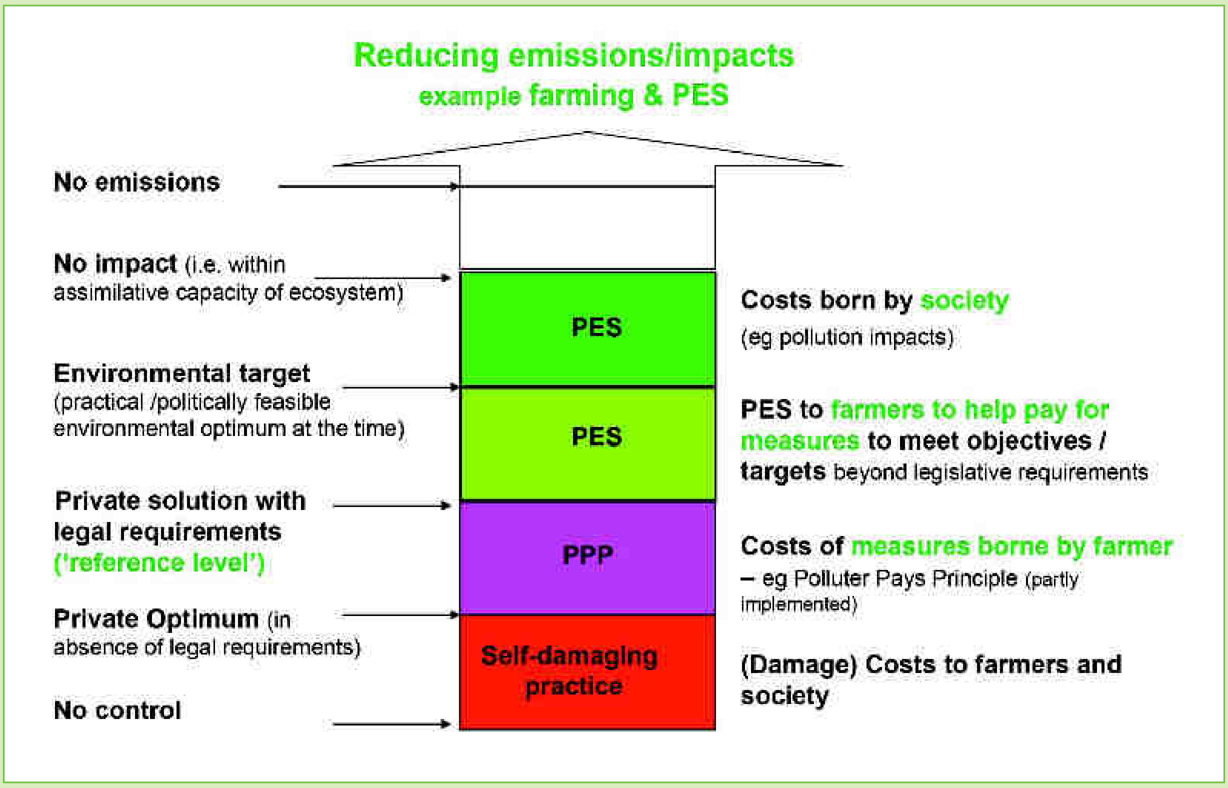
In some cases, governments may chose to use PES pragmatically as an incentive to get practice up to the legal standard – here it operates simply as a subsidy (see also Chapter 6) and runs counter to the 'polluter pays principle' (PPP). This cannot really be seen as a long-term solution, given concerns related to cost, budgets, governance, equity and efficiency. In other cases, governments may find it more appropriate to raise standards, strengthen enforcement and implement the PPP more fully (see Chapter 7).

It should be noted that even with legal standards complemented by positive incentives, there will often be some residual adverse environmental impacts compared with undisturbed ecosystems. These impacts are ultimately borne by society unless or until cost-effective means or technological solutions are found to avoid them. For example, pesticide or fertiliser use may comply with standards and even respond to incentive instruments designed either to discourage their use (e.g. taxes and charges, see Chapter 7) or to reward reductions in use (PES). Despite this, impacts may remain to the extent that relevant legislation and targets do not demand zero impact i.e. where use of fertilisers or pesticides is within the assimilative or regenerative capacity of the ecosystem (see Figure 5.3).

For these reasons, **the effectiveness and feasibility of PES is closely tied to the regulatory baseline and its enforcement** (see Chapter 7). A key challenge is to determine the appropriate reference level i.e. to distinguish between what resource owners/managers can reasonably be expected to do at their own cost and what more they might agree to undertake on the basis of PES.

The answer will depend on how environmental rights and duties are allocated between beneficiaries and

Figure 5.3: PES and the Polluter Pays Principle (PPP)



Source: Patrick ten Brink, own representation building on Scheele 2008 providers, whether formally or through de facto established practices. This varies between different legal systems and social contexts. Where downstream populations assert a right to clean water, it may be considered that upstream landowners should bear the costs of reducing pollution in accordance with the polluter pays principle. Conversely, if those landowners enjoy unencumbered rights to manage their land as they see fit, the burden of persuading them to modify their practices may fall on service beneficiaries (Johnstone and Bishop 2007)[4].

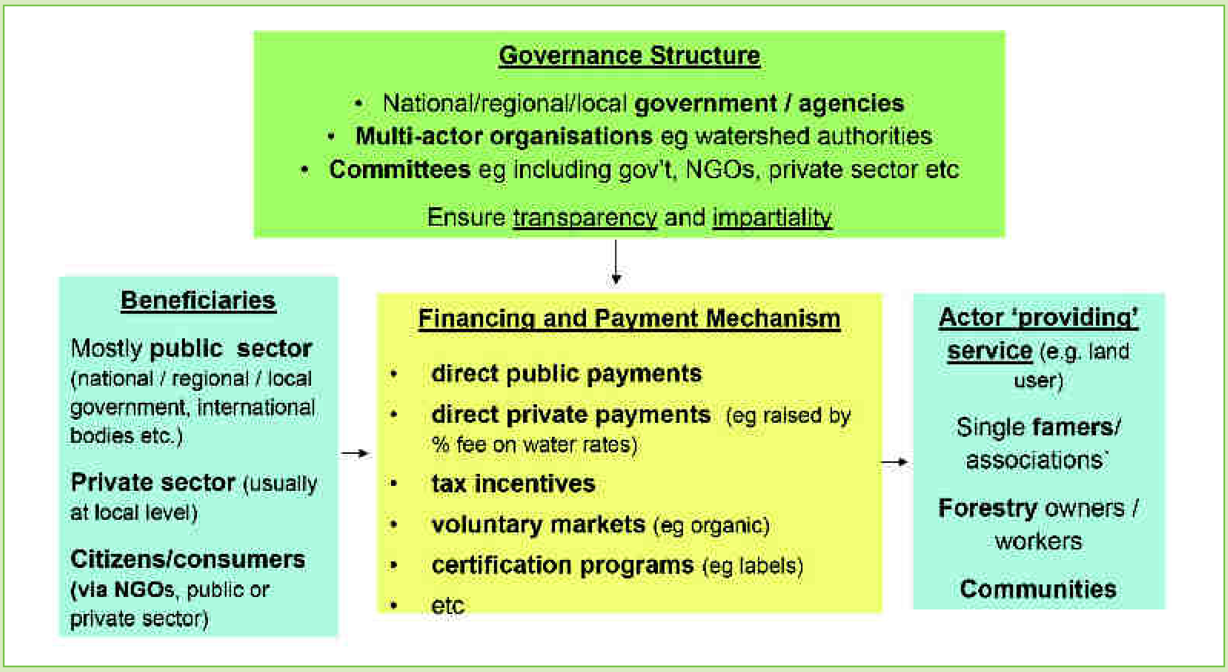
PES are sometimes criticised as a 'second best' solution by those who believe that beneficiaries have a right to enjoy ecosystem services that would have been available in the absence of damaging activities (i.e. free public goods delivered by nature); based on this argument, PES is less ethically satisfactory than strengthening the law to make polluters pay. Others suggest that PES is often just a disguised subsidy to encourage compliance with existing laws and can unfairly burden the public purse (where governments finance PES). In response to such concerns, the justification for PES is that it can be more cost-effective than strict enforcement, more progressive (where providers are relatively poor land users), and/or that it secures additional benefits beyond the minimum legal requirements. PES can also be seen as a temporary measure to motivate the adoption of new management practices and technologies which may eventually become economically justifiable in their own right (Johnstone, N. and Bishop, J. 2007).

Defining reference levels in terms of business-as-usual scenarios (BAU) carries a risk that resource owners exaggerate the level of environmental threat in order to win more payments for conservation[5]. This risk is particularly relevant in the case of REDD (e.g. overstating the rate of deforestation that would occur in a BAU scenario without payments: see Section 5.2 below).

THE STRUCTURE OF PES

As noted in Section 5.1.1, PES are highly flexible and there is no one model or blueprint. There are **many ways to structure schemes, depending on the specific service, scale of application and context for implementation**. Some are based on legal obligations (e.g. PES linked to carbon markets under legally-binding emission targets) whereas private PES schemes are voluntary with little government

Figure 5.4: PES stakeholders and their interactions



Source: adapted from Pagiola 2003

involvement. Sources and mechanisms for payments vary as do the providers (e.g. communities, farmers, forest owners, agribusinesses, timber companies) and the beneficiaries. Figure 5.4 provides a generic outline of the basic structure for most PES.

5.1.3 APPLICATIONS, BENEFITS AND LESSONS LEARNT

APPLICATION OF PES TO DIFFERENT CONTEXTS

PES can be implemented at different geographic scales, depending on the nature of the beneficiaries, the providers and the spatial relationship between them.

If a site provides a service that is mainly useful locally (e.g. pollination of crops), then a local PES makes sense. If it provides national benefits (e.g. pest control), then it is arguably for national government to initiate the appropriate PES or to use legal measures to secure a public good or service. Provision of global benefits (e.g. as in the case of biodiversity and carbon services) may require an internationally coordinated approach (see Section 5.2 below on REDD).

The first national PES schemes in developing countries were pioneered in Costa Rica (see Box 5.2) and Mexico (Programme for Hydrologic-Environmental Services (PSA-H) focused on threatened forests to maintain water flow and quality). The Costa Rican programme is amongst the best-known and studied PES examples and has proved very popular with landowners (requests to participate have outstripped funding). The scheme presents impressive results, at least at first sight. The instrument, its design, sources of funding and engagement are periodically reviewed and adjusted.

Box 5.2: An evolving nationwide scheme: the Pagos por Servicios Ambientales, Costa Rica

Background: Set up in 1997, the national PSA programme remunerates landholders for providing carbon sequestration services, and hydrological services via watershed protection and for preserving biodiversity and landscape beauty. From 1997-2004, Costa Rica invested some US$ 200 million, protecting over 460,000 hectares of forests and forestry plantations and providing additional income to over 8,000 forest owners. By 2005, the programme covered 10% of national forest areas.

Level of payments: US$ 64 per hectare/year were paid for forest conservation in 2006 and US$ 816 per hectare over ten years for forest plantations.

Source of funds: The programme is based on partnerships at national and international level, contributing to long-term financial sustainability. The primary source of revenues is a national fossil fuel tax (US$ 10 million/year) with additional grants from the World Bank, Global Environment Facility and the German aid agency (Kreditanstalt für Wiederaufbau (KFW)). Funds are also provided through individual voluntary agreements with water users (US$ 0.5 million/year) which will increase with the gradual introduction of a new water tariff and potential new opportunities from carbon finance.

Lessons learnt: The PSA programme has helped slow deforestation, added monetary value to forests and biodiversity, increased understanding of the economic and social contribution of natural ecosystems and is generally considered a success. However, recent assessments suggest that many areas covered through the programme would have been conserved even without payments, for three main reasons: deforestation pressures were already much reduced by the time PSA was introduced; the use of uniform payments (fixed prices); and limited spatial targeting of payments in the early stages of implementation. The programme is being adjusted in response to these lessons.

Source: Portela and Rodriguez 2008; Pagiola 2008 in Wunder and Wertz-Kanounnikoff 2009; and personal communication, Carlos Manuel Rodríguez, former Minister of Environment of Costa Rica

PES schemes can also be piloted at local level and subsequently rolled out on a wider scale. In Japan, the combination of serious forest degradation and the findings of a national valuation of forest ecosystem services shifted the policy landscape. The resulting estimates of monetary values helped generate sufficient political support for changing local tax systems in over half of the country's prefectures (see Box 5.3 and also Chapter 4 on the importance of valuation).

The issue of **regulatory baselines and additional ecosystem benefits** comes up in two cases related to improving groundwater quality, involving both private and public beneficiaries. In the Vittel bottled water case (Box 5.4) and agricultural payments in Germany (see Box 5.5) existing regulations were not stringent enough to prevent pollution of groundwaters with nitrates and pesticides or to make the polluters pay for avoidance. In response to product quality and cost concerns (Vittel) and broader health and biodiversity concerns (both cases), a pragmatic approach was adopted. These agreements can be characterised as PES, as regards provision of public goods through increased biodiversity, or as a subsidy for environmental services with regard to the contribution to reduced pollution (see Chapter 6).

Box 5.3: Using valuation to justify payment of local tax revenues for forests in Japan

Background: About two-thirds of land in Japan is forest cover. However, local forest industries have for decades been negatively affected by having to compete with cheaper timber imports. Many forest lands were simply abandoned without proper management after plantation, resulting in serious degradation of forest land and related ecosystem services. In 2001, the Science Council of Japan estimated that the value of ecosystem services under threat amounted to 70 trillion JPY (Yen) per year or US$ 620 billion/year (see table):

Evaluation of Multiple Functions of Forests

Ecosystem service	Value per year of forests for 2001 (JPY)	Billion US$/yr
Absorb carbon dioxide	1.24 trillion/year	10.8
Substitute for fossil fuel	0.23 trillion/year	2.0
Prevent surface erosion	28.26 trillion/year	245.7
Prevent loss of top soil	8.44 trillion/year	73.4
Ameliorate flooding	6.47 trillion/year	56.2
Conserving headwater resources	8.74 trillion/year	84.7
Purify water	14.64 trillion/year	127.3
Health and recreation	2.26 trillion/year	19.6

Note: for the first seven services the replacement cost method was used; for health and recreation, household expenditures (travel costs) were used.

Source of funds: The scheme was introduced in Kochi Prefecture in 2003. By June 2009, 30 out of 47 prefectures had adopted comparable 'forest environmental taxes' or 'water and green forest management taxes'. Each prefecture levies 500-1,000 Yen (approximately US$ 5-10) per inhabitant and 10 000-80 000 Yen (approximately US$ 100-800) per business every year to fund restoration and enhancement of forest ecosystem services (excluding timber production).

Use of the funds: Tax revenues are usually paid into a special fund spent on forest management activities to maintain water resources, prevent natural disasters or enrich biodiversity by altering mono-species forest to mixed species forest etc. To ensure long-term environmental benefits, the Prefecture and forest owners usually conclude an agreement not to harvest the forest in the short term but to maintain it for a certain period of time (e.g. at least 10 years) before getting financial assistance through the scheme.

Source: Science Council of Japan 2001; MAFF Japan 2008

Box 5.4: Private sector contracts for PES: the example of Vittel mineral water, France

Background: Since 1993, Vittel has conducted a PES programme in its 5,100 hectare catchment in the Vosges Mountains to maintain high water quality. 26 farmers ('sellers of ecosystem services') in the watershed are paid to adopt best low-impact practices in dairy farming (no agrochemicals; composting animal waste; reduced stocking rates).

Use of funds: The programme combines cash payments (conditional upon the adoption of new farming practices) with technical assistance, reimbursement of incremental labour costs and arrangements to take over lands and provide usufruct rights to farmers. Average payments are EUR 200 hectare/year over a five year transition period and up to 150,000 EUR per farm to cover costs of new equipment. Contracts are long-term (18-30 years), with payments adjusted according to opportunity costs on a farm-by-farm basis. Land use and water quality are monitored over time which has provided evidence of improvement in relevant ecosystem services compared to an otherwise declining baseline. This high service value clearly makes the investments profitable.

Structure and lessons learnt: The Vittel scheme built on a four-year research programme by the French National Institute for Agricultural Research (INRA) and took 10 years to become operational. It is implemented through Agrivair, a buyer-created intermediary agency that helps to mediate between parties. Total costs in 1993-2000 (excluding intermediary transaction costs) were almost 17 million EUR or US$ 25 million. The tenacity of Vittel in securing an agreement reflects the fact that it was simply significantly cheaper to pay for a solution with farmers than to move the sourcing of water elsewhere (in France, natural mineral waters are not allowed pre-treatment).

Sources: Perrot-Maître 2006; Wunder and Wertz-Kanounnikoff 2009

A well-documented case of PES as value for money comes from the Catskills Mountains, US. A comprehensive PES programme for this 200 km2 watershed costs around US$ 1-1.5 billion over ten years, significantly less than the estimated cost of a water filtration plant (one-off costs of US$ 4-6 billion and operational and maintenance costs of US$ 300-500 million). Nearly all (93%) of the farmers in the region participate and water bills have been raised by 9% instead of doubling in the case of new filtration capacity (Wunder and Wertz-Kanounnikoff 2009; see Chapter 9 for further details on the case).

Using water rates to fund PES can be done in different ways. One study analysed 17 local PES schemes where fees are charged to domestic water users. Seven made the additional costs visible in water bills; percentage premiums are added to final water bills in Pimampiro, Ecuador (20%) and in Cuenca, Quito (5%); a flat rate per cubic metre is used in Heredia, Costa Rica; and in Zapalinamé, Mexico, contributions are voluntary and users can choose the level, helping to address social concerns (Porras et al. 2008). To give an example of scale, charges paid by federal water users in Mexico's national PSA-H scheme generated US$ 18 million in 2003, rising to US$ 30 million in 2004. These monies are disbursed to individual and collective owners of natural forests that serve watershed functions. Payments for preservation of cloud forest (US$ 40 per hectare/year) exceed those for other tree-covered land (US$ 30 per hectare/year) (Muñoz-Piña et al. 2007).

PES WITH MULTIPLE CO-BENEFITS

PES schemes can be designed to **create or support employment related to the provision of ecosystem services**. The type and number of jobs will obviously depend on the scale of the scheme and the nature of the activity involved. A large-scale example is the Working for Water (WfW) public works programme in South Africa which protects water resources by

Box 5.5: Public water quality contracts for PES: the example of farmers in Germany

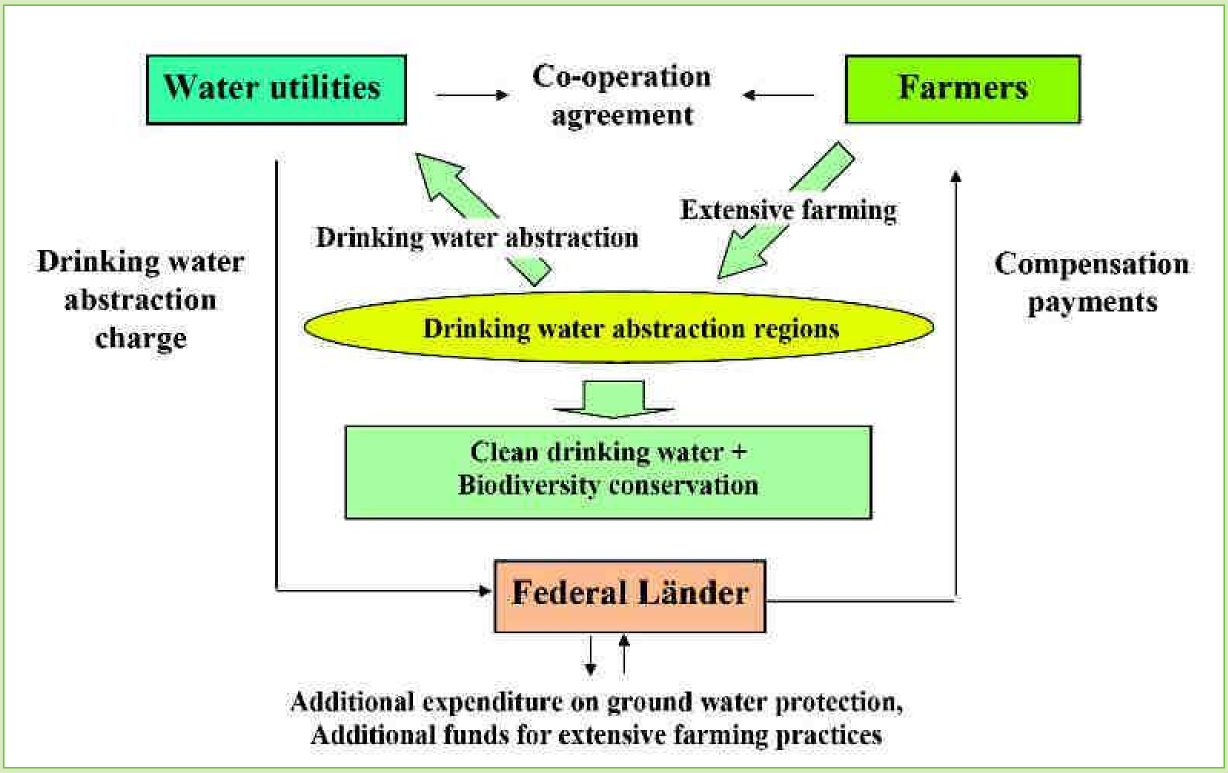
Background: Nitrates in drinking water can be hazardous to health, particularly for children, but their removal – along with other agricultural pollutants – is very costly. It is economically more efficient to prevent these substances from entering drinking water supplies in the first place.

In Germany, the Bundesländer (federal states) achieve this through a combination of mandatory 'groundwater extraction charges' and voluntary measures. Water utility companies have to pay a charge to the relevant 'Bundesland' for every cubic metre of groundwater extracted, part of which is used to pay farmers to reduce use of nitrogen-based fertilisers and pesticides.

Use of funds: Increasingly, the Länder use the money to fund voluntary cooperation projects between local water utilities and farmers, which makes it easier to protect groundwater with little additional effort or loss of agricultural output. An estimated 435 projects took place in 2002, involving 33,000 farmers over 850,000 hectares i.e. 5% of agricultural land in Germany. In Lower Saxony, such projects covered 50% of the areas from which water was extracted.

Lessons learnt: Cooperation between water utilities and farmers not only secures supplies of high quality groundwater at low cost but also helps to protect biodiversity e.g. by preserving grasslands rich in species and creating new grassland areas (about 50% of Germany's biodiversity, including several endangered species, is found on extensively farmed land). Additional payments to achieve other nature conservation objectives can be modelled on this example.

Public water quality contracts for PES – a schematic



Source: Niedersächsisches Umweltministerium, Niedersächsisches Landesamt für Ökologie 2002 eliminating the spread of invasive plants. WfW has more than 300 projects in all nine South African provinces. It has employed around 20,000 people per year, 52% of them women[6], and also provided skills training, health and HIV/AIDS education to participants. WfW is best understood as a PES-like programme as it does not make payments to landowners for continuous service provision but instead consists of 'landowner' (the municipal government) contracting workers to manage public land sustainably (Wunder et al. 2008; see Box 5.6).

Box 5.6: Local environment and employment gains via the Working for Water Programme

In 1999, the South African municipality of Hermanus responded to a water shortage by introducing a block rate tariff system to reduce water demand. A significant percentage of revenues collected were paid to WfW to clear invasive alien plants in the mountain catchment of the reservoir supplying Hermanus with water, in order to restore natural fire regimes, the productive potential of land, biodiversity and hydrological functioning.

The formal agreement between the municipality and WfW continued until 2001, by which time the project had treated 3,387 hectares of land, created 91 person years of employment and prevented losses estimated at between 1.1-1.6 million m^3 of water per year. Contracting costs were R2.7 million and the estimated total cost R4.9 million (including project management costs and other overheads).

Source: Turpie et al. 2008

On the other hand, some PES schemes can reduce rural employment if land is completely taken out of production or dedicated to less labour-intensive management practices to secure environmental benefits. While such a strategy has been applied in EU and US agri-environmental programmes with few negative equity impacts, this could pose problems in developing country contexts e.g. for landless households that rely on selling labour to farmers as a source of cash income (Zilberman et al. 2006).

The Socio Bosque Programme in Ecuador is a recent ambitious PES scheme that aims to combine protection for a wider set of ecosystem services with poverty concerns and addressing climate change (see Box 5.7). This is of interest because payments for carbon storage and sequestration are expected to be a major driver of PES in the coming years. If targeted at areas of high biodiversity value, ecosystem service provision and potential for poverty alleviation, they can offer major win-win opportunities (see also Section 5.2 on REDD).

In some cases PES involve **non-monetary benefits** rather than a monetary reward. For example, protected area managers are increasingly exploring collaborative management models to reduce tension across park boundaries and better integrate protected areas into broader regional development. In Kulekhani, Nepal, local PES-like schemes to regulate water or reduce erosion provide communities with development assistance in the form of medical services and education, rather than cash payments. In east and southern Africa, communities living near protected areas are sometimes granted limited access to the ecosystem in return for supporting conservation action. However, the effectiveness of such indirect approaches may be questioned (Ferraro and Kiss 2002).

5.1.4 OPPORTUNITIES AND CHALLENGES

PES can help make the value of ecosystem services more explicit and thus modify and potentially reverse incentives for resource users to over-exploit or convert them. In some cases, demand for such services is currently low but may become more important in the future in response to increased scarcity of the service being provided (e.g. due to population growth or loss of other areas providing similar services). To determine whether PES could help secure future benefits, we need to assess the level of ecosystem service provision and how this could change in the future and affect demand.

Voluntariness is a key feature of PES (see Box 5.1) although legal/regulatory underpinning is essential if their full potential is to be realised. There is potential to scale up existing PES (from local initiatives to national

Box 5.7: Large-scale PES to alleviate poverty and reduce deforestation in Ecuador

Ecuador has about 10 million hectares of native forest cover but its deforestation rate is one of the highest in South America (around 200,000 hectares lost each year). This leads to emission of about 55 million tons of CO_2 and also entails a huge loss of ecosystem services and subsistence for local people.

In 2008, pursuant to its National Development Plan, the government of Ecuador designed and approved the **Programa Socio Bosque** (Forest Partners Programme) to combine development and conservation objectives and directly benefit poor farmers and indigenous communities. The mechanism consists of a **direct payment per hectare of native forest per year to landowners on condition that they conserve (part of) their forest**. Participation is voluntary and compliance will be monitored on a regular basis through interpretation of satellite images and field visits. Specific programme goals over the first six years are to:

- protect over 4 million hectares of forest to conserve globally important biodiversity, protect soils and water and mitigate natural disasters;
- reduce greenhouse gas emissions from deforestation and forest degradation as an integral part of the national REDD strategy (PES measures will be supported by stronger enforcement of illegal logging and a national reforestation plan); and
- increase income and protect human capital in the poorest rural areas of the country with a total number of beneficiaries of about 1 million people.

Criteria to prioritise areas for implementation are being finalised and may include: high deforestation threat; high value for ecosystem services (carbon storage, water protection and biodiversity); and high levels of poverty.

Progress to date: The first contracts were signed in December 2008, benefiting about 15,000 people and covering 180,000 hectares of forest. In 2009, the scale of implementation increased: by May 2009, another 8000 beneficiaries had been registered, representing an additional 140,000 hectares. A dedicated trust fund has been established to assure long-term financial sustainability and transparent use of resources. The government intends to complement its own resources with support from international cooperation and through national and international PES schemes and carbon markets.

Sources: Marcela Aguiñaga, Manuel Bravo*, Tannya Lozada*, Free de Koning** and Luis Suárez***
** Ministerio del Ambiente del Ecuador*
*** Conservación Internacional Ecuador*
Background information available at: http://www.ambiente.gov.ec/contenido.php?cd=278

coverage), to implement PES in more countries, to make PES more efficient and to address issues of permanence. To date, however, not many PES schemes have been effectively expanded.

PES involving the private sector offer the potential to raise additional finance and thus complement public conservation funding. As public and private PES may operate differently, it is important to **explore the relative benefits of voluntary and regulatory approaches**. While private actors can play a role in PES, the willingness to pay of existing beneficiaries is often not sufficient to cover start-up or operating costs. This may be due to ‘free rider’ problems or to a lack of knowledge of the full benefits provided by ecosystems. In such cases, governments may need to provide extra incentives or find alternative solutions. One such solution might be to make a scheme obligatory once a certain percentage of beneficiaries agrees to it, mitigating the free-rider problem.

PES schemes face **several constraints**. They require significant investments in information and capacity building. Priorities include mapping the supply and demand of ecosystem services, understanding current and expected future use of resources, engaging relevant stakeholders, supporting certification schemes and training administrators.

High transaction costs create a barrier to developing PES and reduce their cost-effectiveness. Depending on the value of the ecosystems concerned, there may be a justification for states (or international agencies) to subsidise start-up or transaction costs to facilitate progress e.g. by paying for mapping ecosystem services or for stakeholder participation processes.

PES are not appropriate everywhere. They can be particularly difficult to implement where resource tenure or use rights are insufficiently defined or enforced e.g. in the high seas and some mangroves, coral reefs, flood plains and forests without clear ownership. Where institutional capacity and transparency are lacking or where resource access and ownership are in dispute, PES 'buyers' have little incentive to participate because they have few guarantees that the activities paid for will actually be implemented – or even that a legitimate service provider can be identified.

PES design and implementation can also be compromised where there is unequal bargaining power between stakeholders (i.e. imbalance between service providers and beneficiaries). This can affect who is included in the scheme, the way the money is shared, the rate of payment and the conditions set for service provision and access (see Figure 5.5 below).

In some cases, a PES targeting a single service will not be sufficient to halt its degradation or loss as the payment will be less than the opportunity costs of a range of alternative resource uses. However, PES schemes can be part of a broader mix of policy instruments that addresses the full range of ecosystem services from an area.

More generally, the proper **sequencing of measures** is important for achieving effective and coherent policies. Introducing payment schemes without the prior or simultaneous removal or reform of policies with adverse consequences on ecosystems and biodiversity will lead to incoherent and wasteful policy packages. This has been repeatedly underlined by the Organization for Economic Development and Co-operation (OECD), in particular with regard to environmentally harmful subsidies (see Chapter 6).

The ability to **quantify, monetise and communicate the values of ecosystem services to key stakeholders** – from politicians to industry to local communities – can help build support (see Box 5.3 above). However, the lack of a biophysical assessment and economic valuation of an ecosystem service need not preclude PES (Wunder 2007). Some of the most valuable services may be those that are most difficult to measure. In some cases, precise quantification of the service would be prohibitive (e.g. for small watershed schemes). In these cases, arguments based on the precautionary principle may be enough to justify starting PES, although economic valuation should be used as and when new information becomes available to adjust payment levels, targeting or conditions.

5.1.5 MOVING FORWARD ON PES DESIGN AND IMPLEMENTATION

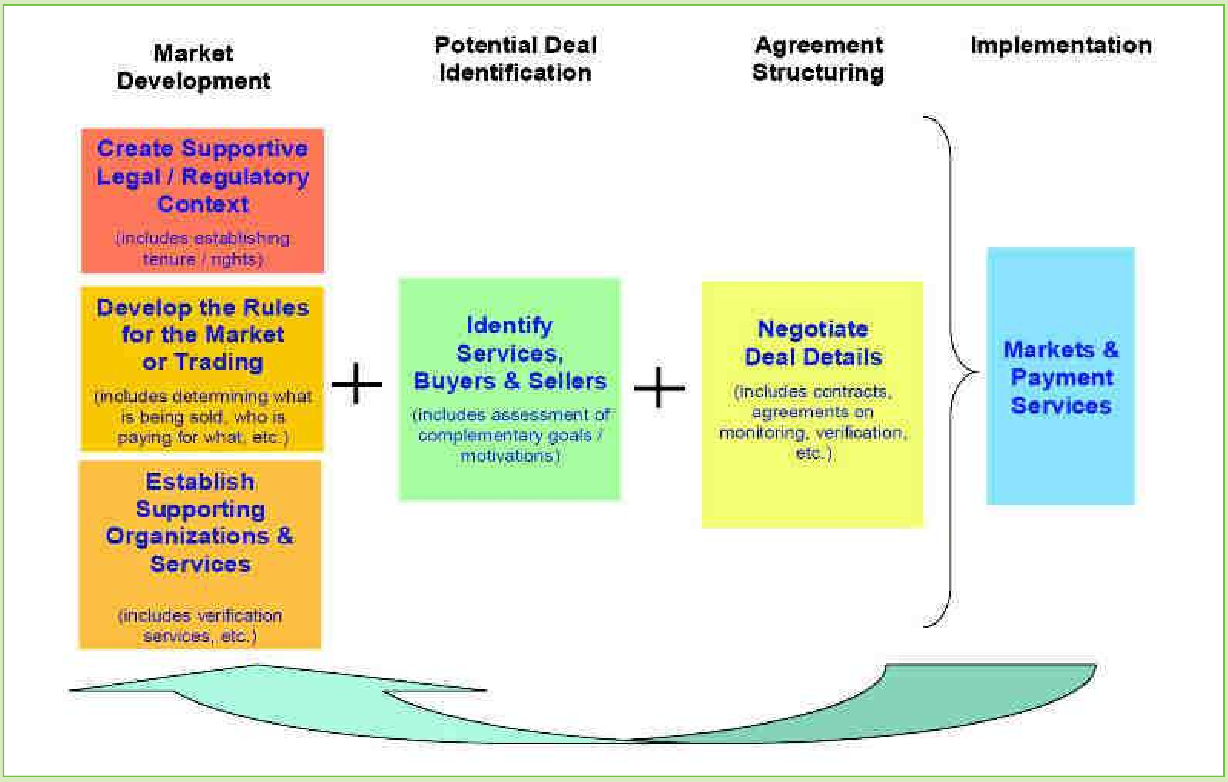
Experience to date has underlined the importance of **careful preparation to ensure that PES schemes are effective and appropriate for local conditions**. Information on the social, economic and ecological context and the legal and institutional context needs to be taken into account. Ideally, PES should be targeted, understandable, fair, cost-effective, accountable, enforceable, coordinated with other instruments and responsive to community needs. In practice, the reality can be very different.

Key steps for PES development include identifying services and stakeholders, setting the baseline, negotiating the deal and implementing the scheme (see Figure 5.5) as well as monitoring and enforcement.

SUPPORTIVE LEGAL AND INSTITUTIONAL CONTEXT

PES schemes require rules and institutions to function effectively, including mechanisms to enforce contracts.

Figure 5.5: The main stages of PES development



Source: adapted from Brand 2002

This can have equity implications as new rules change the distribution of rights and responsibilities over ecosystems and their services. Institutions will be needed to:

- **facilitate transactions and reduce transaction costs.** Most ecosystems provide a range of services, even if only one or a subset of these are recognised by a PES scheme. Payment can be made for a specific 'bundle' of services from large numbers of producers or there may be different instruments or different buyers for different services, evolving over time (see Figure 5.6). In some cases a service will be a free co-benefit;
- set up **insurance or other mechanisms** to manage risks;
- provide **related business services** e.g. for beneficiaries of ecosystem services to be willing to pay for them, better methods of measuring and assessing biodiversity in working landscapes must be developed.

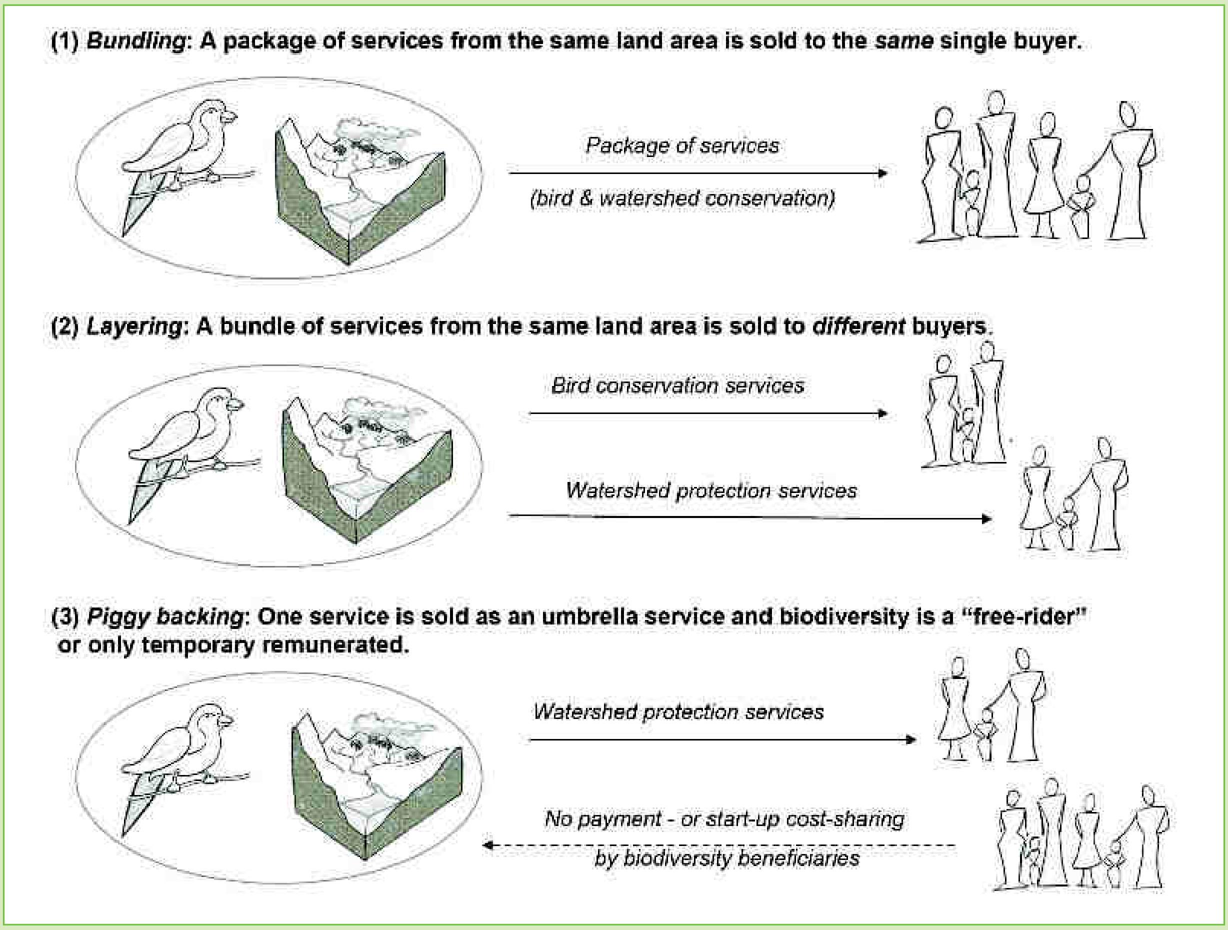
A range of institutional actors are required in a PES deal, including for its establishment and for the maintenance of registers to keep track of payments. Figure 5.7 presents a typical scenario.

IDENTIFICATION OF SERVICES, BUYERS AND SELLERS

Several conditions need to be met to enable PES, including economic, technical, governance and practical factors:

- on the **demand side**, where the supply of a valuable service is threatened, the beneficiary of the service needs to be aware of the threat, willing to pay to maintain the service and able to do so;
- on the **supply side**, the opportunity costs of changing resource management practices must not be too high. It must be possible to improve the supply of the ecosystem service through a change in resource use e.g. land set-aside, adoption of organic production practices, use of water saving irrigation techniques (see also Wunder 2008);

Figure 5.6: Strategies for marketing biodiversity joint service provision



Source: Wunder and Wertz-Kanounnikoff 2009

- with respect to **technical information**, it is important to understand the ecosystem service, who provides it and how, who benefits (using spatial mapping), historical and expected future trends in demand and supply and other contextual factors. Such information is necessary for appropriate targeting of payments to those who can actually deliver the desired service; and
- in terms of **governance**, trust between beneficiaries and suppliers (or the potential to build trust) is essential, along with appropriate legal and institutional support for monitoring and contract enforcement, clarity on resource tenure and mechanisms for redress.

NEGOTIATION OF PES DEALS

In principle, PES initiatives should be **financially self-sustaining** to secure ecosystem services over the long term. However, where continuous payments by beneficiaries are not feasible, it may be possible to convert a one-off payment (e.g. a grant) into long-term flows by setting up trust funds or to pool payments from different beneficiaries (see the 'layering' strategy in Figure 5.6).

PES have distributional consequences so it is critical to address issues of ownership, reward and distribution explicitly to ensure that they do not aggravate existing inequities. **Wide participation in decisions relating to PES design and implementation can help ensure transparency and acceptance and avoid the covert privatisation of common resources.** The distribution of costs and benefits in PES schemes should be monitored consistently. Participatory resource assessments and valuation can help ensure that PES schemes take account of traditional knowledge and practices and the interests of all stakeholders. Capacity-building and, where needed, adequate institutional measures are important to ensure that weaker stakeholders are able to participate in PES negotiations and share their insights on ecosystem conservation. In Costa Rica and Mexico, 'collective contracting' was introduced to facilitate the participation of poorer small farmers after it was realised that they would otherwise be excluded.

PES schemes are not generally designed to reduce poverty but they can offer new opportunities for the rural poor to earn additional income (see Box 5.8). Many rural people earn their living from activities such as forestry and farming in which income fluctuates by season and year. PES based on ecosystem restoration or improved land management could provide a stable source of additional income and employment in rural areas.

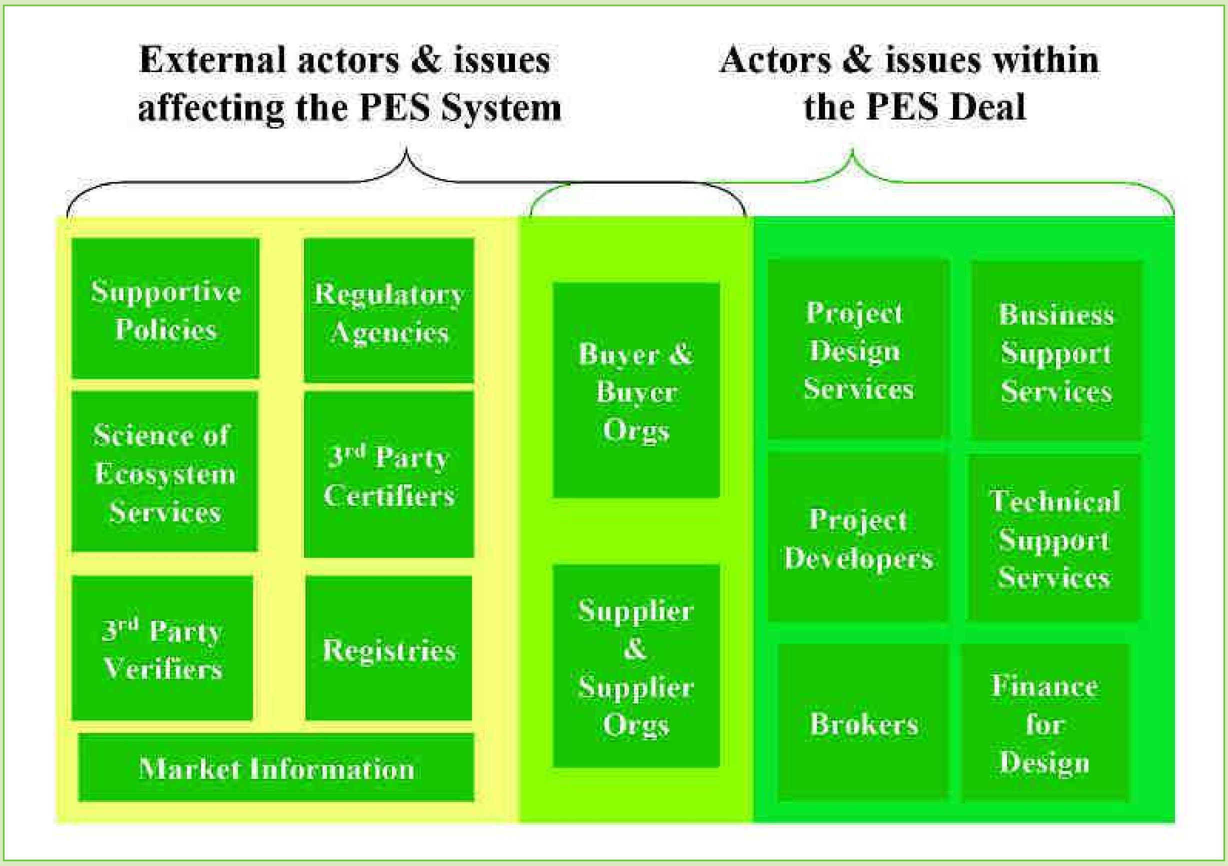
OVERARCHING CONDITIONS FOR SUCCESS

Effective PES requires – and can help to strengthen – certain 'enabling conditions' such as:

- reliable scientific information (e.g. sources of ecosystem services, their spatial distribution and beneficiaries);
- economic data (start-up and implementation costs, including opportunity costs of managing resources for ecosystem services, non-market values and incentive effects of alternative PES arrangements);
- identification and participation of key stakeholders.

Successful PES schemes typically demonstrate transparency, reliability (of payments etc.), appropriate cultural conditions (e.g. acceptance of differential payments for environmental stewardship, trust) and strong commitment by all parties. Effective monitoring

Figure 5.7: Institutional actors involved in PES deals



Source: adapted from Bracer et al. 2007 and enforcement is critical to ensure delivery of the intended services and their measurement. Payments must be clearly linked to service provision and may be withdrawn if resource users abandon management practices associated with the service. Monitoring data on the quality and quantity of site services can help improve the targeting of payments or make other refinements (see also Chapter 3).

As noted, PES will not work everywhere. It may be difficult to secure sufficient support for PES in situations where competing (destructive) resource uses are highly lucrative. Weak governance, unclear resource tenure and high transaction costs can also be major barriers.

Box 5.8: Phased performance payments under PES schemes in Tanzania

On Mafia Island, Tanzania, a two-part payment scheme was set up to encourage the mainly poor local population to conserve sea turtles. It consists of 1) a fixed payment for finding and reporting a nest and 2) a variable payment that is a function of the nest's hatching success. The initial payment provides immediate recompense for not harvesting nests (important as poor residents apply high discount rates to future payments) and also makes the overall payment scheme less risky for poor residents than if all payment were solely dependent upon successful hatchings. The post-hatching variable payment then provides an incentive not to poach eggs once the nest has been reported.

There are around 150 turtle nests on the island and 41,000 residents. Participation in the scheme is agreed directly between volunteers and villagers and based on oral agreements. About half a dozen individuals actively searching for nests account for the majority of payments. The scheme reduced poaching rates of turtle nests dramatically, from 100% at the year of its introduction in 2001 to less than 1% in 2004. Moreover, from 2001 to 2004, the number of hatchlings increased in both absolute terms (from about 1200 to a little over 10,000) and relative terms (from 55% to 71% of the eggs remaining at hatching time).

Source: Ferraro 2007

As with any innovation, a critical step is to secure support from leaders at various levels who can communicate the importance of ecosystem services and the potential of PES to both providers and beneficiaries. There is also a need for careful analysis and effective communication of experiences, both positive and negative, to replicate and scale up successful initiatives.

5.2 INTERNATIONAL PES: REDD AND BEYOND

This section outlines the economic, social and environmental arguments in favour of international cooperation on payments for ecosystem services of global benefit (5.2.1). It focuses on the content and design options for the proposed mechanism under the United Nations Framework Convention on Climate Change (UNFCCC) for Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries, giving particular consideration to the scope for biodiversity co-benefits alongside carbon benefits (5.2.2). Ways to market additional biodiversity benefits alongside REDD are considered in 5.2.3. Finally, 5.2.4 outlines emerging initiatives for International Payments for Ecosystem Services (IPES) specifically focused on biodiversity-related global ecosystem services.

5.2.1 THE RATIONALE FOR INTERNATIONAL ENGAGEMENT

Global biodiversity benefits – including carbon storage, genetic information for bio-industry and pharmaceuticals, international hydrological services, wildlife and landscape beauty - need to be recognised, and costs and benefits fairly shared if we are to halt their degradation. Commitment to **IPES can help secure rewards** for such benefits. Without this, the decision facing many land owners, as well as local and national governments, will remain tilted against conservation and opportunities to contribute to conserving or maintaining their international public good values will be missed.

Several instruments can be broadly classified as a form of IPES (OECD 2009), including bioprospecting, conservation concessions, biodiversity offsets and international grants. International markets for 'greener' products and services are also key mechanisms to conserve natural capital but arguably fall outside IPES (see Sections 5.5 and 5.6).

Regional and continental PES schemes - or equivalent cooperation – can be designed to address ecological functions in large transboundary ecosystems, such as the Nile, Lake Victoria or the Amazon (see Box 5.9). Collaboration to identify interdependencies and recognise service providers and beneficiaries is likely to lead to better solutions than following national interests alone. The latter may deliver short-term gains for a few but long-term losses for all as natural capital erodes.

5.2.2 DESIGNING REDD WITH BIODIVERSITY CO-BENEFITS[7]

"If a post Kyoto climate agreement fails on avoiding tropical deforestation, the achievement of overall climate change goals will become virtually impossible. The lives and livelihoods of millions of people will be put at risk, and the eventual economic cost of combating climate change will be far higher than it needs to be."

Bharrat Jagdeo, President of Guyana

This section looks at a new international financial mechanism that is proposed to help internalise the carbon-related ecosystem services provided by forests. Under the auspices of the UNFCCC, Parties are proposing that a mechanism on Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries is integrated into the post-2012 climate change regime. Given the important role that forests play in climate change mitigation and adaptation, as well as in biodiversity provision, the section considers how biodiversity co-benefits in REDD can be maximised and how potentially adverse impacts on biodiversity could be avoided.

Deforestation and forest degradation accounts for about 17% of global greenhouse gas (GHG) emissions (IPCC 2007c). Successful agreement on a REDD mechanism could therefore significantly contribute to meeting the UNFCCC's ultimate objective, namely "to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (Article 3) (see Box 5.10).

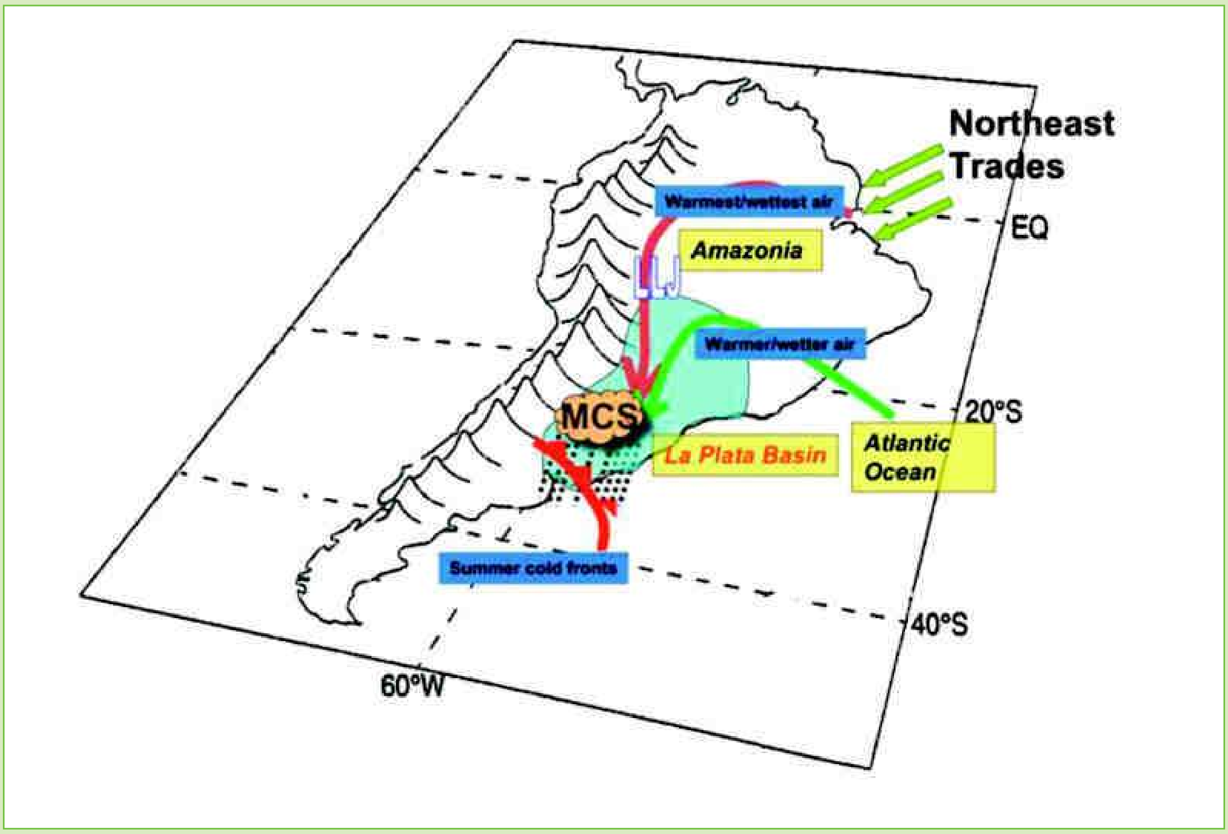
The actual amount of deforestation/degradation that could be avoided – and thus the level of emissions prevented or new sequestration capacity gained – will depend inter alia on:

- the baselines that are set (what area with what carbon store and what carbon sequestration rate is being lost and at what rate?);
- the incentives behind the loss (who benefits and by how much?); and
- financial mechanisms (discussed below).

It is expected that REDD will have a substantial impact on climate change mitigation because it is estimated to be a low-cost GHG mitigation option compared to many other emission abatement options (see Box 5.11). Moreover, sustaining forests and high forest biodiversity improves both the carbon storage capacity of forests and their resilience to future shocks – such as ability to withstand changes in climatic conditions, pollution and invasive alien species.

Box 5.9: Opportunities for multi-country PES: example of the Amazonian 'water pump'

Five countries share the Amazon basin. Amazonia's forests evaporate roughly eight trillion tonnes of water each year (IPCC 2007b) which falls as rain, helps maintain the forests and is transported to the Andes and down to the Plata River Basin, where agriculture, hydropower and industry generate about US$ 1 trillion for these countries (Vera et al. 2006). The region's food, energy and water security are thus underpinned by the Amazonian 'water pump'. National and international PES could help to maintain this critical service.



Source: adapted from Marengo et al. 2004

Box 5.10: The evolution of REDD-Plus under the UNFCCC

At the 11th meeting of the Conference of the Parties to the UNFCCC (COP-11, Montreal, 2005), Papua New Guinea proposed integrating a mechanism to reduce emissions from deforestation into the post-2012 climate change regime. The proposal received widespread support and a formal process was created to examine the possibility of positive incentives and policy approaches for REDD.

The Bali Action Plan (Decision 2/CP.13, adopted in December 2007), mandates UNFCCC Parties to negotiate a post-2012 instrument that includes financial incentives for forest-based climate change mitigation actions in developing countries. Paragraph 1b(iii) of the Plan specifically calls for

"policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries".

At COP-14 (Poznan, 2008), the items on conservation, sustainable management of forests and enhancement of carbon stocks were highlighted as being of equal importance. This gave rise to the latest term within the REDD negotiations, namely REDD-Plus (REDD+).

COP-15 (Copenhagen, December 2009) marks the culmination of the two year process launched in Bali to agree a post-2012 regime, including REDD+. Even if an agreement is reached, the specific design elements and implementation approaches for REDD+ will probably only be addressed after Copenhagen.

The possible scope of activities in a REDD+/forestry mechanism has been significantly enlarged over the last three years and could potentially reward 'enhanced positive changes' through forest restoration/rehabilitation.

Table 5.1: Possible scopeof credible activities in a REDD/forestry mechanism

Changes in:	Reduced negative change	Enhanced positive change
Forest are (hectare)	Avoided deforestation	Afforestation and reforestation (A/R)
Carbon density (carbon per hectare)	Avoided degradation	Forest restoration and rehabilitation (carbon stock enhancement)

Source: Angelsen and Wertz-Kanounnikoff 2008

Although REDD focuses on carbon emissions, the UNFCCC's Bali Action Plan recognises that action to support REDD "can promote co-benefits and may contribute to achieving the aims and objectives of other relevant international conventions and agreements". A notable example of this potential for synergy concerns the Convention on Biological Diversity (CBD) (see Box 5.11).

INTERNATIONAL REDD DESIGN OPTIONS AND THEIR IMPLICATIONS FOR BIODIVERSITY

Several outstanding technical and methodological issues still need to be resolved through the UNFCCC process to ensure that any future REDD mechanism is environmentally effective, cost-efficient and equitable (Karousakis and Corfee-Morlot 2007; Angelsen 2008). Key REDD design elements with implications for biodiversity are outlined below. These relate to scope, baselines/reference levels, different types of financing

Box 5.11: The costs and benefits of reducing GHG emissions from deforestation

Estimated costs of reducing emissions from deforestation vary across studies, depending on models and assumptions used. In comparison to GHG mitigation alternatives in other sectors, REDD is estimated to be a low-cost mitigation option (Stern 2006; IPCC 2007c).

Eliasch (2008) estimated that REDD could lead to a halving of deforestation rates by 2030, cutting emissions by 1.5-2.7 Gt CO_2/year and would require US$ 17.2 billion to US$ 33 billion/year. It estimated the long-term net benefit of this action at US$ 3.7 trillion in present value terms (this accounts only for the benefits of reduced climate change).

A study from the Woods Hole Research Centre estimates that 94% of Amazon deforestation could be avoided at a cost of less than US$ 1 per tonne of carbon dioxide (Nepstad et al. 2007). Olsen and Bishop (2009) find that REDD is competitive with most land uses in the Brazilian Amazon and many land uses in Indonesia at a carbon price of less than US$ 5 per tonne of CO_2 equivalent. Kindermann et al. (2008) estimate that a 50% reduction in deforestation in 2005-2030 could provide 1.5-2.7 Gt CO_2/year in emission reductions and would require US$ 17.2 billion to US$ 28 billion/year (see Wertz-Kanounnikoff 2008 for a review of cost studies).

Sources: Stern 2006; IPCC 2007a; Eliasch 2008; Nepstad et al. 2007; Kindermann et al. 2008; Wertz-Kanounnikoff 2008

mechanism, monitoring and reporting/verification methodologies (see Parker et al. 2009 for a synopsis of REDD proposals).

SCOPE OF REDD AND REDD-PLUS

A well-designed REDD mechanism that delivers real, measurable and long-term emission reductions from deforestation and forest degradation is expected to have significant positive impacts on biodiversity since a decline in deforestation and degradation implies a decline in habitat destruction, landscape fragmentation and biodiversity loss. At the global scale, Turner et al. (2007) examine how ecosystem services (including climate regulation) and biodiversity coincide and conclude that tropical forests offer the greatest synergy. These cover about 7% of the world's dry land (Lindsey 2007) yet the world's forests contain 80 to 90% of terrestrial biodiversity (FAO 2000). Targeting national REDD activities at areas combining high carbon stocks and high biodiversity can potentially maximise co-benefits (see Figure 5.8 on Panama below)[8].

A REDD-Plus mechanism could have additional positive impacts on biodiversity if achieved through appropriate restoration of degraded forest ecosystems and landscapes. Afforestation and reforestation (A/R)[9] activities can provide incentives to regenerate forests in deforested areas and increase connectivity between forest habitats. However, there is a need for safeguards to avoid potential negative effects. A/R activities under a future REDD mechanism that resulted in monoculture plantations could have adverse impacts on biodiversity: firstly, there are lower levels of biodiversity in monoculture plantations compared to most natural forest and secondly, the use of alien species could have additional negative impacts. Conversely, planting mixed native species in appropriate locations could yield multiple benefits for biodiversity. Plantations can also reduce pressures on natural forests for the supply of fuel and fibre.

NATIONAL AND SUB-NATIONAL BASELINES/REFERENCE LEVELS

Baselines provide a reference point against which to assess changes in emissions. Various proposals have been tabled for how these could be established for REDD at national, sub-national[10] and project levels. The accounting level selected has implications for **'carbon leakage'** i.e. displacement of anthropogenic emissions from GHG sources to outside the accounting boundary, with deforestation and/or forest degradation increasing elsewhere as a result. Such leakage could have adverse consequences for biodiversity if deforestation/degradation were displaced from an area with low biodiversity value to one with higher value. In general, national level emissions accounting is better able to account for international leakage than sub-national and/or project level accounting[11].

Another important question about REDD relates to **'additionality' i.e. achieving emission reductions that are additional to what would have occurred under the business-as-usual scenario** and how protected areas (PAs) are treated within this context. Some high carbon/high biodiversity ecosystems may be located in legally-defined PAs, giving the impression that the carbon they store is safe and that they would not offer additional sequestration benefits. While this is true for well-managed PAs, many sites remain vulnerable to degradation through encroachment, poaching and other illegal activities (Leverington et al. 2008). This reflects inter alia the significant financing gap that exists for many PAs across the world (see Chapter 8).

Ensuring carbon additionality will depend on whether and how REDD finance is extended to PAs. About 312 Gt of terrestrial carbon is currently stored in the existing PA network: if lost to the atmosphere, this would be equivalent to approximately 23 times the total global anthropogenic carbon emissions for 2004 (Kapos et al. 2008). Targeting REDD funding at PAs at risk of degradation/deforestation or which have potential for improved ecological status – rather than at 'safe' PAs – could yield both high carbon and biodiversity benefits.

GROSS VS NET DEFORESTATION RATES

Another issue under negotiation is whether gross or net deforestation rates will be considered when estimating emission reductions[12]. From a climate perspective, the most relevant figure is what the atmosphere actually experiences (the rationale for using net values). However, the use of net rates could hide the loss of mature (i.e. primary and modified natural) forests and their replacement with areas of new forest, either in situ or elsewhere. This could result in significant losses in biodiversity (sCBD 2008).

REDD FINANCING

There are three prevailing positions on how REDD financing could be generated[13]. These have different implications for how biodiversity co-benefits could be promoted and which stakeholders would be involved in decision-making processes.

Market-based approaches: If REDD were financed via the regulated international carbon market, credits would need to be fungible (interchangeable) with existing Assigned Amount Units (AAUs) under the Kyoto market[14]. The unit of exchange would be tonnes of carbon equivalents (tCO_2e). Demand for credits would be generated by the carbon market which would drive investment towards the least-cost mitigation options (subject to any restrictions that governments might place on market access for REDD credits). Given their ability to engage the private sector, market-based approaches to REDD are likely to mobilise higher levels of sustainable and long-term financing, leading to larger areas of conserved forests and larger biodiversity co-benefits.

Fund-based approaches: Another approach is to mobilise REDD finance via inter alia voluntary contributions (ODA), auctioning assigned amount units (AAUs) in the carbon market and earmarking (part of) these revenues or revenues from other fees, fines and taxes. In general, fund-based approaches can be designed to disburse REDD finance based on any objectives and criteria established by donor (and host) countries. Whereas carbon market financing is tied to delivering emission reductions, fund-based approaches could be used not only to finance such reductions but also to support capacity-building needs in developing countries to make REDD operational. They may also target biodiversity co-benefits or be designed to target biodiversity benefits directly. However, the way in which funds are generated may have implications for how they are disbursed (see Karousakis 2009). In general, fund-based approaches are likely to deliver lower volumes of REDD finance over the long-run.

Phased approaches: More recently, a phased approach to REDD finance has been proposed that combines market and fund-based approaches. The

Meridian Institute (2009) suggests three phases entailing:

- voluntary funding for national REDD strategy development and capacity building;
- implementation of policies and measures proposed in national REDD strategies, supported by an internationally-binding financial instrument funded by e.g. auctioning AAUs; and
- payment for performance on the basis of quantified forest emission reductions measured against agreed reference levels. This could be financed on a large scale by the sale of REDD units within global carbon markets or by a non-market mechanism.

Pending agreement on a REDD-Plus mechanism, a growing number of international contributions and funds have already been set up to help address deforestation. Sponsors include the World Bank, Norway, Japan, Germany, the United Kingdom, Australia, the European Commission, Brazil and Guyana (see Box 5.12).

MAXIMISING BIODIVERSITY CO-BENEFITS OF REDD AT NATIONAL AND LOCAL LEVEL

As noted, biodiversity co-benefits can be maximised if REDD activities are implemented in areas of high carbon and high biodiversity benefits. Identifying suitable areas requires tools to assess where these benefits occur geographically and are spatially correlated. By mapping where these benefits overlap, governments and/or private-sector investors can capture two environmental

Box 5.12: Funding initiatives to address deforestation

National donor activities

- the Norway Forest Fund, which has committed US$ 2.8 billion over five years from 2008;
- the Japanese Government's Cool Earth Partnership designed to support adaptation to climate change and access to clean energy, which includes forest measures; US$ 2 billion per year from a US$ 10 billion fund is allocated for adaptation measures;
- the Australian Deforestation Fund, aimed at reducing deforestation in the Southeast Asia region, with funds of AUS$ 200 million; and
- the German commitment of 500 million EUR/year for biodiversity.

Source: adapted from The Prince's Rainforests Project, http://www.rainforestsos.org/ and http://www.mofa.go.jp/policy/economy/wef/2008/mechanism.html

Beneficiaries

- the Congo Basin Fund, supported by Norway and the UK, with funding of US$ 195 million;
- Brazil's Fund for the protection of the Amazon rainforest has received a commitment for an initial US$ 130 million from Norway (drawn from the Norwegian Forest Fund).

Source: adapted from The Prince's Rainforests Project, http://www.rainforestsos.org/

Emergency funding

The Prince's Rainforests Project has proposed an emergency global fund to protect rainforests, financed by a public-private partnership in developed countries which could include issuing Rainforest Bonds. The aim is to raise around £ 10 billion per year. An international working group was formed in April 2009 with G20 support to study a range of proposals.

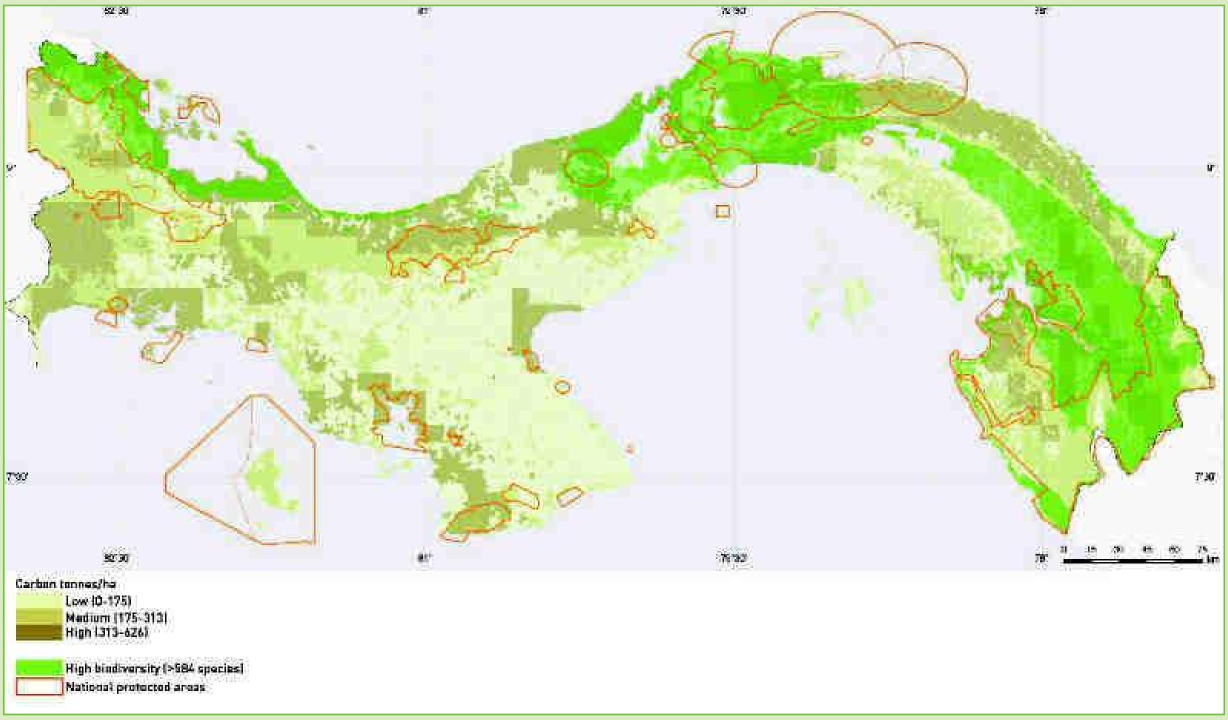
Source: http://www.rainforestsos.org/pages/emergency-package/

Reforestation registered under the UNFCCC Clean Development Mechanism (CDM)

Eight forestry projects have been registered under the CDM. The first African project registered is the Nile Basin Reforestation Project, undertaken by Uganda's National Forestry Authority in association with local community organisations. The project in the Rwoho Central Forest Reserve will generate up to 700 local jobs and receive revenues from the World Bank BioCarbon Fund for planting pine and mixed native tree species on degraded grasslands. It is designed to deliver co-benefits for livelihoods, greater climate resilience and biodiversity (through reduced pressure on the country's remaining native forests).

Source: World Bank Press Release No:2010/093/AFR. http://beta.worldbank.org/climatechange/news/uganda-registers-first-forestry-project-africa-reduce-global-warming-emissions

Figure 5.8: National carbon and biodiversity map for Panama



Source: UNEP-WCMC 2008: 15

services for the price of one. For example, the **Carbon and Biodiversity Demonstration Atlas** (UNEP-WCMC 2008) includes regional as well as national maps for six tropical countries showing where areas of high carbon storage coincide with areas of biodiversity importance (see Figure 5.8).

This example illustrates the variety of different approaches for identifying high biodiversity areas at a regional scale. UNEP-WCMC uses six indicators for biodiversity: biodiversity hotspots, endemic bird areas, amphibian diversity, global 200 terrestrial ecoregions, global 200 freshwater ecoregions and centres of plant diversity. Areas of 'high biodiversity' are those where at least four indicators overlap, with areas in dark green indicating a greater degree of overlap.

Spatial tools of this kind can help governments and potential private sector investors to identify and prioritise REDD activities. Further work is needed to establish similar maps based on national biodiversity data combined with greater spatial understanding of the economic values of biodiversity and ecosystem service benefits. Spatially-explicit cost-benefit analysis involves:

- identifying areas with high carbon storage/sequestration and biodiversity benefits (ideally, also areas with high carbon storage that are important providers of other ecosystem services);
- identifying areas of high risk of deforestation and forest degradation;
- evaluating the opportunity costs of alternative land uses and development pathways.

The more cost-effective the strategy for targeting biodiversity co-benefits, the greater will be the results from available budgets. However, as noted, leakage and additionality issues within and between countries need to be assessed when choosing target areas and measures should be put in place to avoid other problems (e.g. illegal logging, reforestation with non-native species). This calls for a policy mix that integrates REDD-Plus, new Protected Areas (PA) designations/investments, improved regulation and enforcement as well as development of markets for certified forest goods (see Section 5.5 below).

If successful, such approaches could free up existing biodiversity financing (e.g. from ODA and/or developing country government budgets) currently invested in high carbon/high biodiversity areas. These sums could then be re-directed to target biodiversity conservation in high biodiversity/low carbon areas, delivering additional benefits.

5.2.3 MARKETING BIODIVERSITY BENEFITS ALONGSIDE REDD

It is possible to go beyond capturing biodiversity co-benefits through REDD to create biodiversity-specific incentives. REDD payments could in theory be layered with payments for other forest-related ecosystem services or for biodiversity benefits directly (see Figure 5.6). Measures to address leakage and ensure additionality, discussed above, should also be applied to such initiatives.

The UNFCCC Bali Action Plan called for **REDD demonstration activities** to obtain practical experience and share lessons learnt. Such activities are in the early stages of design and implementation but can eventually contribute to good practice guidance for a future REDD mechanism[15]. They provide policy makers with an important opportunity to promote approaches that maximise biodiversity co-benefits in REDD as well as associated monitoring, reporting and verification processes to assess biodiversity performance over time.

REDD demonstration activities and voluntary agreements that can support REDD are already underway. They provide preliminary insights and emphasise the need to provide alternative livelihoods to communities that depend on forests, improve governance and clarify land tenure (see Box 5.13).

Current initiatives that are considering biodiversity in REDD activities include the World Bank Forest Carbon Partnership Facility (FCPF) which has incorporated biodiversity considerations in its REDD Readiness Fund. REDD country participants are required to submit a Readiness Preparation Proposals (R-PPs, formerly named 'R-Plan') that includes measures to deliver and monitor multiple benefits as part of national REDD strategies, including but not limited to biodiversity, poverty reduction and benefit sharing.

The UN-REDD Programme also supports multiple benefits through e.g. consultations with pilot countries; spatial analyses of the relationship between carbon storage, biodiversity and ecosystem services in forests; and the development of tools to assist decision-makers in promoting synergies, addressing conflicts and managing trade-offs.

Finally, in the **voluntary carbon market**, several initiatives already bundle carbon and biodiversity benefits. These take the form of voluntary premiums for REDD credits that provide additional biodiversity benefits[16] and include the Climate, Community and Biodiversity Alliance (CCBA), Plan Vivo, CarbonFix, Social Carbon and the California Climate Action Registry (see Karousakis 2009 for further information). For example, the CCBA has established voluntary standards for forestry projects, including REDD demonstration activities. The criteria relevant to biodiversity are: 1) net positive biodiversity impacts; 2) offsite biodiversity impacts; and 3) biodiversity impact monitoring. Projects are audited by independent third party certifiers and each project is subject to a 21 day public comment period.

5.2.4 DIRECT INTERNATIONAL PAYMENTS FOR GLOBAL ECOSYSTEM SERVICES

"The conservation of many ecosystems suffers from the fact that the costs of preservation are borne locally, but its benefits are often enjoyed globally"

"A mechanism needs to be devised to compensate societies that preserve the global commons."

UNEP Global Green New Deal policy brief, March 2009

"Cui bono?" (Whose benefit?)

L. Cassius Longinus Ravilla, Roman censor

This section provides an overview of emerging mechanisms that specifically address biodiversity as a global public good and create incentives for the preservation of global ecosystem services.

Box 5.13: Example of a multiple-benefits REDD project in Madagascar

Background: Less than 15% of Madagascar's land area remains forested, having lost about half of its forest cover since 1953 with much regional variation (Hanski et al. 2007); for instance, most of the coastal lowland forests have been cleared. Recently, unprotected natural forest was lost at a rate of 0.65% annually in the period 2000-2005 (MEFT; USAID and CI 2009). The Ankeniheny-Mantadia-Zahamena corridor project in east-central Madagascar is designed to protect some of the last remaining low and mid-elevation primary rainforest.

Project design and goals: The project targets the delivery of multiple benefits for biodiversity, human livelihoods and climate change mitigation. It is structured to take advantage of carbon financing from the emerging voluntary and compliance markets through the sale of emissions reductions from REDD. Endorsed by the government in 2004 and developed with NGO support led by Conservation International (CI), the project provides for the creation of a new protected area. Its objectives combine protection against deforestation with reforestation of targeted sites to restore habitat connectivity, enhancing local resource management capacity (approximately 315,000 people live in 30 surrounding communes) and endemic species conservation.

Project governance and funding: The Environment Ministry acts as project manager, protected area administrator and 'vendor' of the carbon offsets created through REDD and reforestation activities. Communities and NGOs are organised into Local Management Units, federated within sectors, and ultimately report to the Ministry. CI and the World Bank's BioCarbon Fund (BioCF) provide the technical expertise and financial support to access carbon finance mechanisms, including future application of REDD carbon accounting methodology and monitoring emissions reductions.

Because carbon finance is rarely able to cover high start-up and transaction costs in forest carbon projects, the project combined carbon-credit purchase commitments and project support from the BioCF with targeted biodiversity investments from CI and the government and community development funding through USAID and the World Bank.

Source: personal communication Olaf Zerbock and James McKinnon, Conservation International

BIODIVERSITY AS A GLOBAL PUBLIC GOOD

As underlined throughout this report, biodiversity and ecosystem services provide critical inputs to local and national societies in terms of production, cultural values and recreational amenity. However, **biodiversity is also a global public good** which merits international cooperation and support for its conservation, restoration and management in its own right.

The supply of public goods usually falls to government as such goods are by definition non-excludable and non-rival: this makes it hard for business or individuals to profit from producing them. Recognising biodiversity as a global public good implies that governments have a role to ensure its international provision, either by creating conditions for organisations, businesses and individuals to undertake larger-scale and more effective conservation or by taking on this task themselves.

There are good reasons for governments to invest in natural capital and ecosystem services beyond their national borders or to devise international payments for ecosystem services (see also Chapters 9 and 8):

- **global benefits derive from biodiversity** and from local, regional and international ecosystem services, notably non-use values. These need to be made explicit and reflected in government policies;
- efforts to reduce biodiversity loss will require particular efforts from biodiversity-rich developing

countries, many of which cannot easily afford the investments required. Significant and sustained support from developed countries is needed to **underpin economic development without global environmental impoverishment**;

- importing primary commodities into developed economies without internalising their full environmental costs may be seen as **exporting environmental pressure to other countries**. Alongside continuing efforts to internalise environmental costs, consistent with the polluter pays principle, mechanisms to compensate or avoid negative environmental impacts abroad could decrease pressure and buy time to make the shift to more sustainable production.

In addition to carbon sequestration and capture (see Section 5.2.2 on the REDD mechanism), other global contenders for IPES schemes include **nitrogen deposition, bioprospecting (see Section 5.3 below on Access and Benefit Sharing), water and rainfall regulation and global cultural services provided by species and natural areas**. These are all key examples of locally provided ecosystem services with far-reaching benefits.

Biodiversity provides additional global public benefits in the form of non-use values. These can be divided into option values, bequest value, existence value and intrinsic value (see Chapter 4). Such values are not limited to a specific region or country; many have international values and some also global values. Next to the global direct and indirect use values described above, they are a fundamental reason for international and intergovernmental cooperation to ensure the conservation and sustainable use of biodiversity.

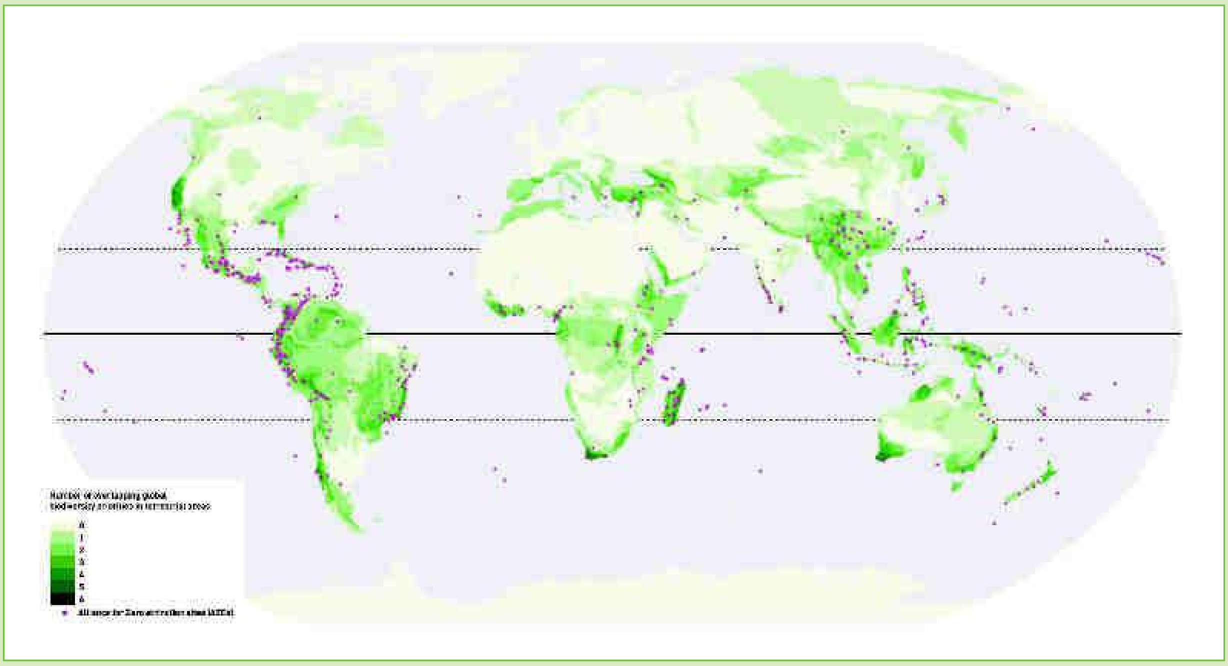
In spatial terms, ecosystem use and provisioning are unevenly distributed throughout the world. This is the case for important use values (e.g. agricultural harvests are more abundant in certain regions), cultural values (e.g. charismatic species are found only in certain locations), carbon storage (see Kapos et al. 2008) and biodiversity-rich areas. This unequal distribution is partly a consequence of past human development paths and population movements and partly due to natural endowments and climatic conditions.

Projected biodiversity loss is particularly high in developing countries, many of which are burdened with other priorities like combating poverty and providing education, jobs and economic development (see Figure 5.9 for comparative maps of biodiversity risk areas and the human development index). Developed economies have a co-responsibility to protect global public goods by assisting developing countries to conserve biodiversity. In the short run, sustainable management and conservation will not take place without significantly more investments in the countries where the brunt of projected biodiversity loss will take place.

Biodiversity's role in the global economy is clearly revealed by the interdependency of countries through regional and international trade. Many countries import a high proportion of their primary consumption products, which ultimately derive from ecosystems. **Ecosystem services important for international production should be managed on a long-term basis and protected by appropriate laws. Environmental costs should be internalised in the prices of products that are traded internationally as well as nationally.** Green purchasing criteria, standards and public procurement (see Sections 5.5 and 5.6) are examples of mechanisms that can encourage exporters to internalise environmental costs.

Figure 5.9: Comparative maps of biodiversity hotspots and major wilderness areas and the UN's Human Development Index (HDI)

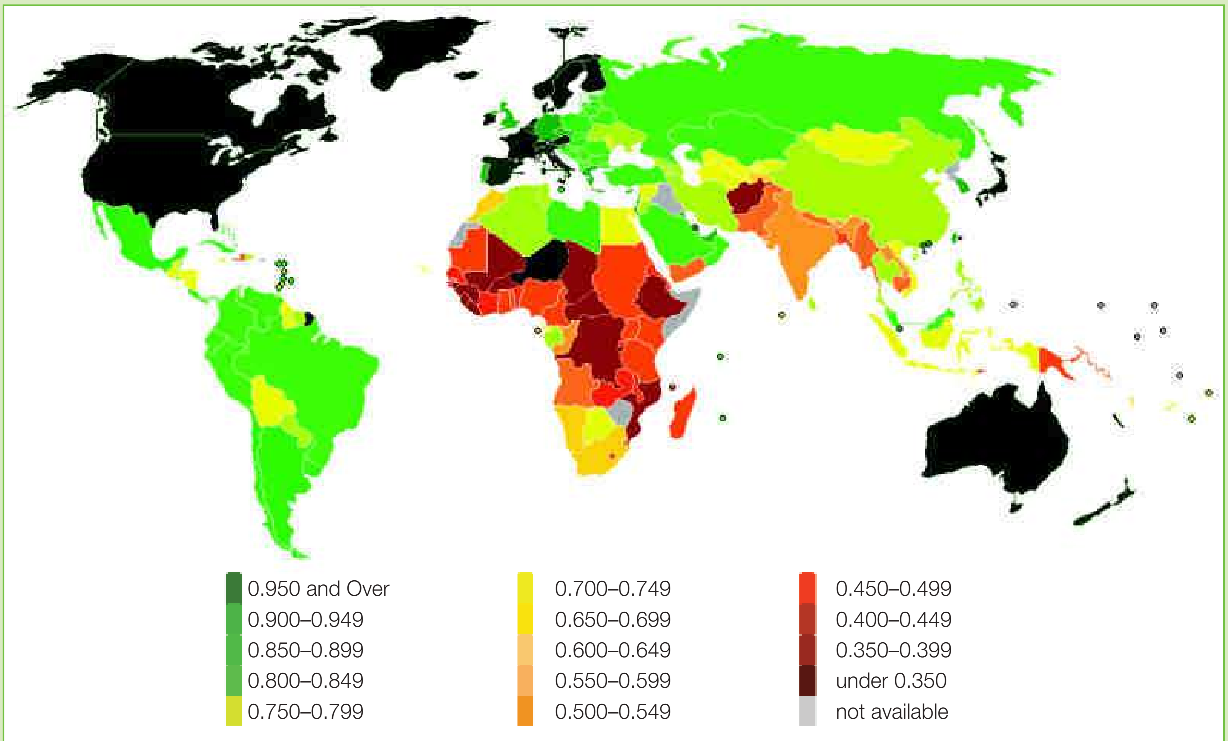
(i) Global Biodiversity 'priority areas' map



Key: this map builds on Conservation International's Hotspots, WWF's Global 200 ecoregions, Birdlife International Endemic Bird Areas (EBAs), WWF/IUCN Centres of Plant Diversity (CPDs) and Amphibian Diversity Areas plus Alliance for Zero Extinction (AZE) sites

Source: Kapos et al. 2008: 7

(ii) Human Development Index (HDI) map



Source: UNDP 2009: 16

Box 5.14: Think PINC – the 'Proactive Investment in Natural Capital' proposal

"We propose that a new mechanism of Proactive Investment in Natural Capital (PINC) is created to promote adaptation in existing protected areas and standing forests that may not benefit directly from REDD funds."

Trivedi et al. (2009)

PINC, proposed by the Global Canopy Programme, seeks to act as a complementary funding stream to a REDD mechanism for large areas of standing forests that are not immediately threatened or may not benefit from REDD (depending on its design and implementation). It recognises the immense value of tropical forests in monetary and non-monetary terms and calls for a mechanism to reward the function of large areas of forests as global providers of multiple ecosystem services beyond carbon storage (e.g. biodiversity protection, rainfall generation, water supply regulation and atmospheric cooling, which are likely to become increasingly important as a result of climate change).

Source: Trivedi et al. 2009

SHAPING IPES AND GLOBAL INVESTMENT IN BIODIVERSITY

Different approaches for international transfers for biodiversity conservation and for mobilising international investment in natural capital have been proposed. Boxes 5.14 and 5.15 describe some recent ideas and initiatives.

Without the means to make a global ecosystem service 'excludable' – i.e. limiting its use by non-paying benefactors – alternative ways must be found to create demand for investment in such services. This argument also applies to international agreements on access and benefit sharing (see Section 5.3 below). Global targets for contributions to biodiversity conservation can be used to determine burden sharing and/or market mechanisms can offer countries the option to deliver certain ecosystem services in a more cost-efficient way (e.g. Tradable Conservation Obligations, see Box 5.15).

Whatever approach is taken, **international agreements supported by national legislation are likely to be needed to ensure sustainable long-term financing for global biodiversity. Governments should seek ways to engage the private sector and to create appropriate incentives for business to reduce adverse impacts and invest in biodiversity and ecosystem services**.

Box 5.15: Stimulating international demand for biodiversity through a Green Development Mechanism

The Dutch Ministry of Housing, Spatial Planning and the Environment (VROM), the International Union for Conservation of Nature (IUCN) and the United Nations Environment Programme (UNEP), in cooperation with the CBD Secretariat, are facilitating expert discussions ahead of CBD COP-10 (Nagoya 2010) on new international incentives for biodiversity. The **Green Development Mechanism (GDM)** initiative seeks to create a global mechanism to stimulate demand for the preservation and sustainable use of biodiversity and to mobilise new and sustained financial support.

A range of different potential instruments are being explored. Tradable Conservation Obligations are one way in which countries could commit to contribute to certain biodiversity conservation targets, within national borders or abroad (hence 'tradable'). Other ideas include footprint compensation measures (e.g. donation levels that use footprint as one of a mix of indicators) and coordination of biodiversity offset obligations (eg 'no net loss' commitments) at the international level.

See also: Swanson 2009; Swanson, Mullan and Kontoleon 2009

5.3 THE ECONOMICS OF ACCESS AND BENEFIT SHARING (ABS)

"My father said: You must never try to make all the money that's in a deal. Let the other fellow make some money too, because if you have a reputation for always making all the money, you won't have many deals."

J. Paul Getty

This section looks at economic factors that influence the value of genetic resources (5.3.1) and considers ways to overcome current constraints on maximising such value (5.3.2). This is a key issue to those who own genetic resources or involved in land use decisions that affect them. Typically such groups are made up of relatively poor rural farming or indigenous communities. Benefits from genetic resources could play an important role in improving their livelihoods as well as stimulating better use of stocks of genetic materials. The resulting gains could thus be spread more widely between developing and developed countries.

A key CBD objective is the fair and equitable sharing of benefits arising from the utilisation of genetic resources. Following the call for action by Heads of State at the World Summit for Sustainable Development (Johannesburg, 2002), negotiations are now under way within the CBD to develop a dedicated international regime to implement relevant provisions of the Convention (see 5.3.3 and 5.3.4 below).

5.3.1 THE VALUE OF GENETIC RESOURCES

Genetic resources provide source material for a range of commercial products from mainstream pharmaceutical to botanical medicines, new seed varieties, ornamental horticultural products, new enzymes and microorganisms for biotechnology, crop protection products and personal care and cosmetic products. Table 5.2 presents data on the estimated size of the market for these product categories and the percentage derived from genetic inputs to provide an indication of the economic value of activities dependent on genetic resources.

A key question in the ABS context is **how much of the**

Table 5.2: Market sectors dependent on genetic resources

Sector	Size of Market	Comment
Pharmaceutical	US$ 640 bn. in 2006	25-50% derived from genetic resources
Biotechnology	US$ 70 bn. in 2006 from public companies alone	Many products derived from genetic resources (enzymes, microorganisms)
Crop protection products	US$ 30 bn. in 2006	Some derived from genetic resources
Agricultural seeds	US$ 30 bn. in 2006	All derived from genetic resources
Ornamental horticulture	Global import value US$ 14 bn in 2006	All derived from genetic resources
Personal care, botanical and food & beverage industries	US$ 22 bn. for herbal supplements US$ 12 bn. for personal care US$ 31 bn for food products All in 2006	Some products derived from genetic resources. Represents 'natural' component of the market.

Source: SCBD 2008

value of final products is attributable to genetic material and how much to other factors of production (labour, capital, local knowledge et al.)? To answer this, we need to distinguish between:

- what a producer of drugs or other products has to pay to obtain the genetic material; and
- what the material is worth to the producer (i.e. the maximum that a company would pay).

The **difference between this maximum payment and the cost of obtaining the genetic material is called its 'rent'**. Questions asked in the literature sometimes relate to the cost of exploitation and sometimes to the rent. It is important not to confuse the two. The costs of obtaining genetic material are paid to relevant parties in proportion to their effort whereas the rent can go to either party (i.e. the company that uses the material or the party that provides it). This sharing needs to be carried out in a way that is fair and equitable (see Section 5.3.3).

The economic rent is calculated by taking the value of the final product and subtracting the costs of development, production and collecting and classifying the genetic material. These calculations are complex as research development is an uncertain activity: some return has to be provided to compensate for the riskiness of the venture. Furthermore, since most numbers involved are large and the rent is the difference between them, the calculations are obviously affected by even small errors in the numbers.

Several estimates of economic rent have been made to date. To the dismay of those who believe that genetic resources are a global resource of high value, these estimates come out rather low. A key early study (Simpson et al. 1996) calculated values of genetic resources in 1996 prices at between US$ 0.2/hectare (California), and US$ 20.6/hectare (Western Ecuador) and argued that these estimates could be on the high side. Other studies making the same point include Barbier and Aylward (1996) and Frinn (2003). Reasons identified for values being so low included the **high cost of developing the final goods and bringing them to market, the long time lags involved and inefficiencies in the systems for exploiting genetic resources**.

Subsequent studies have tried to improve on these estimates. Craft and Simpson (2001) argued that if we base calculations not on the price of final drugs but on the willingness to pay of those who benefit from lifesaving drugs, the rent could be two orders of magnitude higher than the above estimates. However, this raises the question of how (and also whether) to capture higher use values. Massive increases in the price of drugs would exclude many poorer users and could hardly be described as a fair division of the benefits of genetic resources.

There are now far more uses of genetic resources than covered in Simpson et al. (1996) which should increase their net value. Finding more effective and cost-efficient ways to collect information about and screen genetic materials can also increase the rent. Rausser and Small (2000) estimated the possible increase as equal to one order of magnitude higher than the estimates in Simpson et al. (1996). Although Rausser and Small's estimate has in turn been criticised (Costello and Ward 2006), there is no doubt that lowering transaction costs should increase the economic rent (see Section 5.3.2).

For developing countries, one constraint on increasing the value of genetic material is the growing importance of micro-organisms for which the tropics are not an especially important source. However, this is not always the case as companies collecting from nature continue to be interested in samples from diverse and extreme environments (sCBD 2008). The need to develop strong partnerships with providers as a way of monitoring development of natural product compounds is as strong as ever.

Current arrangements for sharing whatever rent exists are not particularly favourable to communities living in the area where genetic resources are located. Several agreements made in the 1990s to share the benefits of products derived from such resources attracted considerable attention. Reviews of eight of the most important[17] showed that:

- most contained an element of royalty-sharing;
- their duration varied from two to eleven years;
- some required the bio-prospector to contribute financially to biodiversity protection in the region; and

- some contained an element of technology transfer to develop local preparation and screening capabilities;
- the financial resources involved in these transactions were relatively small (see Box 5.16).

Although a comprehensive assessment of the transfers actually made ex post is not available, it is unlikely to amount to more than a few million dollars over the duration of each contract. Even if we accept the lowest estimates of the value of these resources, the total amount of economic rents paid should be higher than paid to date.

Although more socially responsible companies would no longer consider genetic resources as available for free, it is very likely that a significant amount of bioprospecting still takes place without prior informed consent as required under the CBD. In such cases a fair share of the rent is not passed back to the owners or managers of genetic resources. It would be useful to make an estimate of the total payments actually made for access to such resources and how this figure has evolved over time. To our knowledge, no such estimate yet exists.

5.3.2 ADDING VALUE THROUGH MORE EFFICIENT BIOPROSPECTING

Considerable efforts have been made to understand how agreements for the exploitation of genetic resources could be made more efficient. Contractual and institutional frameworks are evolving and lessons learnt from the first generation of contracts can improve the design of future agreements. This section considers ways to lift or reduce institutional and market constraints that limit the value of such resources, including steps to minimise transaction costs whilst retaining flexibility.

BETTER SCREENING OF GENETIC MATERIALS

Asymmetric and incomplete information about materials of interest is still an obstacle to contract development. On the technical side, positive deve- lopments include more efficient scientific and technological tools for screening and use of specialist intermediaries to carry out these activities, leading to better up-front information and lower costs for product developers. The bioprospecting industry is steadily moving in this direction: most large companies are forming partnerships with smaller companies and universities that generate leads from research into natural products (sCBD 2008). This trend should increase the rent from genetic resources, part of which needs to revert to the communities where the resources are located.

Technological progress should be accompanied by increased resources for collection and classification of materials. In developing countries, this is still mainly

Box 5.16: Examples of benefit sharing and payments under bioprospecting contracts

Costa Rica: The best known and emblematic contract was signed between INBio (National Biodiversity Institute) and Merck Pharmaceutical Ltd. in 1991. INBio received US$ 1 million over two years and equipment for processing samples and scientific training from Merck.

Source: http://www.biodiv.org/doc/case-studies/abs/cs-abs-tbgri-in-en.pdf

Brazil: In 1999, Glaxo Wellcome and Brazilian Extracta jointly signed a contract where Glaxo paid US$ 3.2 million for the right to screen 30,000 compounds of plant, fungus and bacterial origin from several regions in Brazilian forests.

Source: Neto and Dickson 1999

India: Scientists at the Tropical Botanical Garden and Research Institute (TBGRI), a publicly funded research institute based in Trivandrum, worked with the Kani tribals of Kerala to obtain traditional knowledge about medicinal use of the plant Arogyapaacha (Trichopus zeylanicus). TBGRI successfully developed a drug from the plant and sold the technology to a Coimbatore-based pharmaceutical company which agreed to pay Rs. 1 million and a 2% share in the royalty. These proceeds are being shared equally by TBGRI and the tribal community.

Source: http://www.biodiv.org/doc/case-studies/abs/cs-abs-tbgri-in-en.pdf carried out by relatively inefficient public sector institutions strapped for funds. However, such work does not have to be carried out exclusively by public bodies. It could be made a fee-based service involving the private sector: creation of an intermediary market for such services would improve bioprospecting efficiency and increase the net value of resources.

BETTER USE OF TRADITIONAL KNOWLEDGE

Reliance on traditional knowledge about the properties of local plants and other species is currently small and seems to be growing smaller. This may be partly due to the emphasis in drug development on disease categories that do not feature prominently in traditional medicine and partly to the increasing role of micro-organisms and diminished role of plants in discovery (sCBD 2008: 106). Nevertheless, many researchers believe that such knowledge can help in new product development but that the process is hampered by the lack of appropriate mechanisms to document and transfer it and to reward information providers[18].

It has been argued that recognising intellectual property rights (IPRs) for traditional knowledge would increase incentives to use them to protect genetic resources. However, establishing IPRs requires proof of novelty, discovery and innovation – which rules out their application to genetic resources.

An alternative way to address this issue is through contracts that require product developers to share the benefits in proportion to the information provided and used. Currently we have no mechanism for determining benefit share in the event of a dispute. One proposal, to get round this problem, albeit one with obvious shortcomings, is to offer traditional knowledge owners specific rights recognised by the courts in countries where the development of relevant materials takes place (Sarr and Swanson 2007).

The creation of such rights, if upheld by the competent courts, could lead to a situation where the 'North' offers contracts that the 'South' is likely to accept. However, the design and enforcement of such rights could take many forms – from private international law alone (where the key issue would be the content of the ABS contract) to more forceful mechanisms to prove claims (i.e. the proposed international certification of origin currently under consideration in CBD-led negotiations: see Section 5.3.4). Such certification could be voluntary or mandatory and apply not just to traditional knowledge but to genetic resources more widely. Reaching agreement within this range is still a contentious issue within the negotiations.

IMPROVING CONTRACT DESIGN

Typically, sellers (usually public institutions) supply screened samples, novel compounds and research leads derived from their field collections. They are responsible for obtaining permission to access genetic resources and/or traditional knowledge, which requires them formally or informally to negotiate with source suppliers[19] before conducting field collection. Sellers also collaborate with companies on development and commercialisation of these resources, which may entail separate contracts or other agreements with private companies.

Buyers[20] are usually engaged in industries carrying out research and development (R&D) into commercial applications of genetic resources. Although these span several sectors, the pharmaceutical industry undoubtedly represents the largest market, invests a higher proportion of turnover in R&D than other industries and incurs higher risks in the drug discovery and development process. Pharmaceutical companies thus play a crucial steering role in driving efficiency gains in bioprospecting contracts.

The most important provisions of genetic resource contracts relate to:

- sharing of royalty revenues in cases where the company patents a new discovery (e.g. a medicinal drug) derived from R&D involving the genetic material sold in the contract;
- transfer of R&D technology and screening capabilities to local institutions and/or local capacity-building and training;
- the structure of the financial agreement: in addition to royalties and technology transfer, this includes up-front payments and milestone payments;
- possible financial contribution by the buyer to protect local biodiversity e.g. through partial transfer of the royalty revenues; and

- ancillary provisions e.g. possible common use of the resource and/or whether exploitation rights are exclusive or not.

EXTENDING THE LENGTH OF CONTRACTS

Bioprospecting activities, especially in the pharmaceutical industry, are characterised by high:

- **asset specificity**, in particular site-specificity (particular genetic materials are sited in particular locations) and dedicated assets (companies invest in bioprospecting to exploit the possibility of patenting new discoveries) (Williamson 1979)[21];
- **uncertainty**: firms investing in R&D are unsure about the probability of new discoveries (Williamson 1979); and
- **complexity**: the activity generates several (positive and negative) impacts on biodiversity exploitation, research, innovation, corporate competitiveness and wealth redistribution.

Long-term contracts represent a way to minimise transaction costs[22] linked to the above factors or to

Source: Getty Images.

bureaucratic and administrative constraints (e.g. generated by procedures such as public tenders or authorisations in countries exercising sovereign rights over biodiversity within their jurisdiction). Minimising such costs is important to provide incentives for companies to invest in R&D and to share benefits in accordance with CBD provisions.

Specific areas where there may be scope for improvement include:

- building a high level of trust between the parties, given the complexity of the issue and the impossibility of monitoring all aspects related to agreements (as in Section 5.2 above); and
- instituting facilities for tracking benefits and resolving disputes across jurisdictions to make royalty sharing agreements enforceable. As with traditional knowledge, this will need inter-governmental cooperation.

5.3.3 EQUITABLE SHARING OF BENEFITS DERIVED FROM GENETIC RESOURCES

Equitable sharing of benefits is desirable not only on equity grounds, but also because it ensures more effective management of genetic resources.

Traditional economics states that market institutions determine the efficient allocation of resources and the issue of equity can be left to policy makers. If applied to the context of genetic resources, this would mean that it did not matter who received what proportion of the rent from their exploitation: the market structure would ensure that materials were exploited and conserved optimally.

However, recent literature shows that the traditional divide between equity and efficiency does not hold in this field (Gatti et al. 2004; van Soest and Lesink 2000)[23]. Genetic resource contracts negotiated between corporations and institutions in provider countries are very different from atomistic market transactions. A better way to analyse their outcomes is to use empirical results from game theory experiments which strongly suggest that the final outcome depends on the perception of fairness by the respective parties. People prefer no deal to a deal they think is unfair (based on results from ultimatum games where one party offers a contract on a take-it-or-leave-it basis). They may even opt for 'strategic destruction' when offered a bad deal (for an application to TRIPs and biodiversity, see Gatti et al. 2004).

The benefits of bioprospecting should thus be shared in such a way that rural and indigenous communities in developing countries (where most genetic material of interest is located) receive a fair and equitable proportion of the value derived from its exploitation. This will not only contribute to improved living standards for the poor but also increase incentives to conserve remaining biodiversity.

How can this be done? Suggestions include:

- forming a cartel to negotiate on behalf of all owners of such resources i.e. like the Organization of the Petroleum Exporting Countries (OPEC) on behalf of global oil producers[24]. Like all cartels, this might succeed in obtaining a higher share of the rent from exploitation of genetic materials but also be unstable with strong incentives to undercut the agreed price (e.g. the price of crude oil has fluctuated since 1974, when the cartel started restricting supply);
- giving providers of genetic resources and associated traditional knowledge specific rights in the courts of countries where such material is developed. As noted above, this is a complex area and the appropriate structure is not self-evident. Well-designed benefit-sharing contracts and/or internationally recognised certificates of origin would clearly be crucial; and
- increasing the share of development undertaken in provider countries e.g. by locating some of the emerging partnerships between large corporations and smaller companies and universities in developing countries and working closely with local source providers.

Finally, we need to recognise that greater transparency and knowledge about the value derived from genetic materials will make it easier for all parties to reach an equitable accord. At present the rent derived from such materials is still somewhat obscure, with some researchers claiming that overall rent is small. No-one has really estimated how much goes to each of the parties. **More research on what the rent is – and how it is being shared at present – should help make the case for larger transfers to provider countries.**

5.3.4 TOWARDS AN INTERNATIONAL REGIME ON ABS

Many of the activities identified above will require coordinated international action. From this perspective, the successful conclusion of current negotiations under the CBD for an international ABS regime could make a critical contribution in the following areas:

Short to medium term:

- facilitating capacity building and the transfer of resources where necessary to improve efficiency in genetic resource management e.g. through the establishment of companies that undertake more of the intermediate work related to product development (screening, classification, primary investigation of materials to discover leads);
- strengthening compliance and monitoring frameworks to ensure fair and equitable sharing of the benefits through the implementation of prior informed consent (PIC) and mutually agreed terms (MAT) agreements;
- ensuring that ABS agreements cover all fields of use of genetic resources (i.e. are not focused solely on pharmaceuticals).

Medium to long term:

- improving knowledge generation/exchange and dissemination of pertinent information on e.g. the accurate value of genetic resources; the rent available to be shared between resource providers and developers; analysis of the link between equitable distribution of rents and their efficient management; and so on.

5.4 TAX AND COMPENSATION MECHANISMS TO REWARD STEWARDSHIP

Economic instruments have a central – indeed indispensable – role to play in valuing nature's public services to society (OECD 1999; Bräuer et al. 2006; Emerton et al. 2006; EC 2007). These services can be targeted by a range of policy instruments including levies (5.4.1), intergovernmental fiscal transfers (5.4.2) and government spending (5.4.3) (Ring 2002).

Fiscal instruments to safeguard ecosystem services and biodiversity are part of the agenda for ecological tax reform (Meyer and Schweppe-Kraft 2006; Ring 2008a). Such instruments could be used more widely to provide incentives for conservation and to raise funds for conservation (OECD 1999; Emerton et al. 2006: 39). Such tools are also central to social policy, including the redistribution of wealth and income – making them especially **suitable for combining biodiversity and ecosystem conservation with poverty reduction** (OECD 2005; World Bank 2005).

5.4.1 USING PUBLIC LEVIES TO STIMULATE CONSERVATION

As highlighted in this report, **the value of biodiversity and many ecosystem services cannot always be captured by market mechanisms alone**. Economic instruments such as taxes, charges and fees – as well as targeted exemptions from these instruments – are a crucial element of the policy maker's toolkit and complement regulation (see Chapter 7), direct payments for services (PES, see Section 5.1 above) and voluntary approaches from certification, informal codes of conduct to non-binding agreements[25]. Economic instruments can provide strong incentives for more sustainable behaviour by citizens, businesses and even governments themselves – if they are well-designed and based on relevant indicators.

Although **land, property and income taxes have considerable potential to integrate and reward ecological concerns**, they are rarely used for this purpose. Tax systems can provide a number of options to reduce existing tax burdens, either through credits or exemptions. A tax exemption can function like a PES to reward positive conservation efforts: the difference is that the PES is a direct payment for a service whereas the exemption is effectively a non-payment (of moneys that would otherwise be due as tax). Even if the financial outcome is similar, the instrument design is different and so, often, is public perception. Some see tax breaks as a form of 'thanks for efforts' that are preferable to payments for services rendered, although in economic terms they may be equivalent.

Tax exemptions or credits can be used to reward landowners who undertake biodiversity conservation or agree to forego future development in order to safeguard habitats (Boyd et al. 2000). Such exemptions take many forms and are found in a range of jurisdictions (Shine 2005). Familiar examples include conservation easements and tax incentives for land donation for conservation (see Box 5.17).

Tax incentives are not limited to gifts of property or interests therein. In the Netherlands, for example, savers and investors are exempt from a capital gains tax if they invest in specified green projects or capital funds (Box 5.18).

5.17: Tax incentives for conservation easements and ecological gifts in North America

An easement is a legally binding restriction placed on a piece of property to protect its resources (natural or man-made) by prohibiting specified types of development from taking place on the land. It may be voluntarily sold or donated by the landowner.

United States: The US has long experience of using easements to secure long-term conservation of natural areas. They are currently used by over 1260 local and regional 'land trusts' or conservancies, which act as the easements' trustees. By 2000, land trusts had protected over 1 million hectares (nearly 2.6 million acres) through conservation easements — almost 500% up on 1990. Usage of this type of instrument has continued to grow. By 2005, land trusts held conservation easements on over 2.5 million hectares (6.2 million acres) and government agencies and national non-profit organisations also had sizable holdings under easement (Land Trust Alliance 2006).

The Nature Conservancy is the largest non-profit holder of conservation easements with 1.3 million hectares (3.2 million acres). The Natural Resources Conservation Service (NRCS) funded by the U.S. Department of Agriculture has responsibility for monitoring, managing, and conducting enforcement activities on approximately 11,000 conservation easements covering more than 800,000 hectares (2 million acres) (Risman et al. 2007).

Easements can be purchased or donated. Donations have been a big part of the story, motivated by the ability to reduce taxes and claim charitable deductions. Progressive changes in tax codes and development of appraisal techniques are practical developments that have encouraged their use, whilst easement contracts are fairly routine and straightforward to put together. Such instruments have played a role in helping people understand the public interest in conserving biodiversity values on private property – the whole reason for easements is that there are public goods arising from private lands.

Part of the explanation for the popularity of easements in the US is that environmental land use regulations are relatively weak, governed by municipalities rather than state and federal governments: private property reigns supreme, but landowners may donate or sell the public interests in their land. There may be less need for easements in countries with tighter land use restrictions and highly developed rights of public access e.g. in European countries such as Germany or the UK.

Key questions when designing easement contracts include their duration (perennity), monitoring and enforcement in order to avoid challenges to use/development restrictions arising as properties change hands over generations.

Sources: Boyd et al. 2000; http://www.nature.org/aboutus/howwework/conservationmethods/privatelands/conservationeasements/files/consrvtn_easemnt_sngle72.pdf

Canada: The Ecogift Programme was introduced in 2001. It provides tax benefits to owners of ecologically sensitive land if they donate it – fully or partially – to specified recipients who take responsibility for its sustainable management and conserving natural habitat. The list of possible recipients is strictly defined by legislation and includes the Federal Government, provincial or territorial governments, municipalities, municipal or public bodies performing government functions and charities approved by Environment Canada. The donor of the land (or the interest in the land) receives tax benefits in return:

- the total value of the ecogift from an individual donor may be used to calculate a non-refundable tax credit;
- the value of the gift can be directly deducted from taxable income of a corporate donor;
- capital gains are exempt from taxes.

Source: http://www.qc.ec.gc.ca/faune/pde-egp/avantages_e.asp

5.4.2 GREENING INTERGOVERNMENTAL FISCAL TRANSFERS

Public spending includes fiscal transfers between different levels of government – which are often neglected in conservation strategies. Huge amounts of tax revenues are redistributed from national to sub-national and local governments to provide the latter with monies to build and maintain schools, hospitals and roads and so on. These public finance mechanisms are critically important for local and regional decision-makers (see TEEB D2) but are rarely considered in terms of their ecological impact (Ring 2002).

Government spending at local, national and international levels needs to fully integrate biodiversity conservation and maintenance of ecosystem services. Integrating such concerns into systems for distributing tax revenues to lower levels of government can encourage decision makers to take more care of nature whilst also nurturing their tax base. Currently, however, tax incentives are mainly directed towards attracting more businesses, residents and construction activities which give rise to land uses that destroy or damage natural habitats (see Chapters 6 and 7) instead of setting incentives towards conservation (see Chapter 8).

Changing the economic signals can create win-win situations. By way of example, many federal authorities use the area of a municipality or province as one criterion for determining fiscal transfers – it is only a small step to include 'protected area' as an additional criterion for allocating tax revenues. This could help raise funds to address the local management and conservation objectives of protected areas (see Chapter 8) and reduce their image as a fiscal burden or obstacle to development. Positive effects will be even stronger if people living in and around these sites receive some of the benefits involved in ecological fiscal transfers: this could help to reduce local opposition to protected areas in some cases.

Decisions to establish protected areas are often taken by higher levels of government with local decision-makers having little influence on site selection. Including protected areas as a criterion for intergovernmental fiscal transfers could help to reconcile the local costs of protected areas with their benefits, which often reach far beyond municipal boundaries.

Box 5.18: 'Green Funds Scheme' in the Netherlands (Regeling groenprojecten)

The Scheme was set up to encourage projects that have a positive effect on the environment. The government offers a tax advantage to 'green' savers and investors, while banks can offer loans at lower interest rates for projects such as sustainably built houses, wind farms, developing forests or organic agricultural businesses. In the Dutch tax system, savers and investors normally pay 1.2% capital gains tax over the amount saved or invested. However, green capital is exempt from such tax, up to a maximum of 52,579 EUR per person (2006).

Source: http://www.senternovem.nl/greenfundsscheme/index.asp

A few countries have taken steps to introduce ecological fiscal transfers to compensate municipalities for land-use restrictions imposed by protected areas. Since 1992, several states in Brazil have introduced 'conservation units' (CUs), a protected area-based indicator, for the redistribution of value added tax from state level to municipalities (Grieg-Gran 2000). In January 2007, Portugal amended its municipal finance law to introduce ecological fiscal transfers to reward municipalities for designated EU Natura 2000 sites and other protected areas within their territories (De Melo and Prates 2007).

Using such criteria to redistribute tax revenues between different levels of government can help realign the incentives of public actors, as the Brazilian experience shows (see Box 5.19). However, care should be taken to ensure that such transfers are clearly linked to wider benefits and that higher levels of government do not end up assuming the burden of providing local goods and services (e.g. sewage disposal) that are normally provided by municipalities from their own resources.

As with PES schemes, **spatially explicit modelling and GIS tools can help illustrate the potential consequences of ecological fiscal transfers at the planning stage**. Fiscal transfer schemes are country-specific and politically sensitive, due to the substantial

Box 5.19: Ecological fiscal transfers in Brazil

12 out of 27 Brazilian states have adopted the 'ICMS[26] Ecológico' (see map) and others are preparing relevant legislation. Different states have implemented different ecological indicators for redistribution of state value added tax income to municipalities but all use Conservation Units (CUs) as the ecological indicator related to PA categories for biodiversity conservation.

Paraná was the first state to introduce the ecological ICMS, in 1992. 2.5% of the amount distributed at local level is allocated according to the quantity and quality of CUs; another 2.5% considers water protection areas within a municipality's territory. By the year 2000, CUs had increased by 165% and municipalities with larger shares of protected areas had considerably benefited from increased revenues.

Source: May et al. 2002; Ring 2008b

Box 5.20: Modelling intergovernmental fiscal transfers for conservation in Germany

This model of Saxony's fiscal transfer system from state to local level is based on administrative, social and economic data from 2002. It has been enlarged by the conservation units (CU) indicator to take account of local ecological services whose benefits cross municipal borders. CUs are standardised areas within the borders of a municipality that belong to existing categories of protected areas defined by Saxony's nature conservation law (Figure 5.10). The map in Figure 5.11 shows relative changes in general lump sum transfers if CUs are used in addition to existing indicators (inhabitants and schoolchildren) to calculate the fiscal need of a Saxon municipality.

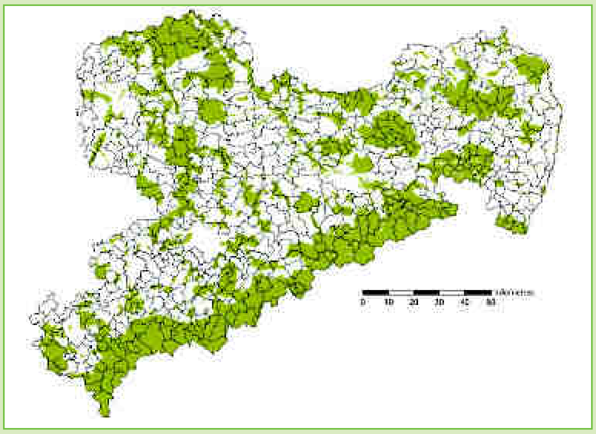


Figure 5.10: Protected areas overlaid over municipal borders in Saxony, Germany

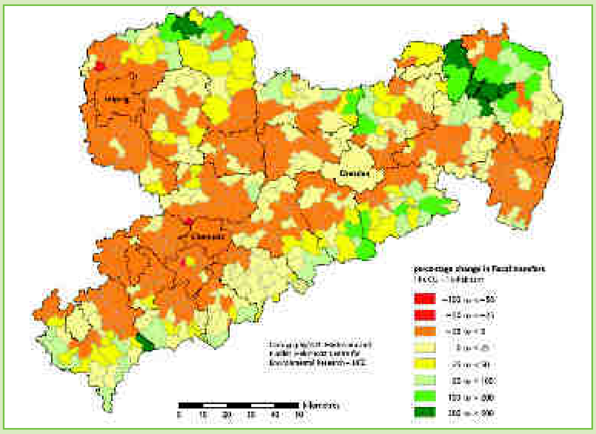


Figure 5.11: Percentage change in general lump-sum transfers when the Saxon fiscal transfer system 2002 was expanded to include designated protected areas.

Source: Ring 2008a

financial flows involved. Building on existing transfer schemes and integrating suitable ecological criteria (e.g. protected area coverage in hectares as a percentage of territory covered) can help decision makers promote innovative solutions to raise funds for conservation.

For Switzerland, Köllner et al. (2002) have developed a model for intergovernmental transfers to the local level, based on biodiversity indicators and cantonal benchmarking. For Germany, Ring (2008a) suggested ways of incorporating protected areas into the intergovernmental fiscal transfer system in Saxony (see Box 5.20).

5.4.3 COMPENSATING LAND USERS FOR WILDLIFE DAMAGE

Compensation payments are designed to indemnify land users, mostly farmers and fishermen, for the damage caused by particular wildlife species e.g. damage to livestock by wolves (Fourli 1999) or to fishing gear by seals (Similä et al. 2006). These kind of payments can be controversial but many have proven to be effective and are accepted by local stakeholders. Compensation schemes have been set up in many developed and developing countries (see example in Box 5.21 and also the India/ elephants reward programme case in Chapter 8).

Box 5.21: Goose Management Scheme, Scotland

This scheme aims to promote conservation and a sustainable goose population by compensating farmers for damage to agricultural crops caused by wintering wild geese. It requires a specific area on each farm to be set aside for geese, which may then be scared away from the remaining farm areas.

At the start of this initiative, payments were made on the basis of geese headage which involved high transaction costs. Payments are now made on an area basis. The maximum payment is £ 301.55 (about 338 EUR) per hectare of rotational grass or arable land. The payments are made by the UK government according to the five-year agreement in place.

Source: MacMillan et al. 2004

Although compensation payments for wildlife damage are sometimes essential to prevent hunting or culling of protected and highly endangered species, they are often associated with – or may even create – a negative perception of wildlife. In many countries, **perspective is shifting** away from damage compensation schemes (i.e. seeing wildlife as a cost) towards developing public payments that reward the presence of wild animals on private lands or support measures to provide feeding habitats for protected species (i.e. seeing wildlife as positive and making related payments) (Similä et al. 2006; Suvantola in preparation; see Box 5.22 and the discussion on PES in Section 5.1).

Box 5.22: Rewarding conservation of golden eagles by the Sami in Finland

The scheme provides compensation for losses caused by golden eagles to reindeer husbandry in Northern Finland. As recently amended, it aims to promote the conservation status of the species rather than focusing primarily on damage.

Payments are now based on nesting and reproduction of the species and actively involve the Sami people in monitoring nesting sites. Participants have access to information on nesting sites and also provide information to conservation authorities on newly discovered sites. In this way, the scheme discourages disturbance of the eagles during nesting and encourages creation of nesting sites rather than their destruction. There is also ongoing follow-up to build trust between the authorities and those who are subject to the negative impacts of the species' recovery.

Source: Similä et al. 2006; Suvantola in preparation

5.5 DEVELOPING MARKETS FOR GREEN GOODS AND SERVICES

Market mechanisms that reflect the values of biodiversity are well established for some goods and services and have been growing steadily over the last decade[27]. This trend reflects the increasing awareness of many consumers and producers that conventional production and consumption practices threaten the long-term viability of ecosystems. This section outlines progress on market development in key sectors (5.5.1) and identifies barriers to the success of 'green' products and services (5.5.2) before considering ways to expand the reach of biodiversity-friendly markets (5.5.3).

5.5.1 SUPPORT FOR BIODIVERSITY-FRIENDLY PRODUCTS AND SERVICES

Market niches are available for products and services that can reliably distinguish themselves from their competitors by demonstrating conservation credentials, including:

- products characterised by reduced direct impacts on biodiversity, due to adoption of more efficient or low-impact production and processing methods (e.g. reduced impact forestry or fisheries);
- products with reduced indirect impacts on biodiversity as a result of decreased pollution load (e.g. biodegradable detergents);
- products and services based on the sustainable use of ecosystem services and biodiversity (e.g. ecotourism or biotrade).

While most product markets still do not treat biodiversity as a key concern, there is growing evidence from across the world that **conservation can enhance a company's competitive position and be an opportunity in all sectors**. In some cases, biodiversity-friendly products and services can:

- attract market share or premiums for certain products and their suppliers;
- facilitate access to previously inaccessible markets or create entirely new markets;
- offer enhanced product differentiation in increasingly competitive global markets;
- reinforce and validate positive community relations and improved corporate image;
- improve employee morale, retention and productivity; and
- support the poor where they are directly involved in production (Bishop et al. 2008).

BUSINESS ACTION ON GREENING SUPPLY CHAINS

For most business sectors and companies, biodiversity conservation is still seen as a liability rather than a profit centre. The main drivers of private investment in biodiversity come from legal requirements, charitable impulses and informal pressure from shareholders, local communities and NGOs. The business case for such investment is more often expressed in terms of protecting firms' market share or minimising risk to reputation.

However, there are exceptions. Some retailers committed themselves in the early 1990s to stock only timber products certified as meeting strict environmental performance standards. For example, the B&Q Do-It-Yourself chain in the UK, owned by Kingfisher, was one of the companies responsible for setting up the Forest Stewardship Council (see below) to provide a credible mechanism to demonstrate responsible purchasing of timber products.

Such private voluntary actions can help make markets work better for the environment. When large companies choose to direct their purchasing power in a particular direction, they can have a large impact on trade and production practices around the world. Such initiatives require vision and commitment from the top as well as considerable patience as such options are not easy or cheap to implement. However, the payback in public relations and corporate social responsibility are often deemed worth the risk.

PUBLIC SUPPORT FOR GREEN MARKETS

In April 2009, the **European Commission issued a Communication signalling its strong support for the Fair Trade movement** (EC 2009). It applauded private sector initiative in this area although stopping short of mandating any action. Fair Trade focuses on social rather than environmental criteria but EU support is a positive development for the certification industry in general. Individual governments can also support biodiversity-friendly products and services through green public procurement policies and practices (see Section 5.6).

Several international institutions recognise the value of encouraging products and services that take biodiversity and ecosystems into account. **The CBD, UNCTAD, CITES and a growing number of countries support BioTrade** activities for the promotion of goods and services derived from native biodiversity under strict sustainable development criteria.

NON-GOVERNMENTAL ORGANISATIONS AND GREEN MARKETS

NGOs have played a significant role in developing voluntary environmental standards for a range of products and services. WWF worked in partnership with Unilever to establish the Marine Stewardship Council (MSC) for the certification of sustainably produced marine products (see Box 5.24) and has helped catalyse demand for certified timber. International NGOs such as Conservation International and WWF are currently involved in various fora addressing biofuel production e.g. the Round Table on Sustainable Palm Oil.

Since the mid-1990s, several non-profit organisations have been established to assess the sustainability of selected commodities and services against emerging standards on biodiversity-friendly production. These programmes are increasingly formalised through independent certification and assurance mechanisms, with both NGOs and private firms competing to offer verification and audit services (see below).

CERTIFICATION OF FORESTRY PRODUCTS

The International Tropical Timber Organisation (ITTO), established under UN auspices to administer a trade agreement between producers and consumers of tropical timber, describes sustainable forest management as forest-related activities that do *"not damage the forest to the extent that its capacity to deliver products and services – such as timber, water and biodiversity conservation – is significantly reduced. Forest management should also aim to balance the needs of different forest users so that its benefits and costs are shared equitably"*[28].

Several certification schemes now exist for forest management, of which two are responsible for the majority of forest certification (see Box 5.23).

Between 2001 and 2005, global coverage of certified forests expanded by about 50 million hectares per year, mainly due to a rapid increase in certified forest area in North America (Figure 5.12). By 2009, 325.2 million hectares worldwide had been certified under various schemes (8.3% of total forest area: UNECE/FAO 2009).

In terms of global roundwood production (i.e. sections of timber in raw unmanufactured state), approximately 26% was harvested from certified forests between May 2008 and May 2009. However, the rate of expansion has decreased over the last three years. Between May 2008 and May 2009, the rate of increase did not exceed four million hectares (Table 5.3).

This **reduction in the rate of expansion of certified forests** may reflect the fact that, in the developed world at least, most of the larger forest areas are already certified. Certifying forests in developing countries presents continuing **challenges linked to lack of capacity, resources and incentives to participate** as a significant proportion of forest areas are owned by smaller non-industrial and communal sectors. The geographical bias of certified forests towards the northern hemisphere inevitably limits the effectiveness of certification as an instrument for protecting biodiversity (see Table 5.3 and Section 5.5.2 below).

Box 5.23: Market penetration to date by major forest certification schemes

The **Programme for the Endorsement of Forest Certification Schemes** (PEFC) is an international umbrella organisation working for the assessment and mutual recognition of national schemes. These must comply with basic PEFC requirements but may adhere to stricter environmental criteria. PEFC certification may cover smaller schemes e.g. the American Tree Farm System (ATFS) for small forest owners. Members include 25 independent national schemes that have undergone rigorous assessment: they cover over 200 million hectares of forest, making it the world's largest scheme.

Source: http://www.pefc.org

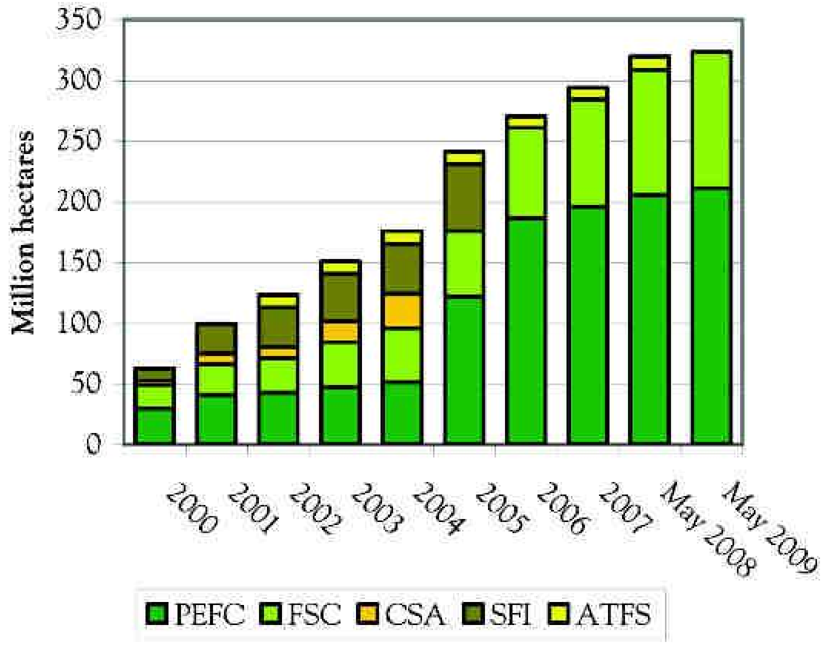
The **Forest Stewardship Council (FSC)** is an independent, non-profit organisation established in 1993. Members include environmental and social groups, representatives of the timber trade, indigenous people's organisations and forest product certification organisations. FSC certification is based on ten principles that encompass principles of sustainable development and equity as well as environment. By 2009, FSC had certified over 113 million hectares in 82 countries. The value of FSC-labelled sales is estimated at over US$ 20 billion, representing four-fold growth since 2005.

Source: www.fsc.org; FSC 2009; UNECE/FAO 2009

Use of certified or controlled wood fibres from sustainably managed forests in drinks carton manufacture is rising sharply. In 2008, usage by Tetrapak, Elopak and SIG Combibloc (which represent 80% of the global market) increased from 47% to 77% according to independent verifier ProForest. The three companies have pledged to purchase 100% of their paperboard from 'legal and acceptable' sources by 2015, using standards developed by FSC, PEFC or equivalent schemes.

Source: ENDS Bulletin 17.11.09 (www.endsreport.com/bulletin)

Figure 5.12: Forest area certified by major certification schemes (2000-2009)



Source: UNECE/FAO 2009

Table 5.3: Global supply of roundwood from certified resources (2007-2009)

Region	Total forest area (million ha)	Total certified forest area (million ha)			Total forest area certified (%)		
		2007	2008	2009	2007	2008	2009
North America	470.6	164.2	181.7	180.3	34.9	38.6	38.3
Western Europe	155.5	80.8	84.2	82.2	52.0	54.1	52.8
CIS	907.4	20.6	24.6	25.2	2.3	2.7	2.8
Oceania	197.6	9.9	9.4	10.3	5.0	4.8	5.2
Africa	649.9	2.6	3.0	5.6	0.4	0.5	0.9
Latin America	964.4	12.1	15.0	14.6	1.3	1.6	1.5
Asia	524.1	1.6	2.0	3.0	0.3	0.4	0.6
World total	**3,869.5**	**291.8**	**319.9**	**321.1**	**7.5**	**8.3**	**8.3**

Sources: UNECE/FAO (2009) using individual certification schemes; the Canadian Sustainable Forestry Certification Coalition; FAO and authors' compilations 2009.

CERTIFICATION OF SUSTAINABLE FISHERIES

As demand for fish and other marine and aquatic species continues to increase and the commercial fishing industry goes to ever greater lengths to access new fish resources, a consensus is emerging that the world's fisheries are in peril. The impact of fisheries and aquaculture on the wider marine and coastal environment is also of grave and growing concern. Aquaculture expansion, seen as a means to reduce pressures on wild stocks, has been implicated in the loss of coastal habitat (e.g. mangroves in tropical zones) whilst the farming of higher value species (e.g. salmon and prawns) still requires substantial fishmeal inputs.

The fisheries sector has a substantial direct interest in engaging with the issue of biodiversity and ecosystem protection to:

- **secure long-term supplies of target fish.** Healthy ecosystems have higher productivity, but require management of the ecosystem as a whole;
- **safeguard reputation and access to markets.** Consumers and retailers are increasingly concerned about the impacts of fisheries on target and non-target species and seabed habitats and are demanding assurances that the industry take action to address them.

Several initiatives have been launched to conserve fish stocks more effectively. The FAO Code of Conduct for Responsible Fisheries establishes a voluntary framework on which to base sustainable fishing practices[29]. The Seafood Choices Alliance, a global association of fishers, fish farmers, wholesalers and restaurants, works to promote ocean-friendly seafood[30]. For tuna, the Global Tuna Conservation Initiative launched by WWF and TRAFFIC is working to establish an ecosystem-based management approach for tuna stocks[31].

Of the fisheries market labels, the Marine Stewardship Council (MSC) is the most widely recognised and has the largest geographic coverage (see Box 5.24).

CERTIFICATION OF BIODIVERSITY-FRIENDLY AGRICULTURAL PRACTICES

The impact of agricultural practices (e.g. conversion and degradation of natural habitat, pollution) has been identified as the main reason for the loss of terrestrial biodiversity (sCBD and MNP 2007). By 1990, over two thirds of the area within two of the world's fourteen major terrestrial biomes and over half of the area within four others had been converted, primarily for agriculture (MA 2005b).

Box 5.24: Volume and value of fisheries certified by the Marine Stewardship Council

The MSC is a non-profit organisation which uses eco-labelling and independently-verified fishery certification programmes to recognise sustainable fishing practices and contribute to the health of the world's oceans. A fishery has to demonstrate that it meets three principles (sustainable fish stocks; minimising environmental impact; effective management) to be certified.

Between 1 April and 30 September 2008, the number of fisheries involved in the MSC programme rose by 41%[32]. By 2009, over 2,300 MSC-labelled products were available in 42 countries, derived from annual catches of nearly 4 million tonnes[33]. The quantity and value of such products continues to grow rapidly. Their retail value was expected to reach US$ 1.4 billion, an increase of US$ 400 million over 2008 sales.

Source: www.msc.org

At the same time, the agricultural sector can provide important biodiversity benefits through modified management systems and alternative technologies and practices (e.g. organic farming, agro-forestry systems, soil conservation techniques, conservation of riparian forests). Agroforestry (combining trees and shrubs with crops and/or livestock) has been part of traditional agriculture for years (see Tetetay and Tegineh 1991). Trees on farms can have multiple benefits e.g. soil regeneration, producing high-level fruits, fibre and medicines, and maintaining ecosystem services such as water, carbon sequestration and biodiversity[34].

Farmers in many countries are increasingly addressing environmental concerns through changes in their production practices. Various labels and certification standards – such as 'sustainable', 'organic', 'free-range' and 'fair trade' – are now used to distinguish farms using environmentally favourable practices from those using conventional methods. Depending on how such standards are implemented, they could enable agri-businesses of all sizes to promote conservation and sustainable use of biological resources (Bishop et al. 2008).

Organic agriculture is by far the largest type of certified agriculture, generating 30.8 billion EUR in 2006. By the end of that year, nearly 31 million hectares of land were certified organic (constituting around 0.7% of the agricultural land analysed in a comprehensive review by Willer and Yussefi 2007). By the end of 2007, a further 1.5 million hectares had been certified[35]. Global sales of organic food and drink have been increasing by over US$ 5 billion a year, reaching US$ 46 billion in 2007[36]. The vast majority of organic products are consumed in Europe or North America (Bishop et al. 2008).

There is much debate about the contribution of organic farming to biodiversity conservation (Bengtsson et al. 2005; Gibson et al. 2007). Different certification schemes require different biodiversity measures, leading the International Federation of Organic Agricultural Movements (IFOAM) to develop a guide for farmers on biodiversity management and landscape quality in organic agriculture (Bosshard et al. 2009).

Other biodiversity-friendly agriculture initiatives include:

- the **Rainforest Alliance programme on sustainable agriculture** whose standard, certified by the Sustainable Farm Certification[37], aims to protect wildlife, wildland, workers' rights and local communities[38];
- **GlobalGAP** (Good Agricultural Practice), a private sector body that sets voluntary standards for agricultural product certification around the globe that cover biodiversity issues. This is a business-to-business label not directly visible to consumers[39];
- **Ecoagriculture Partners**. This partnership of organisations from NGOs in developing countries (e.g. African Conservation Tillage Network) through to international bodies like WWF and UNEP was established at the World Summit on Sustainable Development in 2002 to *"enhance rural livelihoods; conserve biodiversity; and sustainably produce crops, livestock, fish, and forest products"*[40].

TOWARDS ECOTOURISM LABELLING

The tourism industry is responsible for some 220 million jobs (or 7% of total employment) and over 9% of global GDP[41]. **Tourism is a key export for 83% of developing countries: for the world's 40 poorest countries, it is the second most important source of foreign exchange after oil**[42]. Several biodiversity hotspots are experiencing rapid tourism growth: 23 hotspots have seen over 100% growth in tourist visits in the last decade (Christ et al. 2003).

Well-managed tourism can offer a vital source of funding to projects supporting biodiversity and local communities and provide an alternative to more damaging forms of development, such as agriculture, logging, mining or consumptive use of wildlife. **Ecotourism – "responsible travel to natural areas that conserves the environment and improves the welfare of local people"**[43]– stipulates that the net impact of travel on the environment and on local people must be positive. This goes further than nature-based tourism (i.e. travel to unspoilt places to experience and enjoy nature) which focuses more on what the tourist can gain and less on ensuring that natural areas are protected (see Box 5.25).

The ecotourism sector grew between 20-34% annually during the 1990s (Mastny 2001[44]). **In 2004, the nature and ecotourism market grew three times faster than the tourism industry as a whole**[45]. In the USA in 2006, private spending on wildlife-related recreational activities (e.g. hunting, fishing and observing wildlife) amounted to US$ 122 billion or just under 1% of GDP (US Fish and Wildlife Service 2007). The key to continued growth of this form of tourism is maintenance of natural areas in good condition. This requires reinvestment of some tourism revenues in the protection of ecosystems.

Although the tourism industry has experienced growth in biodiversity-friendly niches and products, it lags other sectors in establishing formal certification processes. However, there are now a growing number of certification and labelling initiatives worldwide which provide an opportunity to achieve higher industry standards. In 2002, the Final Report of the World Ecotourism Summit set out guidelines for certification of ecotourism schemes, recommending that they should be global in concept but local in application and accessible to very small ecotourism enterprises.

The new Tourism Sustainability Council (formed by a merger between the Partnership for Global Sustainable Tourism Criteria and the Sustainable Tourism Stewardship Council in September 2009) has the potential to provide a global accreditation body for ecotourism programmes that meet agreed standards. One criterion for assessing the impact of this initiative will be how well it meets the needs of small tourism operators, especially in the developing world.

Box 5.25: Biodiversity benefits from nature-based tourism in the Philippines

In Olango Island reef in Cebu, most revenues received by the area (an estimated US$ 2.5 million annually) come from on- and off-site expenditures of diving tourists. It has been estimated that if reef quality and wetland stewardship were improved, the area could see a 60% increase in annual net revenues not only from reef and mangrove fisheries but also from tourist expenditures.

Source: de Groot et al. 2006

THE NATURAL COSMETICS SECTOR

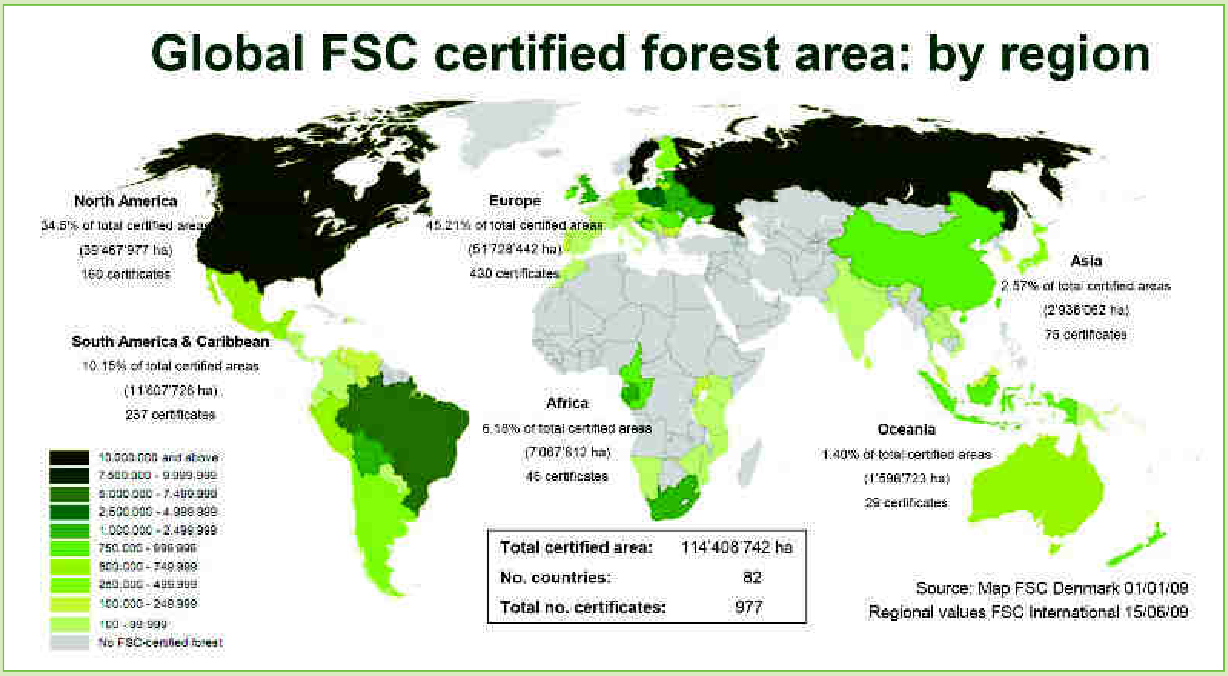
Cosmetics, care products and remedies based on natural ingredients form part of the expanding trade in biodiversity products, although no formal certification schemes are in place. A study by Organic Monitor put the global market in natural cosmetics at US$ 7 billion in 2008, driven by the EU and US markets[46]. A report for the European Commission found that demand for natural cosmetics is being mainstreamed, driven by growing awareness of human environmental impacts and a desire to eliminate the use of products containing harsh chemicals. The natural cosmetics sector is growing at roughly 20% per year in the EU and has already achieved a 10% market share in the US (Global Insight 2007).

5.5.2 BARRIERS TO THE SUCCESS OF CERTIFIED PRODUCTS

Uneven coverage, linked to the cost and complexity of certification

Despite impressive recent growth, the overall market share of certified products remains low. For example, MSC-certified seafood products have grown steadily over the past decade but still account for just 7% of the FAO's total recorded global capture fisheries production (MSC, pers. comm.).

Figure 5.13 FSC certified forest per region, as of 1 January 2008



Source: FSC 2008a

Forest certification, in place since 1993, still only covers 8.3% of the world's production forests. Developing nations in Africa, Latin America and Asia have vast and biodiverse forests but only 0.9%, 1.5% and 0.6% of certified forest respectively (UNECE/FAO 2009: see Table 5.3 above and Figure 5.13 below). FSC, the main certifier in tropical and sub-tropical regions, increased its coverage in Africa by 88% in the year to May 2009 and now has a certified area of approximately 5.6 million hectares (UNECE/FAO 2009). However, in Indonesia, the FSC has certified just over 1% of the total forest estate.

The expansion of certified biodiversity-friendly products and services is hampered by the cost and complexity of implementation, reflected in relatively low levels of certified production in developing countries. The direct costs of certification may be insignificant for large operators but can be a challenge for many small-scale producers and community enterprises[47]. MSC does allow a small part of a fishery to be assessed and certified but this depends on the whole stock being sustainable, i.e. individual operators who adopt improved practices may incur higher costs than their competitors without any credible marketing advantage.

DIFFICULTIES IN COMMUNICATING BIODIVERSITY VALUES

A more fundamental barrier to the expansion of voluntary green markets is limited consumer willingness to pay (WTP). A study focusing on eight EU Member States found a low level of awareness and WTP for certified products amongst end-users (Forest Industries Intelligence Limited 2009; cited in UNECE/FAO 2009). There are indications that end-user reluctance to pay the higher cost of certified products has steered importers and manufacturers away from FSC certification when sourcing from countries in the tropics, towards cheaper products verified as legal but not necessarily sustainable. This also seems to be the case in countries that were traditionally strong FSC supporters e.g. the Netherlands (UNECE/FAO 2009).

A large proportion of certified wood is often not labelled on the market as it is destined for business to business transactions, rather than retail outlets. In countries such as Finland, where most forest area is certified, domestic timber markets have no incentive to differentiate between certified and non-certified wood (ITTO 2008).

While certification systems can signal values important to some groups of people, they do not always capture aspects important to other groups e.g. the cultural values of biodiversity. Although nature tourism depends on a healthy environment, there is no guarantee that the tourism industry will take steps to protect it. There is often a time lag between profit-generating activities and the appearance of environmental degradation, which can make it difficult to develop a coordinated approach involving all relevant stakeholders (Bishop et al. 2008). For example, in 90 of the 109 countries where coral reefs occur, they are damaged by cruise ship anchors and sewage, by tourists breaking off chunks and by commercial harvesting for sale to tourists[48].

LACK OF BIODIVERSITY FOCUS BY CERTIFIED PRODUCTS AND SERVICES

Many certification systems do not make their relationship to biodiversity explicit. Organic farming labels, for example, have been reported to be generally beneficial but the certification does not set out to ensure biodiversity and, depending on local circumstances, could actually reduce species richness (Bengtsson et al. 2005). To further confuse matters, there are substantial differences between standards in terms of how they treat biodiversity.

Certification systems are based on the assumption that adopting certain specified production and processing practices will have positive biodiversity and ecosystem benefits, regardless of the producer's location in the landscape/watershed. In practice, as mentioned above, most certified forests are not very biodiverse[49] and an organic farm located in the midst of a large agro-industrial landscape may not provide much biodiversity benefit for reasons beyond its control. Greater attention to landscape/watershed criteria in certification systems could help ensure better biodiversity outcomes although, as seen in the case of MSC, a broad ecosystem-based approach can weaken incentives for individual producers.

UNINTENDED CONSEQUENCES OF NEW LEGISLATION

New regulations can sometimes limit market opportunities for natural products. For example, a potential barrier to growth in natural cosmetics comes from tighter legislation in the US and the EU (REACH) on the safety of chemicals in cosmetics. This could reduce research investment into potential new ingredients, making it harder for new products to meet the new criteria. The end result could be continued reliance on existing species/products already approved under the legislation, at the expense of lesser-known biodiversity-friendly options.

5.5.3 EXPANDING THE REACH OF BIODIVERSITY-FRIENDLY PRODUCTS

Practical steps to expand the reach of biodiversity-friendly products could be taken to:

- **review and strengthen the biodiversity element of existing and new certification systems** to ensure they monitor biodiversity use and impacts. Implementation methods currently in place require streamlining as customers (and sometimes user industries) are often unclear what a particular label means;

Box 5.26: Social stock exchange for public serving companies

The Social Stock Exchange is a way for investors to invest in businesses established with the aim of delivering particular social objectives, such as alleviating poverty or preventing environmental destruction[51]. Allowing 'social investors' to make educated choices about the impacts organisations have on society could act as a powerful support for companies that provide a social good. Encouraging investment and trade can act as an incentive to keep biodiversity intact in the face of competition from less biodiverse alternatives.

Source: Yunus 2007

Box 5.27: MSC risk-based support framework for smaller fisheries

The MSC's programme on Guidelines for Assessment of Small-Scale and Data-Deficient fisheries aims to provide small-scale and data-deficient fisheries with guidance on the assessment process. This methodology, known as the MSC Risk Based Framework, provides a risk assessment approach to help evaluate key environmental indicators of the MSC environmental standard for sustainable fishing. Although not limited to developing countries, it is likely to have the greatest uptake amongst them.

Source: http://www.msc.org/about-us/credibility/all-fisheries

- **include broader landscape considerations in certification processes** to ensure that business works to improve overall regional biodiversity e.g. to ensure landscape connectivity across agricultural regions, prioritise efforts in high biodiversity areas etc.;
- **create more supply push and market pull for certified products and services** through increased consumer awareness and supply-chain management by large commercial buyers (see also Section 5.6 on green public procurement). This could be done through e.g. networks setting targets[50] or the creation of eco-investment funds to support companies that are certified and/or have shown innovative ways of creating sustainable business models. For example, a Swiss company HotelPlan raised US$ 750,000 in 2002 through a US$ 3 charge on bookings which was used to support sustainable tourism, environmental efforts and emergency one-off projects (cited in Bishop et al. 2008);
- **invest directly or indirectly** in companies that market certified products, particularly from High Conservation Value areas. This could include technical assistance to help develop more profitable businesses and ensure sustainable management practices and access to markets. There is also an opportunity to create incentive programmes for companies committed to purchasing biodiversity-friendly products or that make biodiversity protection their key output (see Box 5.26);
- **make better use of traditional knowledge** of plant (and animal) species to develop new products that could reduce the costs of complying with chemical safety legislation and **make global markets work better for the poor** by helping provide non-timber forest products and other products suitable for bioTrade;
- **support the adoption of certification standards in developing countries**, particularly in regions where they are currently non-existent or embryonic and help small to medium businesses for whom the initial investment becomes prohibitive (see Box 5.27).

Alongside this increasing interest in expanding the reach of biodiversity-friendly products (see also Section 5.6 on green public procurement), **trade concerns need to be borne in mind**. While there are no formal trade implications of private demand for goods (e.g. choice of FSC-labelled goods or organic foods), the position is more complicated when it comes to governments applying instruments like taxes or subsidies to create price incentives for sustainable products (see Box 5.28).

Box: 5.28: Trade and environment

The role of trade in sustainable development policies and ambitions is a complex one. The General Agreement on Tariffs and Trade (GATT) and its successor, the World Trade Organization (WTO), are key components of this relationship. These frameworks to regulate multilateral trade have been established through consensus among their 153 member states and have progressively reduced global trade barriers, thereby contributing to the vast increase in world trade witnessed over the past decades.

Trade and development

According to basic trade theory, increased international trade should lead countries to produce goods for which they have a 'comparative advantage' in their production. This specialisation should, in turn, lead to a more optimal allocation of inputs and production of goods, something desperately needed with the global population predicted to increase to over 9 billion people by 2050. Trade can also act as a force for development, providing opportunities for exports overseas, increasing production and incomes at home and accelerating the global dispersion of technologies – including environmentally important ones.

Trade is often seen as also generating income and contributing to development by freeing up resources for investment in environmental quality and protection of ecosystems and biodiversity (Sampson 2005). However, as UNEP and IISD (2005) note, *"The links between trade and environment are multiple, complex, and important. Trade liberalisation is – of itself – neither necessarily good nor bad for the environment. Its effects on the environment in fact depend on the extent to which environment and trade goals can be made complementary and mutually supportive."*

…and environment

Governments have obligations not only under the WTO, but also various multilateral environmental agreements (MEAs) such as the CBD and the UNFCCC. Debate often arises over a perceived risk of conflict between these different international conventions, rules and disciplines. Although there have been no WTO legal disputes to date regarding a conflict between specific MEA provisions and the WTO, governments may have to balance WTO-related obligations not to discriminate in traded goods with MEA-related obligations to limit or ban the import of goods produced under environmentally harmful conditions or that contribute to environmental degradation.

Both multilateral trade rules and environmental agreements include provisions focused on minimising the risk of such conflict. The GATT includes an article (Article XX) that sets out general exceptions to its rules, including for measures necessary to protect human, animal or plant life and health. Several MEAs specify that their implementation should not adversely affect the rights and obligations derived from other existing international agreements. For example, the CBD (Article 22(1)) contains a provision to this effect but makes an exception for cases where the exercise of such rights and obligations would cause serious harm to biodiversity.

Another potential issue exists for goods and products that have been produced according to criteria that safeguard ecosystems and mitigate environmental pressures. The external costs of their production (i.e. costs that society has to bear) are lower than those of competing goods not produced under such conditions. It has been argued that to ensure a level playing field, the external environmental costs incurred in the production of goods should somehow be reflected e.g. goods produced under environmentally-friendly criteria should be rewarded for the lower costs transferred to society as a whole. This could have implications for international trade, depending on how governments decide to reflect these cost differences (e.g. through standards or labelling schemes).

This report is not the place for an extensive discussion on the future organisation of international governance on trade and environment, but some concerns and observations can be raised:

- It is legitimate to ask whether the WTO is the best venue for an increasing amount of dispute settlement procedures and agenda-setting on sustainability of products and production systems. Given that its primary task is to regulate the provision of a level playing field for world trade, directing the conditions under which products are produced might seem beyond its original intention;

- Whilst the effects of trade liberalisation on economic development have been thoroughly investigated, this is much less true for its impacts on ecosystems and the environment (Verburg et al. 2009). Some studies have found that liberalising trade in agricultural products could lead to large biodiversity losses especially in Latin America and Africa yet would decrease losses in Europe and North America due to transfers in agricultural production (ten Brink B. et al. 2007);

- Trade-offs may exist between the long and short term; between economic development and environmental and living conditions; and between natural capital and GDP. These are especially relevant for developing countries. Restricting trade in products by obliging certain production standards, or by favouring certain products over others, limits the flexibility (also in time) that developing country governments have to set their own priorities, whilst compliance can pose a significant challenge to small and medium-sized businesses in these countries. On the other hand, short-term development by 'mining' natural resources could mean long-term impoverishment.

- Given the ecological footprint of many developed economies and the impacts of producing their imports on climate change and biodiversity loss, there is a powerful argument for them to take action on at least the aspects of production that clearly influence global commons.

- Understanding and defining terms such as 'sustainable production' or 'environmentally-friendly products' is important for ensuring trade and environment policies are mutually supportive. Finding common ground amongst governments on criteria for key terms should be viewed as an important prerequisite before enacting compulsory measures focused on sustainable trade. The broader the support for these criteria, the less resistance there will be to applying them to make trade more sustainable. Another trade-off presents itself here, as front-runner countries have to balance their desire for ambitious criteria with building a coalition based on a minimum level of shared principles.

Sources: Sampson 2005; UNEP and IISD 2005; Verburg et al. 2009 and ten Brink B. et al. 2007

5.6 GREEN PUBLIC PROCUREMENT (GPP)

"By giving a clear signal to all parties involved in the procurement process, public authorities can draw new environmental technologies into the market place that in turn have the potential to strengthen the competitiveness of European industry.

Green Public Procurement will also help EU Member States meet obligations for energy-efficiency in buildings, energy services and reduced CO_2 emissions. The potential of this instrument is enormous and I recommend that public administrations, at all levels, turn policy into practice and demonstrate their willingness to 'green' Europe."

Stavros Dimas, EU Commissioner for Environment

5.6.1 OBJECTIVES AND TAKE-UP OF GPP POLICIES

Green Public Procurement (GPP) means that **public purchasers take account of environmental factors when buying products, services or works. A product or service can only qualify as 'green' if it goes beyond what is required by law and beyond the performance of products commonly sold in the market**. Whereas regulatory standards create a minimum baseline (see Chapter 7), GPP helps to green the markets: ecologically innovative products can increase market share and often get a price premium.

Governments at all levels, public agencies and organisations can quickly make use of GPP to reduce pressures on biodiversity, drive or create markets for green products and green the supply chain. Their vast buying power – from offices and canteens to construction and transportation – can directly expand the market for products and services produced or supplied with less environmental impact (e.g. energy- and water-efficient devices and building techniques, non-hazardous or bio-degradable products, organic or seasonal food, sustainably produced timber and paper).

GPP can facilitate eco-innovation because governments can take more risk when opting for new products, assuming the role of 'launching customer'. This may create economies of scale and help companies to move up the learning curve, put innovative products on the market and create green-collar jobs. Less green products and services are progressively placed at a significant disadvantage when competing for government contracts.

GPP has been rapidly developing since the early 2000s and is now being mainstreamed by environmentally ambitious governments. The EU market for government purchases alone exceeds 1,500 billon EUR/year or 16% of EU Gross National Product. The European Commission has proposed to Member States that by 2010, 50% of their purchasing should be GPP. Some have chosen to set more ambitious targets e.g. in the Netherlands, the national government intends to purchase 100% green by 2010, with levels of 50 to 75% for local and regional governments (see Box 5.29).

Many other large economies – including Japan, China, New Zealand, Korea and the US – also have formal policies in place that stimulate GPP (see Box 5.30).

Box 5.29: The 'Green-7' in the European Union

Seven EU Member States (Austria, Denmark, Finland, Germany, Netherlands, Sweden and UK) consistently have more tenders with green criteria than other Member States, supported by:

- strong political drivers and/or national guidelines;
- national GPP programmes in place for a number of years;
- strong information sources (dedicated GPP websites containing relevant criteria/specifications);
- innovative procurement techniques (most use dedicated tools e.g. life-cycle costs as an award criterion, or functional specifications/requests for environmental variants);
- application of environmental management systems by purchasing organisations.

Source: Bouwer et al. 2006

Box 5.30: Strengthening regulations for GPP implementation in China

China's Government Purchase Law took effect on 1 January 2003. Five years later, official statistics show that about 5.1 billion Yuan (630 million US$) has been saved in government procurement costs.

The Law as enacted established a 'preferential' list which allowed government bodies to shop around for other products if they could justify them on cost and energy-efficiency grounds. Subsequently, the State Council adopted a compulsory list (December 2007) of nine types of products, including air conditioners, fluorescent lamps, televisions, electric water heaters, computers, printers, computer monitors and water nozzles.

A new State Council Order, published on the central government's website, indicates that China will impose tougher compulsory procurement rules for energy-saving products and give priority to eco-friendly products in future public purchases.

Source: China Daily, 14 April 2009

5.6.2 GPP STANDARDS, CRITERIA AND COSTING

Standards and criteria are the backbone of GPP. Producers and suppliers need to know on what basis their products are assessed and how they can improve their chances of winning a contract. Making environmental criteria measurable and transparent is a considerable challenge given the range of products and services purchased by governments. Cooperation with relevant sectors and producers is needed to strike a balance between environmental ambition and product availability. Training of purchasers is important to ensure that policy goals are translated into action.

Through GPP, governments can choose to buy certified or labelled products that are guaranteed to meet purchasing criteria for a given category of products (see Box 5.31 and Section 5.5 above). Such policies may not only have direct environmental benefits but also increase the recognisability and diffusion of market-based labelling schemes.

Greening certain purchases may yield higher environmental benefits than others. Recent studies have focused mainly on CO_2 effects of GPP policies and not yet on direct biodiversity impacts. One found that focusing on construction and electricity products and services is the 'low-hanging fruit' for governments willing to target CO_2 emissions (PWC 2009). GPP's specific benefits for biodiversity could be assessed by analysing procurement criteria with a positive effect on biodiversity and linking this to actual contracts and amounts bought by national/local governments. However, it is already clear that creating demand for products with low environmental impacts is directly or indirectly beneficial for soil and water quality, ecosystem integrity and long-term sustainability of natural capital.

Box 5.31: Tightening criteria for centralised procurement: timber purchasing in UK

The UK established a Central Point of Expertise for Timber (CPET) to advise government on timber purchasing. The CPET advised that the 5 main timber certification schemes (FSC, PEFC, CSA, SFI, MTCC) complied with government criteria on legality, as did certain independent schemes. As purchases not covered by such schemes had to supply 'equivalent evidence' ('Category B' evidence), most suppliers opted to use formal certification as it simplified proof of compliance.

In April 2009, criteria were strengthened. The entry level for GPP consideration was raised from Legal only to 'Legal & Sustainable', effectively ruling out anything but fully certified timber for central government projects. This high-level commitment has boosted demand for and availability of certified timber in the UK market, as measured by rapid growth in certified forest area and in the number of Chain of Custody certificates.

Remaining policy challenges include patchy implementation of detailed compliance specifications through a complex government bureaucracy. However, the mere existence of this policy sends out a clear and powerful message of intent.

Source: www.proforest.net/cpet

Considering the time it can take to develop comprehensive criteria for all products, starting with products with the highest impacts creates the quick-wins. Products whose biodiversity impact can clearly be reduced – and which represent a significant share of public expenditure – include:

- timber (used in construction, water works, furniture and paper: see Box 5.32);
- food (government canteens and restaurants). One estimate suggests that if all public authorities switched from conventionally to organically produced foodstuffs, this would reduce phosphate release in fertiliser by 41,560 tonnes per year (PO4-equivalent), roughly the amount currently used by 3.5 million Europeans[52];
- information and communications technology (ICT). Aside from energy consumption, ICT demand for metals and minerals (e.g. silver, tin, copper, gold, cadmium, lead and mercury) forms a significant part of global trade in these inputs. Governments, as major purchasers, can play a big role in shifting extraction and waste management practices towards lower impact practices.

GPP is not automatically more expensive than conventional procurement procedures: on the contrary, it can be a cost-saving tool for government. Price will depend on the products available, market competition and the way in which costs are assessed.

Assessing a purchase over its entire life-cycle (c.f. simply on purchasing cost) shows that energy-saving products are often worth the investment and can reduce costs in the long run (see Box 5.33).

Lastly, benefits of scale are available where criteria and standards can be applied across a range of markets and/or through joint procurement policies (see Box 5.34). Harmonisation of purchasing criteria across countries could further lower costs but may involve lengthy international negotiation.

Box 5.32: Energy and water savings through green procurement in Denmark

Danish public procurement of virgin paper is around 22,500 tonnes per year. For every tonne of recycled paper, 3,200 kWh of energy and 10 m^3 of water can be saved. It has been estimated that if all public authority use of virgin paper in public procurement was replaced by recycled paper, this would save 73,000 MWh in energy and 225,000 m^3 of water, equivalent to the yearly energy consumption of 15,000 Danish households.

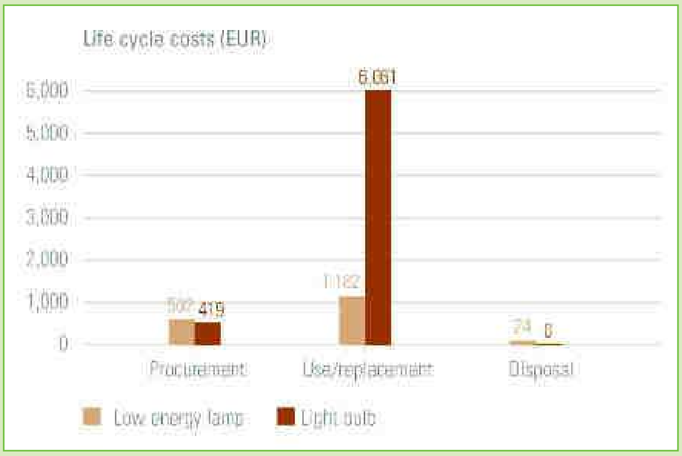
Source: http://www.gronindkobsportal.dk/Default.asp?ID=262

Box 5.33: Cost savings identified through 'whole life costing' in Germany

Whole-life cost analyses for GPP in some German cities reveal that the overall cost of green products and services is often lower than 'normal' products, once their entire life is taken into consideration. The table below provides comparisons between green and other products based on city experiences. Negative values indicate that GPP resulted in cost savings.

Organisation	Product	Non-green Costs (in EUR, incl VAT, incl LCC per year – comparison of bids)	Green Costs (in EUR, incl VAT, incl LCC per year – comparison of bids)	Applied green criteria	Absolute difference (EUR)	Relative difference
Freiburg	All-in-one copier	243,950	291,100	Blue Angel, Star 4.0, RohS-Directive	47,150	19%
	Paper A4	205,980	171,650	Blue Angel	-34,330	-17%
	PC	64,545	65,433	Blue Angel, Energy Star 4.0	888	1%
	TFT displays	9,020	7,177	Energy Star 4.0	-1,843	-20%
Heidelberg	Paper A4	100,000	88,000	Blue Angel	12,000	-12%
	Toilet paper	20,250	15,000	Blue Angel	-5,250	-26%

Source: Öko-Institut and ICLEI 2006



In Hamburg, the Environment Agency replaced all bulbs with energy efficient lamps in 300 buildings. Annual power consumption decreased by 4.5 million kWh, saving 225,000 EUR (at a unit price of 5 centimes). The chart below shows the example of an administrative unit equipped with 50 lamps, taking into account the life cycle of an energy saving bulb (40 months) and interest rate effects for 2004.

Source: Saxon State Ministry for the Environment and Agriculture 2006

5.6.3 TACKLING CONSTRAINTS ON IMPLEMENTING GPP

GPP face a variety of barriers (Bouwer et al. 2006). First, there is often a perception that purchasing green will introduce extra financial costs to the organisation (instead of neutral or reduced costs). As mentioned above, this is not necessarily the case. However, the right balance needs to be struck between ambitious criteria and sufficient supply of goods. Drawing up strict criteria is little use if there are no products available (or too few) that can meet them.

Second, the necessary infrastructure to develop and implement GPP may be lacking. Investment may be required to build capacity for developing and setting

Box 5.34: Joint procurement through the EcoProcurement Service Vorarlberg, Austria

Since 1998, 96 municipalities in Austria's most western province have collaborated on GPP through a environmental association (Umweltverband Vorarlberg). In 2001, the dedicated **EcoProcurement Service Vorarlberg (ÖkoBeschaffungsService – ÖBS)** was launched to:

- organise joint procurement activities on behalf of all member municipalities;
- offer legal and environmental advice on GPP;
- organise workshops on GPP;
- develop GPP guidelines for specific product groups (office equipment and building construction);
- assist municipalities in implementing sustainable construction.

A key driver was the realisation that few municipalities were applying environmental criteria, even when clear guidance was available. Joint procurement was seen as a way to combine financial and environmental benefits and reduce costs. Substantial savings have been made in administrative costs (20-60%) and in prices paid for products (5-25%). In 2005 savings of about 286,500 EUR were achieved.

Source: http://www.iclei-europe.org/index.php?id=3490

criteria, to transfer these into practical tools and assessments and to train purchasing officers. Essential components of GPP policies include third party verification of compliance and supply chain management: the more a product is a combination of inputs, the more complicated it can become to trace the impacts of inputs at their respective points of production.

Third, building support at political and/or managerial level is important for efficient policy implementation. A phased approach can be useful, using demonstrated small-scale success to leverage support for broader roll-out (see Box 5.35).

Box 5.35: Phased implementation of green food procurement policies in Scotland

East Ayrshire, Scotland: Over four years, the local authority transformed the school meal service from a standard public service to a successful model of sustainable food provision supporting local and organic producers and promoting a healthy food culture. The pilot project (one primary school, 20,000 meals in one year) began in August 2004; the second phase from 2005 involved 10 primary schools (220,000 meals); in early 2007, the scheme was expanded to include 26 primary schools and will eventually cover all 44 primary schools and 9 secondary schools in the county.

The scheme was conceived and managed by the East Ayrshire Council and financially supported by the Scottish Executive initiative. It follows the 'Food for Life' model for sustainable food procurement which requires purchases for school canteens to fulfil specific criteria, including:

- at least 75% of food ingredients must be unprocessed;
- at least 50% of food ingredients must be locally sourced;
- at least 30% of food ingredients must be organic.

Positive environmental effects of the initiative include reducing food miles by 70%, reduced packaging waste and saving almost £100,000 in environmental costs.

Source: Sonnino undated

Box 5.36: Compatibility of GPP with free trade rules and disciplines

The General Agreement on Tariffs and Trade (GATT) requires States to treat foreign and domestically produced goods alike (Article III – the 'national treatment obligation') and prohibits discrimination against imported goods that are 'like' domestically produced goods, independent of how or where they have been produced.

However, Article III.8(a) **excludes all products consumed by a government in the course of its normal activity** from the 'national treatment obligation' e.g. furniture, hospital material or social housing. This means that GPP policies have significant scope to explicitly promote biodiversity-friendly purchasing – e.g. by specifying FSC timber based products – without infringing GATT provisions.

Source: FSC 2008b

Fourth, differences in criteria and/or procedures amongst different countries or administrations can create extra costs and uncertainties. Some countries are moving beyond GPP towards 'sustainable public procurement' (SPP) which combines environmental and social criteria in purchasing decisions. Where priorities vary, procurement criteria will obviously also vary between countries or even between regional and local authorities.

In some cases, such differences have raised concerns over international competitiveness. In general terms, there is always the risk that GPP targets and criteria put strain on free trade agreements or, in the case of the EU, the internal market (e.g. criteria that give preference to national producers could distort competition and create suspicions of protectionism). Inclusion of social criteria could also lead to conflicts under trade agreements (see discussion of environmental protection obligations in the context of the GATT/WTO in Box 5.28 and also Box 5.36 below).

GPP can yield broader results when combined with development cooperation efforts and where resources for capacity building and green industry development are available. Supporting greener production in countries of origin, especially developing countries, will open up new markets to providers, improve and expand a reliable supply of green products and lower the price of green procurement.

Looking to the future:
- GPP is a policy instrument with considerable environmental benefits, given the huge markets for government purchases;
- most quantification of benefits has been based on substitution costs (e.g. replacing virgin paper with recycled), reduction in natural resource use (e.g. water) or reduced emissions (e.g. GHG, pollution). Much more work needs to be done to quantify the benefits to biodiversity from certification and labelling programmes;
- the time is right for committed governments to upscale GPP and set national goals as first lessons have been learned and criteria are being devised and revised at an increasing rate;
- harmonisation where feasible could further lower costs and increase GPP's attractiveness;
- transparency and clarity are important for producers at all levels and sizes;
- national GPP policies can be combined with development objectives to support the development of certified markets in other countries.

Chapter 5 has looked at a range of different **instruments to reward providers of benefits from ecosystem services** or to reward products that have less impact on nature. The former included payments for environmental services, mechanisms for access and benefit sharing for genetic resources as well as tax breaks and transfers. The discussion of market-based reward tools has focused on certified products and the use of public procurement to expand and green the markets.

Chapter 6 and 7 discuss closely-related tools. **Chapter 6 considers the need for subsidy reform** to ensure that subsidies reflect the value of biodiversity and respond efficiently to current and future priorities. **Chapter 7 analyses ways in which regulation and pricing can minimise damage to natural capital:** these tools form an essential foundation for the markets analysed in Chapter 5.

Endnotes

[1] The chapter uses the terms (i) environmental services, (ii) ecosystem services, and (iii) ecological services interchangeably. In particular, we usually refer to the Millennium Ecosystem Assessment interpretation of 'ecosystem services' which includes products (provisioning services) as well as intangible services.

[2] Australian Government, Department of the Environment, Water, Heritage and the Arts, URL: http://www.environment.gov.au/biodiversity/incentives/tender.html

[3] United States, Department of Agriculture, http://www.nrcs.usda.gov/programs/CRP/

[4] The approach of remunerating environmental service providers as mean to internalise environmental services is sometimes also referred to as "provider gets" approach to highlight the differing perspective compared to the more widespread application of the "polluter pays" principle. As pointed out by Pagiola et al. (2005), it does not matter -- from a pure efficiency perspective -- whether ''polluter pays'' or ''provider gets'' applies. According to the Coase theorem, either approach will yield the same result provided that markets are competitive, property rights are enforceable, and there are no transaction costs (Coase 1960). In practice, however, few if any of these conditions hold in the case of environmental service (Pagiola et al. 2005). The argumentation is that (i)environmental services have the peculiar characteristic of being the cumulative result of a wide range of spatially dispersed land uses, and (ii) monitoring the impact of many land users scattered over a landscape on the provision of environmental services would be prohibitively costly. The latter is partly reflected by the insufficient compliance with many land use laws (e.g. deforestation bans, fire prohibition), especially in developing countries where equity concerns play an additional role and where adopting a polluter pays approach would impose the cost of environmental protection on often poorer land users rather on better-of service beneficiaries (Pagiola et al. 2005). These elements argue in favor of a "provider gets" approach rather than a "polluter pays" approach when seeking to internalize the generation or conservation of environmental services, especially in the context of developing countries (Wertz-Kanounnikoff 2006)

[5] Auctioning schemes can be designed for this.

[6] See Republic of South Africa, Department: Water and Environmental Affairs, http://www.dwaf.gov.za/wfw/

[7] This section draws on Karousakis (2009) Promoting Biodiversity Co-benefits in REDD. OECD Paris

[8] There might of course be impacts on other ecosystems; perhaps less species rich, but harbouring different species and contributing different services. It will be important to understand knock-on effects of choice of where to fund and hence where not to fund.

[9] Reforestation relates to areas previously covered in forest. Afforestation relates to areas not previously covered in forests.

[10] Sub-national refers to States or provinces, or regions within countries.

[11] Monitoring emission reductions from deforestation/degradation requires two types of data: changes in forest stocks and changes in carbon stocks.

[12] Net deforestation (net loss of forest area) is defined in the FAO Global Forest Resources Assessment (2005) as overall deforestation minus changes in forest area due to forest planting, landscape restoration and natural expansion of forests.

[13] In REDD pilot and demonstration activities, in particular for the 'readiness' phase (i.e. structural and regulatory preparations and capacity building), predominantly fund-based grants are used. These might increasingly be accompanied by loans e.g. when the World Bank Forest Investment Programme becomes operational). Private sector investments might further complement the available funding during the REDD readiness phase, if an agreement on REDD is reached in the UNFCCC.

[14] REDD credits could also be fungible with permits/allowances under existing (domestic) emission trading schemes such as the European Union Allowances (EUAs) under the EU Emissions Trading Scheme (EU ETS).

[15] The UNFCCC REDD web-platform was created to share such information. Due to the early stage, there is currently some information on actions being undertaken but little on the lessons learned. See http://unfccc.int/ methods_science/redd/items/4531.php.

[16] These are in essence 'Green Standard' REDD credits, similar to existing Gold Standard Clean Development Mechanism (CDM) credits which are voluntary premiums for CDM credits meeting additional sustainable development criteria.

[17] More details on the agreements are available from Breibart 1997; ICBG 1997; Mulholland and Wilman 1998; Neto and Dickson 1999; Ten Kate and Laird 1999; Merson 2000; Artuso 2002; Greer and Harvey 2004; and Dedeurwaerdere et al. 2005.

[18] It should be noted that not all indigenous communities are keen on pursuing this line of development as some reject the commercial exploitation of knowledge.

[19] Source suppliers covers source country governments; local management entities; indigenous people/communities, some of whom have the right to grant permission for access to and use of genetic resources and their derivatives; national organisations; and/or stakeholder groups with access to traditional knowledge. This still leaves open, however, the rights and equity issues. Even if we take the suppliers to be national governments that does not infer that all jurisdictions have wholly equitable or indeed well defined rights of sourcing and supply. This is itself a cause of much concern. For more details see Ding et al 2007.

[20] Note that 'buyers' can also be intermediaries, such a local research institutes and universities.

[21] One reviewer of this chapter noted that asset specificity may not apply so forcefully to bioprospecting, arguing that wild and so far undiscovered genetic resources collected for screening purposes usually have no specificity. A provider country can offer their resources to any company interested in the use and companies can approach any provider country.

[22] For a further discussion of how transaction costs economics apply to bioprospecting, see Gehl Sampath 2005,

[23] For further discussion on the constraints on equitable sharing of benefits and related economic issues, see OECD (2003) and Richerhagen and Holm-Mueller (2005).

[24] Suggestion made by Professor Vogel, University of Costa Rica (http://ictsd.net/i/environment/31517).

[25] Voluntary approaches are in place from local to international level. See e.g. for municipalities in Australia http://www.logan.qld.gov.au/LCC/logan/environment/biodiversity/cip/voluntaryconservationagreements.htm and at international level, the FAO Code of Conduct for Responsible Fisheries (http://www.fao.org/docrep/005/v9878e/v9878e00.HTM) and FAO Code of Practice for Forest Harvesting in Asia-Pacific (http://www.fao.org/docrep/004/AC142E/AC142E00.HTM). For further discussion, see Menzies 2002 in ten Brink 2002.

[26] The ICMS is the tax on sale of goods and services which operates at state level in Brazil.

[27] For example, see UNECE 2006 on forests http://www.unece.org/timber/docs/fpama/2006/fpamr2006.pdf and www.msc/org/aboutus/10 for fisheries.

[28] International Tropical Timber Organization: http://www.itto.int/.

[29] http://www.fao.org/docrep/005/v9878e/v9878e00.HTM#2

[30] http://www.seafoodchoices.com/home.php

[31] http://assets.panda.org/downloads/fortuna.pdf

[32] http://www.msc.org/newsroom/msc-news/archive-2009/sustained-growth-of-msc-labelled-products

[33] http://www.msc.org/documents/msc-brochures/ MSC-FisheriesCommitments-Aug09-WEB.pdf

[34] http://www.worldagroforestry.org/af/

[35] Figures from the new World of Organic Agriculture: Statistics and Emerging Trends 2008. cited on their website: http://www.ifoam.org/press/press/2008/Global_Organic_Agriculture_Continued_Growth.php

[36] See Organic Monitor research news http://www.organicmonitor.com/r3001.htm

[37] http://www.sustainablefarmcert.com/

[38] http://www.rainforest-alliance.org/agriculture. cfm?id= main

[39] http://www.globalgap.org/cms/front_content.php?idart=3&idcat=9&lang=1

[40] http://www.ecoagriculture.org/index.php

[41] http://www.wttc.org/

[42] http://www.mekongtourism.org/site/uploads/media/IETS_Ecotourism_Fact_Sheet_-_Global_1__01.pdf

[43] http://www.ecotourism.org/site/c.orLQKXPCLmF/b.4835303/k.BEB9/What_is_Ecotourism__The_International_Ecotourism_Society.htm (source of citation from Mastny 2001).

[44] http://www.mekongtourism.org/site/uploads/media/IETS_Ecotourism_Fact_Sheet_-_Global_1__01.pdf

[45] http://www.wttc.org/

[46] http://www.organicmonitor.com/r1709.htm

[47] See What Do We Know About the Costs and Benefits of Tropical Timber Certification? (2004) Timbmet Group Ltd: Oxford.

[48] Ibid.

[49] Plantations are usually more productive than natural forests, and some argue that the world's timber and fibre needs should be met from plantations, thereby relieving pressure on natural forest to provide the same material.

[50] e.g. through the Global Forest and Trade Network (GFTN), brokered by WWF, consuming and producing companies sign up to the network and report annually to the WWF on progress against individually agreed targets in return for use of its logo for PR purposes (www.gftn.panda.org/about_gftn/)

[51] http://www.socialstockexchange.eu/why/default.html

[52] http://ec.europa.eu/environment/gpp/index_en.htm.

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THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 6: Reforming Subsidies

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Chapter 6

Reforming Subsidies

Table of Contents

Key Messages of Chapter 6

The last decade has seen **increasing and sometimes strenuous efforts to phase out or reform subsidies in various countries**. These experiences indicate that **subsidy reform or removal can alleviate environmental pressures, increase economic efficiency, and reduce the fiscal burden**.

Although declining slightly in some sectors, the **overall level of subsidies remains remarkably high**. Leaving aside conceptual and data deficiencies of global estimates for most sectors, conservative estimates point to hundreds of billions of dollars in annual subsidies. Agricultural subsidies in OECD countries averaged US$ 261 billion/year in 2006–8, global fisheries subsidies are estimated at US$ 15-35 billion and energy subsidies amounted to around US$ 500 billion per year worldwide, and to US$ 310 billion in the 20 largest non-OECD countries in 2007.

Many production subsidies serve to reduce costs or enhance revenues, e.g. the majority of agricultural support measures provided by OECD countries. Together with below-cost pricing for the use of natural resources under consumer subsidies, they effectively provide incentives to increase use of subsidised resources, production and consumption. This not only **increases environmental damage but can also restrict the development and use of more sustainble technologies and processes**. At the global level, **agricultural and fisheries subsidies are particularly worrying** in this respect, and analyses of other sectoral subsidies also highlight the substantial potential for environmental gains through their reform.

Not all subsidies are bad for the environment. Some subsidy programmes are already used to reward ecosystem benefits, like the range of transfer programmes in agriculture or forestry that reward less harmful production methods by compensating lost revenue or making payments against desired outcomes. However, **even 'green' subsidies can still distort economies and markets, and may not be well-targeted or cost-effective**. They too need to be examined carefully.

It is important **not to restrict subsidy reform to the identification and reform of environmentally harmful subsidies**. The reform process also needs to focus on those subsidies which have clearly outlived their purpose, are not targeted towards their stated objectives, or do not reach their objectives in a cost-effective manner. This is because of opportunity cost considerations: **phasing out ineffective subsidies frees up funds which can be re-directed to areas with more pressing funding needs**. From the perspective of TEEB, this includes rewarding the unrewarded benefits of ecosystem services and biodiversity.

Policy-makers already have a range of analytical tools to help them identify subsidies which offer potential benefits from reform, and assess the likely benefits, including for the environment. The growing number of **successful subsidy reforms around the world also provide useful lessons learnt**. Specifically, they show that the design of the reform process is a critical success factor.

Improving the **quality and comprehensiveness of available subsidy data and analytical information** is important for successful reform. **Transparency** is a key precondition for a well-informed public debate on current subsidy programmes, and can provide a powerful motivating force for change. **Dialogue and communication with stakeholders** including the wider public is needed in order to develop a clear set of agreed objectives and a **timetable** for reform.

Redoubled efforts are needed to reform subsidies. With a few exceptions, progress in reforming subsidies is generally too slow and protracted. The reasons are rooted in the political economy of subsidy reform and in some important cases are combined with technological and institutional barriers. Current public expenditure under the stimulus programmes of many countries will require stringent budgetary consolidation policies in the future. **Subsidy reform therefore needs to be a key element of current recovery measures and future budgetary consolidation policies** so as to free up increasingly scarce public resources and re-direct them towards more pressing areas.

The recent commitment of the G-20 to phase out inefficient fossil fuel subidies in the medium term is laudable and needs to be urgently expanded to other relevant subsidies and of course implemented. At the global level, the **removal of capacity-enhancing or effort-enhancing fisheries subsidies and the continued and deepened reform of production-inducing agricultural subsidies, still prevalent in most OECD countries, are priority areas for reform** for better conservation of ecosystems and biodiversity. Depending on national circumstances, most OECD countries need to complement these global priorities with **prioritised reform efforts in other sectors**, particularly those provided in the **water and transport sectors** in addition to **energy subsidies**. These sectors are also interesting candidates for subsidy reform in non-OECD countries, with specific priorities to be determined in light of national circumstances.

Governments should, in the **short run**, establish transparent and comprehensive **subsidy inventories** and assess their effectiveness against stated objectives, their cost-efficiency and their environmental impacts – bearing in mind that the size of a subsidy does not necessarily reflect the extent of its harmful effect. Based on these assessments, governments should develop **prioritised plans of action for subsidy removal or reform**, for implementation in the **medium term** (up to 2020). Windows of opportunity for earlier subsidy reform, arising within the existing policy cycles, should be proactively and systematically seized.

6 Reforming Subsidies

Subsidies are often inefficient, expensive, socially inequitable and environmentally harmful, imposing a burden on government budgets and taxpayers — all strong arguments for reforming the existing subsidy policies.

OECD (2005)

We commit our agencies to support our developing country partners in the design and implementation of fiscal reforms that raise revenue, advance environmental sustainability and assist in reducing poverty.

Statement signed in 2005 by Klaus Toepfer (then Executive Director, UNEP), Ian Johnson (then Vice President World Bank), Olav Kjorven (UNDP) as well as Ministers and government representatives from Denmark, EC, Finland, Germany, Sweden, Switzerland, and the United Kingdom

Chapter 6 addresses the need for comprehensive reform of subsidy policies to reduce harm to biodiversity and ecosystem services and improve effectiveness of public expenditures. **6.1** explains the **terminology and scale** of current subsidies. **6.2** explains how existing subsidies can fall short of their stated objectives and be cost-inefficient, and how **subsidies can harm or benefit the environment**. **6.3** provides a critical breakdown of **subsidies by major sector**, showing ways in which subsidies can be better designed for social and environmental goals. **6.4** presents a possible **roadmap for reform** with guidance on tackling specific obstacles. **6.5** concludes the chapter with **priority actions** for the way ahead.

6.1 SUBSIDIES AND THEIR IMPLICATIONS

Subsidies have been firmly on the international agenda for twenty years. Spurred on by studies by major international and non-governmental organisations in the 1990s, considerable analytical work has been undertaken in the last decade on their implications for the cost-effectiveness of government expenditures, social objectives and the environment.

Practical guidance is now available on identifying and reforming harmful subsidies. This builds on the considerable reform efforts made in various countries – efforts which in some cases have been successful. Lessons learnt from their experience indicate that **subsidy reform or removal can increase economic efficiency and reduce the burden on government budgets while alleviating environmental pressures**.

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6.1.1 WHAT ARE SUBSIDIES?

Subsidies come in many shapes and forms. They can include direct transfers of funds and potential direct transfers (to cover possible liabilities e.g. for nuclear accidents). They may consist of income or price support (e.g. for agricultural goods and water), tax credits, exemptions and rebates (e.g. for fuel), low-interest loans and guarantees, preferential treatment and use of regulatory support mechanisms (e.g. demand quotas). They can take the form of implicit income transfers when natural resources or services are not priced at full provisioning cost (e.g. water, energy).

Some subsidies are *on-budget* (clearly visible in government budgets or can be estimated from budget accounts) while others are *off-budget* (not accounted for in national budgets).

There are two internationally-agreed definitions of a subsidy but other key terms and definitions are also relevant and are used differently depending on the context (see Box 6.1).

Similarly, different measurement approaches are used for different purposes, sectors or contexts (e.g. international trade). Each approach to measurement has its own specific indicators.

6.1.2 HOW BIG ARE EXISTING SUBSIDIES?

The overall level of global subsidies is, quite simply, enormous. Despite a slightly declining trend in some instances, they add up to **hundreds of billions of dollars every year**. Subsidies to agriculture are amongst the largest, estimated at over US$ 250 billion/year in OECD countries alone. Subsidies to other sectors are also significant and probably under-estimated due to limited data and the specific measurement methodologies used (see Table 1.1).

Box 6.1: Subsidies: different definitions for different contexts

A subsidy: '… government action that confers an advantage on consumers or producers in order to supplement their income or lower their cost.' (OECD 2005)

The subsidy definition provided by the United Nations Statistics Division (UNSD) is used for constructing national accounts and covers only budgetary payments to producers. The more comprehensive World Trade Organization (WTO) definition is used for regulating the use of subsidies that affect trade and provides that **"a subsidy is a financial contribution by a government, or agent of a government, that confers a benefit on its recipients"**. This definition excludes general infrastructure provided by government.

Different definitions are used in different contexts, depending on the specific nature of discussions. Terms like 'transfers', 'payments' and the more generic terminology of 'support measures', 'assistance' or 'protection' are all common. In practice, these are sometimes used interchangeably even though they refer to instruments that partially overlap and are associated with different methods of measurement and, as a result, different indicators.

Not all contexts cover all issues. For example, the WTO definition does not include transfers from consumers to producers through border protection. This is one reason why the **broader term 'support'** is used in some contexts (e.g. OECD support estimates for agriculture).

One issue under debate is whether the formal definition of a subsidy should be expanded to include the non-internalisation of external costs. Those who object do so for analytical clarity (i.e. the notion of a subsidy traditionally implies an explicit government intervention rather than implicit lack of intervention) and also point to the practical challenges of computing externalities.

From the perspective of TEEB, what can be clearly stated is that the non-internalisation of externalities – or government inaction more generally – will frequently act like a subsidy. For example, not internalising pollution damages lowers costs to polluters in the market and thereby confers an advantage to them.

Table 6.1: Aggregate subsidy estimates for selected economic sectors	
Sector	**Region**
Agriculture	**OECD: US$ 261 billion/year (2006-8)** (OECD 2009) **Biofuels: US, EU and Canada US$ 11 billion in 2006** (GSI 2007; OECD 2008b)
Fisheries	**World: US$ 15-35 billion** (UNEP 2008)
Energy	**World: US$ 500 billion/year** (GSI 2009a) **US$ 310 billion in the 20 largest non-OECD countries in 2007** (IEA 2008)
Transport	**World: US$ 238-306 billion/year – of which EHS US$173-233 billion** (EEA 2005)
Water	**World: US$ 67 billion – of which EHS US$ 50 billion** (Myers and Kent 2002)

Although these estimates provide important indications of the order of magnitude of global subsidies, they are still **riddled with conceptual and data deficiencies**.

The agricultural sector has the most complete data in terms of comprehensiveness and methodology as well as some of the highest subsidy levels. In contrast, other sectoral coverage remains rather patchy even though considerable progress has been made in the past twenty years to formalise measurement methodologies.

We still have little or no subsidy data available for large parts of the energy and manufacturing sectors or for other environmentally significant sectors such as mining and forestry. Although these sectoral subsidies appear from Table 1.1 to be a pale shadow in comparison to agriculture, their actual support levels are probably underestimated due to incomplete coverage and methodological issues (IEEP 2007; OECD 2003a). Conversely, transport subsidy data may contain elements of over-estimation because measurement methodologies used for this sector often include non-internalised externalities. For these reasons, comparing subsidies across sectors is often difficult or potentially biased.

6.2 HOW SUBSIDIES CAN MISS THEIR MARK

6.2.1 DISTINGUISHING BETWEEN 'GOOD' AND 'BAD' SUBSIDIES

Subsidies are introduced or maintained for various social or economic reasons: to promote economic growth, secure employment or stabilise incomes by helping small producers. These are all 'good' – or at least politically rational - purposes.

However, subsidies all too often end up as long-term rigidities which distort prices and adversely affect resource allocation decisions, benefiting some producers to the detriment of others (including foreign producers). For analytical purposes, it is therefore important to **distinguish between the stated objectives of subsidies and their actual effects**.

The difference between 'good' and 'bad' subsidies often comes down to their specific design and implementation. Key questions (Pieters 2003) include:

- do they serve (or continue to serve) their intended purpose (effectiveness)?
- at what cost (efficiency)?
- how are the costs and benefits distributed (equity)?
- last but not least, are they harmful for the environment in general and for ecosystem services and biodiversity in particular (environmental impact)?

Answering these questions requires a careful **assessment covering all three dimensions of sustainable development** (economic, environmental and social) (De Moor and Calamai 1997; OECD 2005). The assessment process can help identify priorities for phasing out or reform; for instance, subsidies that have clearly outlived their rationale should receive close attention. When a subsidy programme is launched, policy-makers are often not fully aware of all its implications, including the risk of environmentally harmful effects. Ex ante strategic impact assessments, undertaken as an integral part of policy formulation, can help minimise or avoid such effects and many of the other pitfalls associated with subsidies (see Chapter 4). They can also help identify opportunities for better instrument design.

In reality, subsidy programmes rarely seek to implement a single clearly-defined policy objective. They tend to have a long, complex and somewhat chaotic history, having been introduced and amended over decades, often under political pressure, often without a long term strategic vision and frequently for multiple objectives (Barde and Honkatukia 2003).

This mix of explicit and implicit objectives sometimes creates a daunting barrier to reform. It means that subsidies can too easily be presented as 'multifunctional' – the argument being that we cannot afford to remove them. Disentangling the effects and purposes of subsidies and separating myths from reality are important preconditions for successful reform. This makes the issue of cost-effectiveness in achieving stated goals a very useful test (OECD 2003a).

We can see this clearly by looking at subsidies defended on social grounds, for instance, to support smaller marginal producers in critical sectors such as agriculture or fisheries. **However, a careful analysis of distributive effects reveals that many subsidies are actually not well targeted, which means they may not be very cost-effective**. In agriculture for example, a 2003 study showed that most subsidies in OECD countries went to larger farms (which tend to be the richer farms) and that only 25% of market price support ended up as net income gain for farmers; that is, the bulk of the difference ended up somewhere else in the value chain (OECD 2003c).

Box 6.2 provides another illustration of poor targeting, this time with regard to energy subsidies in developing countries.

Whenever social objectives are presented as justification for subsidies, the general rule is that the transfer effects of such subsidies should be at least neutral or, even better, contribute towards more equal distribution of wealth or income. **Put simply, subsidies should work to the benefit (or at least not the detriment) of socially marginalised populations.** This is frequently not the case. Subsidies that disadvantage such populations are prime candidates to consider for prioritised removal or reform (Steenblik et al. in OECD 2007).

Subsidy removal or reform does raise considerable challenges and is often far from a vote-winner. Subsidies are embedded in the policy landscape in most countries and are linked in different ways to a range of other instruments, reflecting different regulatory styles and traditions. Their effects and the potential benefits of their removal or reform – as well as the associated challenges – need to be understood in the context of these inter-connections.

Since subsidies are typically funded through either taxes or deficits, they put considerable strain on governmental coffers and ultimately on current or future taxpayers. Conversely, **phasing out a subsidy frees up funds which can help smooth the transition and/or mobilise public support for wider subsidy reform**. The funds released can be used for different purposes:

- for **general deficit reduction** or **lowering taxes**;
- to **fund alternative policies that target the original objectives of the subsidy more cost-effectively**;
- to be **re-directed to areas with more pressing funding needs** – e.g. to reward benefits of ecosystem services and biodiversity (see Chapter 5).

Box 6.2: Estimated distributional impact of energy subsidies in four developing countries

- In **Bolivia**, the poorest 40 per cent of households receive 15% of the total benefits from fuel subsidies; the richest 60% of households get 85%.
- In **Gabon**, it is estimated that the richest 10% of households capture 33% of fuel subsidies, while the poorest 30% (below the poverty line) receive merely 13%.
- In **Ghana**, the poorest 40% of households get 23% and the richest 60% capture 77% of the benefits of fuel subsidies.
- In **Ethiopia**, the highest-income 20% of the population capture 44% of fuel subsidies, while the lowest-income 20% get less than 9%.

Source: Rijal 2007

6.2.2 HOW SUBSIDIES CAN HARM OR BENEFIT THE ENVIRONMENT

An Environmentally Harmful Subsidy (EHS) is...
"a result of a government action that confers an advantage on consumers or producers, in order to supplement their income or lower their costs, but in doing so, discriminates against sound environmental practices".

Adapted from OECD, 1998 and 2005

Some subsidy types have been identified as critical drivers of activities harmful to ecosystems and biodiversity, resulting in losses of ecosystem services. They negatively impact the environment in two ways.

Under-pricing the use of natural resources. Even without subsidies, the price charged for using natural resources – if one is even charged in the first place – rarely reflects their real value in terms of the ecosystem services that they provide, which leads to overconsumption. This results from free markets that fail to incorporate negative externalities and from poorly defined property rights (see Chapters 2 and 7). Subsidies can aggravate this problem by reducing the price even further to below extraction cost. Their benefits often accrue to consumers of services, for instance, through provision of water and energy at low prices. This kind of subsidy can also lead to increased production if subsidised resources are used as an input e.g. irrigation subsidies to agriculture or energy subsidies to industry in general.

Increasing production. Many policies providing subsidies in OECD countries are implemented in order to support environmentally sensitive sectors e.g. agriculture, fisheries, energy production, transport and heavy industry. Support measures for producers that reduce costs or enhance revenue provide incentives to produce. This leads to increased use of possibly polluting inputs (e.g. pesticides, fertilisers) and higher production levels, which in turn aggravates the risk of environmental damage.

Support that is not conditional on production or input levels tends to be less environmentally damaging than other support mechanisms, although the overall level of the subsidy is also relevant.

The **size of a subsidy does not necessarily reflect the extent of its harmful effect** (OECD 2003a). Even relatively small subsidies can have a major negative impact. For example, subsidies paid to high seas bottom trawl fleets operating outside the Exclusive Economic Zones of maritime countries amount to around US$ 152 million/year (Sumaila et al. 2006). Bottom trawling practices have a major impact on the habitat of deep-sea demersal fish species which, with their long life span and low growth rate, are particularly vulnerable.

Quantifying the impacts on ecosystems and biodiversity is difficult due to the complexity of the analysis:

- first, the effects of subsidies on consumption and production depend on many factors, including what economists term **'price elasticities'** (relative increase in demand or supply of a good due to relative price changes), **'leakages'** (of support away from the intended targets of the subsidy) and the specific regulatory, tax and policy system in place;
- second, there are often several contributing factors, making it very challenging to disentangle the direct causality between subsidies and the exact extent of their environmentally harmful effects;
- third, ecosystem functioning is not fully understood. The strain put on ecosystems by increased production and consumption affects intricate inter-linkages of species in ways that are very difficult to predict and quantify. For instance, there may be 'threshold' levels of pollution and environmental damage beyond which adverse effects on biodiversity increase substantially.

The associated uncertainty, the possibility of rreversible damage and the alarming rate of current biodiversity loss all demonstrate the need to apply precautionary approaches. This could include reversing the burden of proof for damage i.e. requiring potentially damaging subsidy programmes to show, where appropriate, that they are not harmful to the environment (OECD 2003a).

All subsidies operate in the larger context of what Pieters calls a 'policy filter'. This includes a whole range of (environmental) policy tools such as: sustainability criteria (see UNEP and WWF 2007) or emissions standards; environmental taxes, charges or fees; production or extraction limits; tradable pollution or extraction quota etc. (Pieters 2003). These tools may counteract (some of) the adverse incentives created by subsidies. However, the tools applied may not always be successful. Their success depends on effective monitoring and ensuring compliance which can be too costly or beyond the institutional capacity of many States. Moreover, analysis of the political economy of subsidies suggests that, in the presence of large potential profits created by subsidies, lobbying by beneficiaries can lead to weak regulation.

It is important to stress that not all subsidies are bad for the environment. On the contrary: Some are used to correct specific market failures e.g. certain transport subsidies. Road transport and its environmentally harmful effects would further increase if public transport were not subsidised; conversely, removing or reducing support provided to private passenger transport, road haulage and air transport can potentially provide environmental benefits. Energy provides another example: many countries have substantial programmes to support renewable energy development and production - although for some programmes the claimed environmental benefits seem unclear (see below).

Subsidy programmes are already used to generate ecosystem benefits. A prime example concerns transfers to farmers under agri-environment programmes that compensate lost revenue (income foregone) arising from adoption of less harmful production methods. In a growing number of cases – e.g. payments for watershed protection that improves water provision to cities – such transfers can be characterised as payments for ecosystem services (see Chapter 5). Where there is a specific focus on increasing ecosystem service provision to provide a public good, the term 'subsidy' is arguably not appropriate (see Chapter 5 for further discussion).

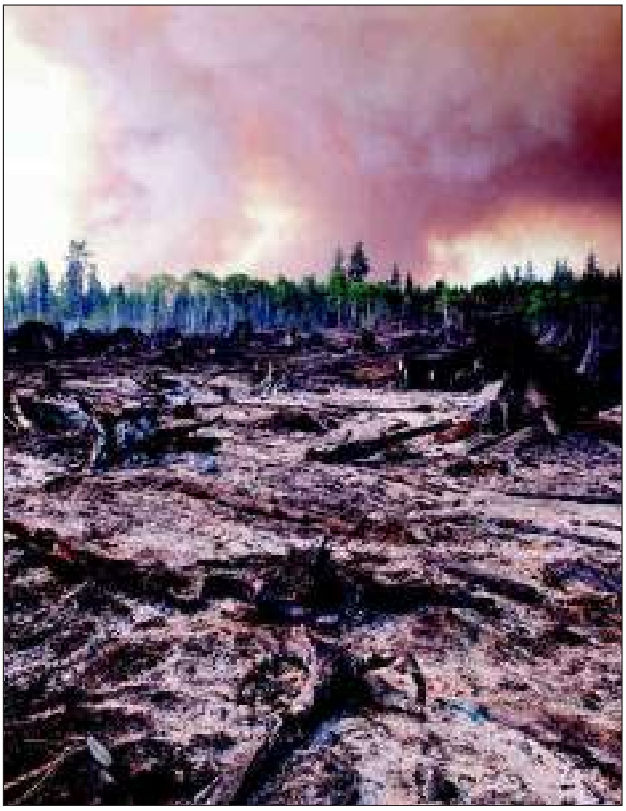
However, even **'green' subsidies can still distort economies and markets and may not be well-targeted or cost-effective**. This is not surprising as there is no a priori reason why 'green' subsidies should be superior in this respect. In some cases, they can even have unintended secondary impacts on the environment. In the fisheries sector, for example, vessel decommissioning schemes aim to reduce fishing capacity in order to reduce pressure on fish stocks, but they often have the unintended effect of creating additional rent that is re-invested in the same or another fishery (UNEP 2004a). For these reasons, even 'green' subsidies need to be examined carefully (OECD 2005).

It is important not to limit subsidy reform to environmentally harmful subsidies alone but rather to aim at a more comprehensive reform process, because:

- the identification and reform of ineffective and inefficient subsidies, even if not directly environmentally harmful, can free up considerable funds which could be used for more pressing environmental needs, such as rewarding the unrewarded benefits of ecosystem services and biodiversity;
- ensuring that 'green' subsidies are targeted and cost-effective will make their case stronger in the policy area/in the eternal tug-of-war over scarce public resources.

As repeatedly emphasised by the OECD in the context of agricultural production (e.g. OECD 2003b; OECD 2009), it is the coherence of the overall policy package which matters. 'Green' subsidies will remain higher than necessary for as long as they are used to offset damage caused by support policies that stimulate harmful production. Simply **introducing new 'green' subsidies without analysing and reforming the entire subsidy landscape runs a high and foreseeable risk of not being cost-effective**.

Lastly, data gaps and lack of certainty over the specific size of subsidies should not lead to delaying action to identify and remove or reform subsidies that are identified as environmentally harmful and/or not cost-effective. With fisheries on the verge of collapse, CO_2 emissions still on the rise and the 2010 Target of significantly reducing the rate of loss of biological diversity all but unreachable, "there is little need to calculate our precise speed when heading over a cliff" (Myers and Kent 1998).



6.3 SPECIFIC IMPACTS OF SUBSIDIES ACROSS SECTORS

6.3.1 AGRICULTURE

Subsidies to agriculture are amongst the largest and merit special attention in light of the sector's critical importance for food security and development. Those providing incentives to produce can lead to increased environmental damage, typically by stimulating agricultural intensification and/or expansion (land use change).

Intensification refers to an increase of agricultural production on a given acreage (through e.g. application of more fertilisers and other agricultural chemicals, more irrigation, more mechanisation). The most significant environmental impacts can include:

- loss of non-target species, including pollinators, due to direct and indirect effects of pesticides;
- reduced habitat diversity due to consolidation of holdings, removal of patches of non-farmed habitats and boundary features, and greater regional specialisation;
- loss of biodiversity-rich extensive farmlands (e.g. semi-natural grasslands) due to increased fertiliser use or increased grazing;
- hydrological changes to habitats as a result of drainage or irrigation (e.g. leading to wetland loss and reductions in groundwater levels from over-abstraction);
- eutrophication of freshwater and marine ecosystems from fertilisers and nutrient rich run-off (see Box 6.3);
- eutrophication of terrestrial ecosystems from deposition of airborne nutrients, particularly ammonia, from intensive livestock systems; and
- soil degradation and erosion e.g. from routine cultivation.

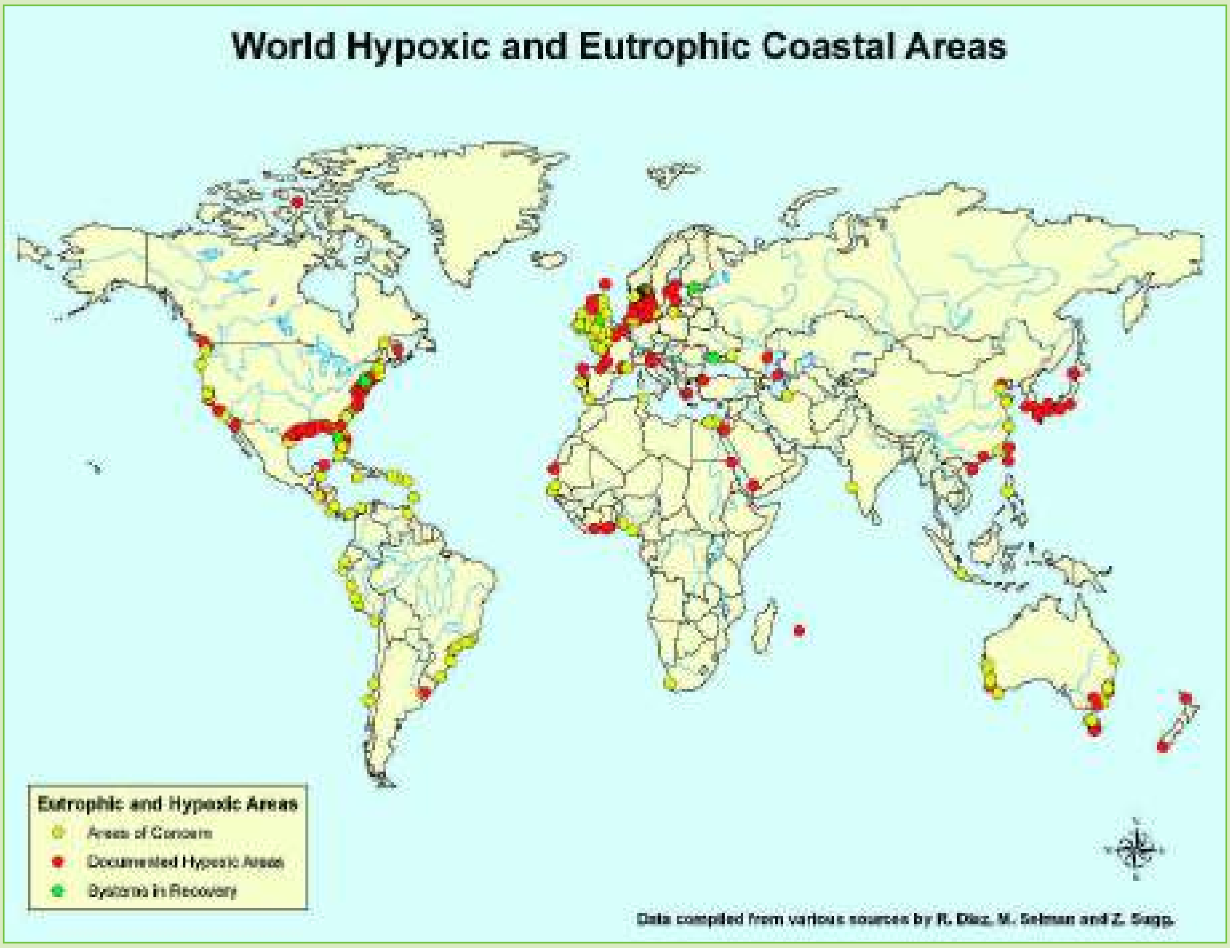
Incentives to increase production may also encourage the conversion of more natural ecosystems into farming areas (land use change). Conversely, subsidy removal or reform could lead to contraction of agricultural land. This could have positive impacts for ecosystems and biodiversity in areas of highly mechanised and specialised production, provided that effective long-term conservation policies are in place to restore the original non-agricultural habitats e.g. wetlands (George and Kirkpatrick 2003).

However, agricultural land contraction could have negative biodiversity impacts if affected areas are located in extensive farming regions where traditional practices play a key role in creating site-specific biodiversity, soil properties and landscape amenities (OECD 2003d; EEA 2004). High nature value (HNV) farmlands include semi-natural areas as well as features like hedges, walls, trees and buffer zones created as an integral part of farm management. In such regions, high agro-biodiversity actually depends on continuing these practices (see Box 6.4).

Box 6.3: Knock-on impacts of intensive agriculture: coastal 'dead zones' continue to spread

Fertiliser run-off and fossil fuel use deprive massive areas of the ocean of any or enough oxygen, killing large swathes of sea life and causing hundreds of millions of dollars in damage (Juncosa 2008).

Expanding coastal dead zones caused by nutrient run-off not only spell trouble for biodiversity but also threaten the commercial fisheries of many nations. Dead zones form seasonally in economically vital ecosystems worldwide, including the Gulf of Mexico and Chesapeake Bay. Agricultural run-off sparks many of these die-offs; increased use of nitrogen fertilisers has doubled the number of lifeless pockets every decade since the 1960s, resulting in 405 dead zones now dotting coastlines globally. The map below splits the sites into documented hypoxic areas, areas of concern and systems in recovery.



Source: WRI 2009

Box 6.4: The EU Common Agricultural Policy (CAP) and its impacts on biodiversity

The CAP has stimulated important structural shifts in farming, investments and technological developments, which has led to resulted in widespread agricultural intensification in the EU. This intensification has had well-documented impacts on biodiversity, including birds, since the 1970s. According to the Pan-European Common Bird Monitoring Scheme (2007), the farmland bird index (an indicator of the health of European farmland ecosystems) has declined by almost 50% in the last 25 years. Non-crop plants and invertebrates have also declined massively, mainly due to fertiliser and pesticide use.

Many of the remaining species-rich agricultural habitats are rare or much reduced. A high proportion of rare and vulnerable species of EU importance are associated with these threatened semi-natural habitats and agricultural landscapes. Many of these habitats and high nature value farming systems, if not threatened by intensification, are at risk of abandonment as they are typically of marginal economic value. These depend on CAP payments designed to support farming in disadvantaged areas or to support environmentally beneficial practices (see also Box 6.5).

Extensive farming systems with high agricultural biodiversity are often located on marginal land (i.e. land that would be taken out of production first when production-inducing subsidies were removed). Stopping production would have negative effects on biodiversity with subsequent losses of related ecosystem services (OECD 2000c).

The close links between biodiversity and extensive farming on marginal land raises a twofold policy challenge:

- to keep these marginal lands under production and preserve traditional practices;
- to take out of production those infra-marginal lands that could deliver significant positive impacts for biodiversity if converted into natural habitats.

This observation does not imply support for production-inducing support in general. It simply recognises the fact that **subsidy reduction or removal is not enough, in isolation, to meet the challenge of maintaining biodiversity-rich extensive farming systems** (see Chapters 5, 7 and 8 for additional policy tools which can be used to preserve ecosystems and biodiversity associated with agriculture).

As with other subsidies, **production-increasing support is more environmentally harmful than support which is 'decoupled' from production**. Since the 1990s, spurred on by the Uruguay Agreement on Agriculture, many OECD countries have increasingly re-designed their support policies in favour of more decoupled measures which are exempt from the Agreement's disciplines under the so-called 'Green Box' (see example in Box 6.5).

Copyright: André Künzelmann / UFZ

Box 6.5: Reforming production subsidies: example of the EU CAP

The 'Agenda 2000' reform of the EU's Common Agricultural Policy (CAP) foresaw gradual reductions in market price support and increasing reliance on direct payments, coupled with rural development programmes and agri-environmental measures under the CAP's 'second pillar'.

In June 2003, after difficult negotiations, EU farm ministers adopted a compromise providing for:

- the introduction of a single farm payment for farmers that is independent from production for the CAP 'first pillar', whose level would be based on historical support payments;
- linkage of this payment to compliance with environmental, food safety, animal health and animal welfare standards ('cross-compliance');
- a reduction in direct payments for bigger farms ('modulation') and transfer of this money to the European Agricultural Fund for Rural Development to finance the new rural development policy (the second pillar); and
- some revisions to the CAP's market policy.

The 2008 agreement pursuant to the CAP 'Health Check' foresees, amongst other measures, the phasing out of some remaining coupled payments as well as increased modulation.

Many agri-environment programmes under the second pillar have generally positive impacts for biodiversity and ecosystems (Boccaccio et al. 2009). However, it is noteworthy that eight years after the introduction of this reform, most support still comes under the first pillar – even though it is gradually approaching an equal share with the second pillar.

Although less environmentally harmful than earlier support policies, the sheer magnitude of support under the first pillar gives reason for concern, because of the limits to decoupling as well as opportunity cost considerations. While cross-compliance and modulation do contribute to better targeting of payments for environmental and social objectives (see Alliance Environnement 2007), it is doubtful that these instruments currently maximise the cost-effectiveness of payments for such objectives.

In 2006-2008, 51% of support measures as measured by the OECD Producer Support Estimate (PSE) took the form of output-based payments (including market price support) or payments based on variable inputs. This was down from 82% in 1986-88. The reduction corresponds to a general decline in the relative level of producer support as a percentage share of total farm receipts, from 37 % in 1986-88 to 23 % today (OECD 2009).

Hence, progress is clearly being made, but more reform efforts are needed:

First, more than half of all support is still directly increasing production. In this context, the OECD cautions that progress on subsidy reform is uneven among OECD countries. It also notes that a significant part of the recent decline in support levels is a consequence of high world prices for agricultural commodities, without any explicit changes in government policies (OECD 2009).

Second, it has to be borne in mind that decoupling can never be complete because of real-world phenomena like market imperfections, risk and political dynamics (OECD 2000b). Under imperfect capital markets, for instance, any kind of income support would be partially reinvested in agriculture, generating additional production in future years. If wealthier farmers are ready to assume more risks, any payment – by increasing their wealth – will affect their production decisions (OECD 2000b). Moreover, scale also matters: even relatively small impacts may add up to a large aggregate distortion if the overall volume of the subsidy is high. These distortions may include the production decisions of potential foreign competitors.

Better targeting of decoupled support measures for specific income objectives or market failures remains a major challenge of ongoing policy reforms in OECD countries (OECD 2009). This includes agri-environment payments. A 2005 analysis of EU agri-environment payments noted generally positive effects of the measures on habitat preservation, but called for development of more impact-oriented monitoring, of evaluation procedures that are better adapted to the variety of issues, as well as for better targeting of measures for the most problematical farms and the most environmentally sensitive areas (Oréade-Breche 2005). The OECD stresses that both decoupling and targeting are among the policy principles that have shown to improve effectiveness, efficiency and equity of policies, and should continue to inspire future policy design (OECD 2009).

Support measures that encourage agricultural production are considered to distort potential trade flows and are therefore slated for 'substantial reductions' in the agricultural trade negotiations under the Doha work programme of the World Trade Organization (WTO). These negotiations also seek to review and clarify the 'Green Box' criteria, while ensuring that due account is taken of non-trade concerns, including environmental objectives (WTO 2004). While the **successful conclusion of the negotiations has the potential to create synergy with the objectives of preserving ecosystems and biodiversity**, the positions of WTO Members are still divergent. The agricultural negotiations remain one of the major stumbling blocks to the successful conclusion of the Doha work programme.

6.3.2 FISHERIES

"More than a decade after adoption of the 1995 U.N. Code of Conduct for Responsible Fisheries, putting an end to overfishing remains a fundamental global challenge… Progress towards improved fisheries subsidies policies has been made since 1997,…but the real work of ending harmful fisheries subsidies has just barely begun".

Achim Steiner, Executive Director, UNEP, and James P. Leape, Executive Director, WWF. Source: UNEP and WWF (2007)

Although subsidies to fisheries are much less substantial than those to agriculture, they are significant both in terms of their potential impact on the environment and also relative to the size of the industry in several countries. For instance, in some EU Member States, fisheries subsidies are higher than the economic value of landings.

Addressing their negative environmental impacts is **a matter of particular urgency as almost one third of global marine fisheries are close to collapse or have already collapsed**. According to the 2008 Fisheries Report by the Food and Agriculture Organization of the United Nations (FAO):

- 28% of marine capture fish stocks monitored by FAO are either overexploited, depleted or recovering from depletion and are yielding less than their maximum sustainable yield (up from 25% in the 2006 report);
- 52% are fully exploited, producing at or close to their maximum sustainable yield;
- the remaining 20% are underexploited or moderately exploited (down from 25% in the 2006 report). Although this figure might imply that more could be produced, it must be borne in mind that at least some of these stocks are low-value species or consist of species for which harvesting may be uneconomical under current market conditions (FAO 2006 and 2008; map presented in Chapter 1).

The fact that some types of **fisheries subsidies can lead to increased fishing effort, and thus have negative impacts on the level of fish stocks**, is universally accepted in the literature on fisheries subsidies (UNEP 2004a). **Excessive capacity or catching power of global fishing fleets has been identified as a main cause of unsustainable fishing levels** (Porter 2001). While industrial fleets play the dominant role in overfishing due to their technology and size, the small-scale fishing sector sometimes also plays a role (see Box 6.6).

Yet, despite considerable overcapacity in the fishing industry, governments continue to subsidise the sector. This encourages further fishing effort which contributes to the decline in global stocks. Paradoxically, the industry is being undermined by the very subsidies supposed to protect incomes in the industry (OECD 2003a, see also Box 6.7). Nowhere is the nexus between sustainably using natural resources and protecting livelihoods more dramatically and tragically visible than in former fishing regions where fisheries have already collapsed.

To help us assess the impact of fisheries subsidies on stocks and the environment generally, we can conceptually distinguish different management regimes (though stylised, they reflect key features of real world management regimes: OECD 2006b; Hannesson 2001).

Box 6.6: The Environmental Impact of Subsidies to the Small-Scale Sector in Senegal

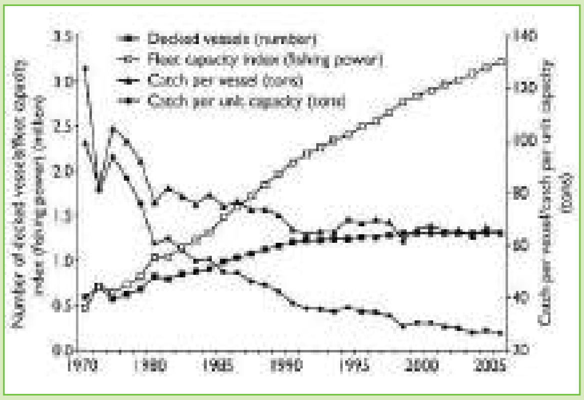
In the late 1970s, the Senegalese authorities started to provide direct support to fisheries, initially to the industrial sub-sector only but later also to small-scale fisheries. As a consequence, the small-scale fishery started to produce more for export than for the domestic market. Fishing effort of small-scale fishing units intensified, aggravating the pressure already exerted on demersal fish stocks by Senegalese and foreign trawler fleets. Today, factories receive 60% of their supply from small-scale fishing units. Most marketed species in this category are now in danger of biological collapse.

Source: UNEP 2003

Box 6.7: Sunken Billions

The contribution of the harvest sector of the world's marine fisheries to the global economy is substantially smaller than it could be. Using a stylised and simple model, a World Bank report estimates the lost economic benefits to be in the order of US$50 billion annually – representing the difference between the potential and actual net economic benefits from global marine fisheries.

Despite increased fishing effort, the global marine catch has been stagnant for over a decade whereas the natural fish capital – the wealth of the oceans – has declined. At the same time, the margin has narrowed between the global costs of catching and the value of the catch. The lost benefits or the difference between the potential and actual net benefits can be largely attributed to two factors. First, depleted fish stocks mean that there are simply less fish to catch and the cost of catching is therefore greater than it could be. Second, massive fleet overcapacity, often described as 'too many fishers chasing too few fish' means that potential benefits are also dissipated through excessive fishing effort.



Source: World Bank and FAO 2008: 21

Under pure *open access*, standard economic analysis shows that over-exploitation of the resource results even without subsidies. However, it is generally agreed that the introduction of some subsidies would make a "bad situation worse" by further increasing exploitation (OECD 2000a; WTO 2000; Munro and Sumaila 2002; UNEP 2004a). This would be true for any subsidy that:

- increases the producer price of the resource (i.e. the price for fish received fishers);
- reduces the operating costs per unit (i.e. per fishing vessel); or
- reduces the purchase price of vessel capital (Munro and Sumaila 2002).

The FAO estimates that 90% of global fish production comes from within the 200 nautical mile exclusive economic zones (EEZ) of coastal States that are recognised under the UN Convention on the Law of the Sea (UNCLOS) and accordingly come under national jurisdiction. If national authorities could retain tight control over the Total Allowable Catch (TAC) in their EEZ, subsidies should have very limited consequences on fish stocks. In many cases, they would prove to be neutral provided that the TAC was fixed at sustainable levels (Munro and Sumaila 2002; UNEP 2004a; OECD 2006b).

In practice, such tight control over total catch is very difficult to achieve and is made more difficult by subsidies. Fisheries with excessive capacity are characterised by a 'race for fish' which puts strong pressure on the individual fisher's profits. This gives fishers especially strong incentives to exceed catch limits and underreport their catch, which aggravates monitoring and enforcement problems of coastal states. **The value of illegal, unreported and unregulated fishing (IUU) is currently estimated to amount to US$ 10 – 23.5 billion per year** (Agnew et al. 2009).

Furthermore, if there is no additional control on fishing effort e.g., through restrictions on the number of boats or how they are used, additional labour and capital will be attracted to the sector to the point where resource rents are competed away. The resulting fleet overcapacity will, in turn, often generate political pressure on fishery authorities to set catch limits beyond sustainable levels (WTO 2000).

In principle, TAC control could be supplemented with additional controls over fishing effort, mainly through restrictions on the number of vessels, the amount of time they are allowed to fish and on fishing gear and techniques. However, despite the best efforts of regulators, it is not always possible to identify and control all the variables that determine fishing effort and it is possible that fishers can expand their effort along uncontrolled dimensions to increase effective effort. As the industry adapts to new restrictions, a race can result between development and application of new regulations on the one hand and the implementation of effort-increasing measures by fishers on the other. This phenomenon will aggravate the ever-present limitations in monitoring and enforcement capacity.

Given such constraints, **capacity enhancing subsidies should be seen as generally environmentally harmful**. These include (see further UNEP 2004a):

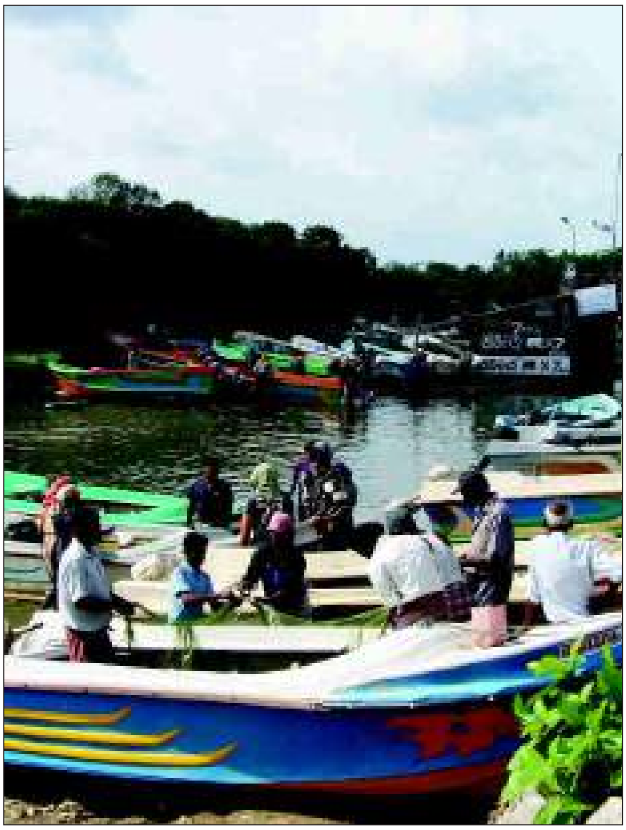
- **subsidies for fleet expansion and modernisation** (grants, low-interest loans, loan guarantees) as these reduce the purchase price of vessel capital;
- **payments to countries for the exploitation of fish stocks** in their EEZ by foreign fishing fleets. These constitute subsidies to the relevant fishing industry if not fully recuperated from the relevant companies;
- **tax preferences for intermediate inputs**, because they reduce the operating costs per vessel. Empirical studies confirm that tax preferences for fuel encourage the purchase of vessel with larger, fuel-intensive engines that, in turn, increase fishing ranges and enable larger catches.

A 2007 study of the University of British Columbia estimates global fisheries subsidies at US$ 30 to 34 billion, of which at least US$ 22 billion exacerbate overcapacity (see Box 6.8).

Removing subsidies will make the task of effective management easier, but in itself will not be effective in achieving conservation goals if the underlying management regime is not also fixed at the same time (see boxes 6.9 and 6.17 on the fisheries reform in Norway and New Zealand).

Some progress has been made in the context of the current WTO negotiations on fisheries subsidies. There is broad support among WTO members for strong rules (or 'disciplines') on fisheries subsidies. However, some developing country members wish to keep policy space for subsidies deemed necessary for diversification and development of certain industries. It is widely recognised, nevertheless, that any subsidies permitted should not lead to overcapacity and overfishing.

A key element in this respect has been the development of 'sustainability criteria' by UNEP and WWF which can help ensure that subsidies falling outside a possible WTO ban do not have harmful impacts on fisheries resources (UNEP and WWF 2007).



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Box 6.8: Fisheries subsidies – the good, the bad, and the ugly

A 2007 study of the University of British Columbia classifies and analyses fisheries subsidies by their effects and impacts – the good, the bad, and the ugly.

Good subsidies encourage the growth of fish stocks by supporting conservation activities and the monitoring of catch rates, through fisheries management programmes and services, and fishery research.

Bad subsidies reduce the cost or enhance the revenue of fishing activities, thus exacerbating overcapacity.

Ugly subsidies are programmes that have the potential to increase capacity and result in harmful impacts, depending on the context and application, such as vessel buyback schemes or fisher assistance programmes.

The study estimates the worldwide level of fisheries subsidies to be US$ 30 to 34 billion, out of which at least US$ 20 billion are bad subsidies. Out of those, US$ 6 billion are for fuel alone. Another US$ 3 billion are characterised as 'ugly subsidies – they are found to be potentially harmful depending on the context and programme. Only US$ 7 billion are characterised as 'good' subsidies.

Source: Sumaila and Pauly 2007

Box 6.9: Removing fishery subsidies in Norway

Norway's experience shows that it is possible to drastically reduce subsidies – which had seemingly become a permanent lifeline – without destroying the industry. From a peak of US$ 150 million/year in 1981 (amounting to approximately 70% of the value added in the industry), these subsidies were reduced by 1994 to only US$ 30 million. Norway's successful reform was probably made easier by timing and measures that smoothed the transition to a more self-supporting industry. Although the number of fishers has declined, the fisheries sector is now self-supporting and in many ways healthier than it was at the height of subsidies.

Subsidy reform may also have contributed to improved fish stocks – although this effect is difficult to isolate from other factors e.g. variability of stocks, improved management regime and the fact that Norway shares its stocks with its neighbours. Nevertheless, cod and herring stocks went up by 110% and 1,040% respectively between 1981 and 1996 as fisheries subsidies were reduced by 85% in conjunction with more effective management measures.

Norway's success was due to several factors. First, optional employment opportunities existed for fishers who 'lost out' in the immediate aftermath of the subsidy removals, as the reforms were undertaken during good economic times. Secondly, the fall in oil prices in 1986 deprived the government of revenue and convinced many of the need for significant reform. Third, there was external pressure in the form of various multilateral agreements. Finally, the transition was gradual which helped fishers to take steps to prepare for the changes. The government combined the transition with other social measures to lessen the impact on those who had come to depend on the subsidies.

Source: OECD 2006b

6.3.3 TRANSPORT

The transport sector is a major contributor to global greenhouse gas (GHG) emissions, local air pollution and noise emissions but still benefits from large subsidies. One group of subsidies take the form of fuel prices kept below production cost. By increasing vehicle use and travel, these aggravate air pollution (i.e. release of noxious gases such as nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) and sulphur dioxide emissions as well as particulates). Vehicles are a major source of GHG emissions – by 2020 global CO_2 emissions from motor vehicles are projected to increase by approximately 83% from 1995 levels. **Emissions associated with the transport sector will have important direct and indirect impacts for ecosystems and biodiversity.**

Another type of subsidy includes direct grants for building road infrastructure not recovered by receipts (through e.g. fuel taxes or charges) and for roads that are not deemed general infrastructure. This is rather a grey area as some roads ostensibly provide a general infrastructure service - even though in reality access to remote areas may disproportionately benefit specific industries such as mining or forestry.

Land use change from the construction of transport infrastructure threatens biodiversity. Encroachment destroys and fragments habitats and has significant impacts on viability of ecosystems and species populations (see Kettunen et al. 2007 for a European perspective). Deforestation patterns in 152 countries, analysed in a recent study, showed that road construction and improvement is one of the three main proximate causes of deforestation (CIFOR 2006). By reducing transport costs, these roads promote forestry in remote areas, open up areas of undisturbed, mature forests to pioneer settlement, logging, and agricultural clearance and also provide access for hunters and poachers. The study recommended that a key government reform to slow tropical forest deforestation would be to reduce or eliminate expenditure on road building near priority conservation areas and to reduce fossil fuel and transport cost subsidies (CIFOR 2006).

Road construction also creates physical barriers to wildlife movement and fragments previously continuous blocks of habitat into smaller areas that may be less able to support complex communities of plants and animals. This could remove ecological 'corridors', isolating members of a species genetically and geographically (Fahrig 2003; Crooks and Sanjayan 2006). Because populations tend to decrease in smaller fragments of habitat, this will increasingly threaten species requiring large home ranges. A recent study by the World Resources Institute on forest fragmentation in six central African countries found that roads have reduced the proportion of forest in large unfragmented blocks from 83% to 49% of the total forest area. In general, **infrastructure expenditure would be less harmful to the environment if it were focused on already opened-up areas** (CIFOR 2006).

As noted in section 6.1, subsidies to some types of transport can also be beneficial to the environment, for instance, those to railways and public transport can reduce car use as well as emissions and local air pollution.

Box 6.10: reforming water subsidies in the Czech Republic

Until 1990, water pricing covered only a fraction of its real cost as it was only €0.02 per m^3. This low price led to indirect subsidisation of water extraction, treatment and distribution. This hidden subsidy was removed in the 1990s, moving to full cost recovery. By 2004 the cost of water had reached €0.71 per m^3. The reform also addressed fees for withdrawing both surface and ground water and discharge of waste water. As a result, water withdrawals between 1990-1999 decreased by 88% in agriculture, 47% in industry and 34% in public water mains.

Source: IEEP et al. 2007

6.3.4 WATER

Water services provision is subsidised by charging rates that do not cover operating and management costs (below-cost pricing), possibly combined with preferential treatment for some user groups (e.g. lower rates for irrigation water). In many countries, water charges have historically been – and in some cases still are – very low. This reflects the view that the provision of such basic services is seen as a duty of government and that access is considered a right.

Although such subsidies are often justified on social grounds, particularly for drinking water, at present **they often do not reach poor consumers effectively**. This is because the poor in many developing countries do not have access to piped water networks in the first place: many pay considerably more for water as they have to rely on private vendors. A recent World Bank study on consumption subsidies for electricity and water in four African countries found that, despite sizable subsidy levels, only 20 to 30% of poor households in the four countries are connected to the utility networks (Komives et al. 2005).

Below-cost pricing, together with low collection rates, results in cash-strapped utilities which can lead to inadequate operation and maintenance. An estimated 40-60% of water delivered by utilities in developing countries is lost due to leakage, theft and poor accounting (IEA 2005). Moreover, cash-strapped utilities will rarely have the necessary funds to expand the network to the poorest neighbourhoods.

Below-cost pricing leads to water over-use and wastage. Associated impacts include falling water tables, reduced availability for other user groups, additional investment needs for water provision (e.g. wells for farmers and households) and, in some cases, damage to the aquifer itself (salt water intrusion and increased pollution). Reforming water subsidies is increasingly urgent in the light of climate change: by 2050, the IPPC projects that the area of land subject to increasing water stress will be more than double the land with decreasing water stress.

In the agriculture sector, the price of irrigation water has been generally low in many countries and its use consequently high. **Irrigation accounts for 75% to 90% of total water use in developing countries and for over one third of water use in many OECD countries.** Irrigation subsidies are again often justified on social grounds, that is, the need to support low income farmers. However, **subsidies generally benefit all farmers indiscriminately and tend to exacerbate waste and to encourage cultivation of water-intensive crops**.

Area-based tariffs for irrigation water are far more common than other payment schemes such as charges based on the volume of water used. Schemes not based on volume give less incentive to conserve water, and this will be exacerbated by subsidized tariffs. For instance, a study of irrigation projects in Brazil revealed that the single most important cause of water over-use was the excessive length of irrigation time (OECD 2003a).

Box 6.11: Targeting water pricing against social objectives

Maltese water pricing uses a 'rising block' system where at lower levels of household water use, the rate per m^3 is significantly lower than for higher use. In 2000 there were nearly 13,000 accounts in the social assistance category. This group represented around 4% of total water use in Malta and around 6% of domestic use. The average consumption charge for the social assistance tranche was 0.56 €/m^3, while for the general residential sector it was 0.79 €/m^3. Rates are higher for higher levels of consumption, but no tariff is charged for 'lifeline' consumption levels below 5.5m^3/person per year. Rates also vary by economic sectors with the highest charges paid by those where affordability is higher i.e. tourist and commercial sectors (1.98 €/m^3) and government (2.59 €/m^3).

Source: GHK et al. 2006

Water scarcity, particularly in water-poor countries, can be exacerbated by cultivation of water-intensive crops (where climate conditions and rainfall patterns should dictate otherwise) and outright waste of water. In Europe as a whole, agriculture accounts for about 24% of total water use, but this reaches up to 80% in parts of Southern Europe (EEA 2009) where, despite evidence of desertification, crops like corn and strawberries are still grown. Water scarcity is expected to further increase in these already semi-arid or arid areas. The Mediterranean basin, together with the western USA, southern Africa and north-eastern Brazil, are particularly exposed to the impacts of climate change, which is projected to further decrease their water resources (IPCC 2007).

The negative impact of subsidised water prices on water resources is increasingly recognised. Several countries are already moving towards full cost recovery. Mexico is often cited as an example of a country that, after wide-scale reform of the agriculture sector, has substantially reduced irrigation subsidy levels, with many irrigation schemes now achieving financial self-sufficiency (Kloezen 2002; Cornish et al. 2004). The EU Water Framework Directive requires EU Member States to take into account the principle of full cost recovery in water pricing policies, in order to promote a more efficient use of resources (see also Boxes 6.10 and 6.11 for country cases and Chapter 7).

6.3.5 ENERGY

> ***"Much greater national and international efforts are indispensable to reduce those subsidies that enhance fossil-fuel use and thus act as a hurdle to combating climate change and achieving more sustainable development paths".***
>
> Achim Steiner, Executive Director UNEP. UNEP 2008a

The effects of energy subsidies on the environment vary depending on the type of energy source subsidised. **Subsidies to fossil fuels are of particular concern. According to the International Energy Agency (IEA), the fossil fuel industry is among the most heavily subsidised economic sectors (IEA 2005).** A recent estimate of the Global Subsidy Initiative calculates producer and consumer subsidies to be at least US$ 500 billion a year globally (GSI 2009a). This is **equivalent to 1% of world gross domestic product**, the figure that the Stern Review estimated necessary to stabilise the world temperature rise to 2°C (Stern 2006).

Fossil fuel subsidies lead to increased noxious and GHG emissions while extraction of some fuels creates a huge ecological footprint. They also act as a disincentive to use alternative technologies or introduce efficiency measures, and can thus lead to a technology 'lock-in'. Several studies have attempted to estimate the GHG emissions reductions which could be achieved by reforming such subsidies. The OECD (Barniaux et al. 2009) estimated the **consumer subsidies removal in the 20 largest developing countries would reduce global GHG by 2% in 2020, rising to 10% in 2050**.

Energy subsidies for producers, the most common form in OECD countries, usually come in the form of direct payments and tax breaks or as support for research and development. Consumption subsidies have been mostly eliminated in the OECD but remain important in many developing countries. Electricity and household heating and cooking fuels are usually the most heavily subsidised: some countries also subsidise road transport fuels (GSI 2009b).

Despite the difficulties in measuring the impacts of these subsidies, partial analyses suggest that the **reform of energy subsidies can significantly reduce GHG emissions and air pollution and be undertaken without severe social implications** (see case studies in Boxes 6.2, 6.12 and 6.13). Against this background, the recent commitment of the G-20, given at the Pittsburgh Summit in September 2009, to phase out inefficient fossil fuel subsidies is highly welcome and should be replicated by others.

In some cases, subsidy reform may also have direct positive impacts for ecosystems and biodiversity. For instance, peat mining is still subsidised in some countries as a major indigenous energy source even though it destroys biodiversity-rich bogs (see Kirkinen et al. 2007).

Box 6.12: Fuel subsidy reform in Ghana

In 2004, it became apparent that Ghana could not long maintain its policy of subsidising petroleum products. Guided by a steering committee of stakeholders from ministries, academia and the national oil company, the government launched a poverty and social impact assessment (PSIA) for fuel, completed in less than a year. By the time the government announced 50% price increases in February 2005, it was able to use the PSIA findings to make its case for liberalising fuel prices to the public—including the fact that existing price subsidies most benefited the better-off. The minister of finance launched a public relations campaign with a broadcast and a series of interviews explaining the need for the price increases and announcing measures to mitigate their impact. These measures, which were transparent and easily monitored by society, included the immediate elimination of fees at government-run primary and junior secondary schools and a programme to improve public transport. While the trade unions remained opposed to the price increases, the public generally accepted them, and no large-scale demonstrations occurred.

Source: Bacon and Kojima 2006

Some consumer energy subsidies may be justified on environmental or social grounds e.g. switching away from wood and other traditional energy sources (straw, crop residue and dung) can reduce deforestation caused by wood burning and reduce indoor air pollution. The argument that these subsidies are pro-poor is particularly pertinent where institutional preconditions for potentially more efficient social policies are poor or absent (e.g. for redistribution of income through progressive income taxation systems).

Nevertheless, there is often substantial scope for reform, in particular if the poor do not benefit from the subsidy because they do not even have access to the service (e.g. consumer electricity subsidies where the poorest are not connected to the grid). Once again, it is the medium to high income groups who benefit from a subsidy. One way of reducing harmful subsidy impacts is to set 'lifeline' rates limiting subsidies to low consumption levels and to target spending on expanding grids into poorer neighbourhoods.

Subsidies are also used to encourage the development and use of renewable (non-fossil) energy sources in order to fight global warming and achieve long-term energy security. However, these may have other environmental consequences. For instance, hydroelectric dams can result in the loss of wildlife habitat and reduce biodiversity (McAllister 2001). Batteries for solar home systems can leak toxic heavy metals. Wind farms can have significant biodiversity impacts, especially if inappropriately located (UNEP 2005; Drewitt and Langston 2008). These impacts need to be carefully assessed and considered in decisions on whether and how to support the development and use of renewable energy sources.

Box 6.13: Removing fuel subsidies in Indonesia

Before raising fuel prices in October 2005, the government of Indonesia put into place a cash transfer scheme targeting 15.5 million poor and near-poor households (some 28% of the population). The transfers (quarterly payments of about US$ 30 per household) lasted for one year. The scheme was widely publicised through newspapers, village notice boards, television talk shows and pamphlets with answers to frequently asked questions.

Though prepared quickly, the programme has performed well. The rapid rollout was followed by many media reports about initial problems, including mistargeting and leakage. The government responded quickly, commissioning an early assessment of the programme which pointed to satisfactory results overall, with transfers made on time and beneficiaries expressing satisfaction.

For poor recipients the cash transfers easily compensate for the fuel price increase. Even with moderate mistargeting – with cash benefits randomly distributed to the poorest 40% rather than the targeted 28% – the programme was expected to prevent an related increase in poverty.

As a consequence, the sharp rise in fuel prices passed without major public protest.

Source: Bacon and Kojima 2006

Biofuels illustrate the complex relationship between renewable energy subsidies and environmentally damaging impacts. Various subsidies are used to encourage production and consumption of biofuels which are promoted as a way to simultaneously increase energy security, reduce GHG emissions, and encourage rural development. These subsidies are provided at different points in the supply chain and include support for intermediate inputs and value adding factors, output linked subsidies, subsidies to distribution infrastructure, consumption incentives and high import tariffs. Several countries have also introduced targets and mandatory requirements that encourage biofuel development.

However, recent analysis suggests that large scale expansion of biofuels promoted by subsidies, targets and mandates will likeley increase net GHG through direct and indirect land-use change (Gibbs 2008; Searching et al. 2008; Fargione et al. 2008).

These subsidies have contributed to the rapid global expansion in biofuel production and use. By 2006 government support to biofuels in the US, the EU and Canada was estimated to have reached US$ 11 billion per year (GSI 2007; OECD 2008b). While the cost of reducing a tonne of CO_2-equivalent through biofuels has been calculated as between US$ 960-1,700 (OECD 2008b), recent CO_2 prices in the European Emissions Trading scheme are in the range of US$ 30-50. However, these calculations did not consider the GHG emissions from associated land use change. **While biofuels subsidies represent a significant strain on public resources, at best they do not therefore appear to be the most cost-effective option for reducing GHGs and there is an urgent need to review these biofuel policies** (FAO 2008), and in fact the public may actually be paying to increase GHG emissions.

An important efficiency determinant is the reduction in GHG emissions of a particular biofuel over the entire production and use cycle. According to the OECD, ethanol based on sugar cane – the main feedstock used in Brazil – generally reduces GHG emissions by 80% or more over the whole production and use cycle, relative to emissions from petroleum-based fuels. However, current support policies in the US, the EU and Canada target feedstocks that tend to reduce GHG emissions by much less (OECD 2008b). All these figures do not account for emissions from associated land use change. When these are factored in, they largely offset the gains from subsituting fossil fules.

The environmental impact of biofuels is the subject of much debate and controversy. This has highlighted that impacts are dependent on various factors, including type of feedstock used (see above), where it is grown, cultivation method used, production and conversion technology, distribution process, impacts of direct and indirect land use change etc.

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It should be emphasised that the subsidies themselves rarely distinguish between different biofuels based on the abovementioned factors or by reference to GHG emission savings achieved. As a result, not only are they poorly focused on their stated climate change objectives but they also exacerbate – by encouraging further production – the well-documented negative environmental impacts associated with the production of many (though not all) first-generation biofuels (see e.g. Koh 2007; Danielsen et al. 2008; Scharlemann and Laurance 2008).

6.4 MAKING REFORM HAPPEN

"People who love soft methods and hate inequity, forget this – that reform consists in taking a bone from a dog. Philosophy will not do it".

Late 19th century American political commentator John Jay Chapman, quoted by Anthony Cox in OECD (2007).

Phasing out subsidies can not only **alleviate environmental pressures** but also **increase economic efficiency** and **reduce the fiscal burden**. Freed funds can be used for **more pressing funding needs, like rewarding those who provide biodiversity benefits** (see Chapter 5). It is therefore important to look beyond environmentally harmful subsidies and also target subsidies that have clearly outlived their purpose, are not targeted at their stated objectives or do not reach their objectives cost-effectively.

Unsurprisingly, there are many calls for subsidy reform and a lot of rhetorical support. More concretely, there is some policy support and action. The OECD has called for subsidy removal or reform in many fora and agricultural and fisheries subsidies are on the WTO's Doha development agenda. The 2002 Johannesburg World Summit on Sustainable Development also highlighted the need to reform subsidies for agriculture, fisheries and energy. In the realm of global environmental policy, several multilateral environmental agreements (MEAs), such as the Convention on Biological Diversity, have drawn attention to the impacts of subsidies on the environmental assets that MEAs protect (CBD 2004).

For energy, the G-20's recent commitment to phase out inefficient fossil fuel subsidies is a welcome step which needs to be replicated by others and expanded to other types of subsidy.

Many countries already foresee priority action on subsidy removal, possibly in the context of (environmental) fiscal reform (World Bank 2005). **A still small but increasing range of successful subsidy reforms can now been seen around the world** (see Boxes in this chapter). And yet, with few exceptions, **progress is too slow and protracted**. The reasons are rooted in the political economy of subsidy reform: in some important cases they are also linked to technological and institutional barriers.

6.4.1 ANALYTICAL TOOLS

A **range of useful tools is available to help policy-makers** identify subsidies whose reform offers potential benefits and assess such benefits, including for the environment:

- the **'quick scan' model** (OECD 1998) addresses the questions: *"is the support likely to have a negative impact on the environment?"* and *"does the support succeed in transferring income to the intended recipient"?*
- the **'checklist'** (Pieters 2003) provides some policy guidance by addressing the question: *"is the subsidy removal likely to have significant environmental benefits?"*
- where the checklist delivers a positive result, the **integrated assessment methodology** (OECD 2007a) will help *create a comprehensive story on the effectiveness of the subsidy rather than a pass-fail test, and look at alternative policies;*
- for **'green' subsidies**, a specific checklist (UNEP 2008b) provides *minimum criteria any subsidy should fulfil to prevent it from turning perverse in the long-run* (see section 6.5 and Box 6.18).

The assumption underlying the OECD integrated assessment approach is that better policies will result when there is an explicit understanding of the distribution of costs and benefits and this information is made available to policy-makers and the interested public. Ideally, this means full disclosure of all costs and benefits, winners and losers, intended and unintended effects (environmental, economic, social) and highlighting where trade-offs exist.

To help policy-makers systematically reform their subsidies in line with tomorrow's priorities, Box 6.14 provides a checklist of useful questions based on the OECD analytical tools presented above.

Box 6.14: Developing a road map for reform: a checklist for policy-makers

Is there a subsidy causing damage to ecosystems and biodiversity?

1. **Is there harm to the environment?**
2. **Is there a subsidy in place that contributes to environmental damage?** (e.g. by influencing consumption, production levels) and if so, what is it?
3. **Does it lead to significant or potentially excessive resource use?** e.g. water use leading to loss from aquifers; thresholds crossed (e.g. salination of aquifers); social impacts from reduced resource availability.
4. **Does it actually harm the environment or do 'policy filters' avoid such pressure/damage?** Consider wider policy scenarios, regulations (e.g. quotas) and enforcement/legality of activities.

Should the subsidy be the target of reform?

5. **Does the subsidy fulfil its objectives (social/economic/environmental)?** If not, it needs reform.
6. **Does the subsidy lack an in-built review process and has it been in place for a long time?** If so, it is likely to need reform (i.e. it has already locked in inefficient practices).
7. **Are there public calls for reform or removal or calls to use the funds for other purposes?** This is often an indicator for Points 8 and 9.
8. **How does the subsidy distribute social welfare?** If there are equity issues, it might be worth reforming it.
9. **Do any of the subsidy impacts lead to social or other economic losses?** e.g. tourism loss following over-fishing.
10. **Are there alternative less damaging technologies available which are hindered by the subsidy's existence of the subsidy?** If so, the subsidy might be slowing innovation and creating technological 'lock in'; reform could bring benefits.
11. **Does it offer value for money?** Where there is still a valid rationale for the subsidy, could the same or less money be used to achieve the same objectives with lesser environmental impacts?

Reform scenarios (if subsidy reform has been identified as bringing potential benefits):

12. Would the reform be **understandable for policy-makers and the public**?
13. Consider **what the reform would entail** (measure changed and compensatory measures). It is rarely a simple case of 'getting rid of the subsidy altogether'.

14. Assess the costs and benefits of potential reform in more detail:

- potential **environmental benefits**: include thinking on benefits in other countries and secondary effects, which can be perverse;
- potential **economic costs**: e.g. national (tax, GDP, etc), sector-wide, for winners and losers within the sector (including new entrants/future industry), for consumers/citizens (affordability);
- potential **social impacts**: e.g. jobs, skills, availability of goods/services, health;
- potential **competitiveness and innovation benefits**
- potential **ethical benefits** e.g. as regard fairness of income, appropriateness of support, links to future generations;
- is the reform **practical and enforceable**?

To identify the likelihood of success and whether it is worthwhile using political capital for reform, the following questions can be useful to set priorities for the road map.

Is there a policy/political opportunity for action?

15. Is there a window of opportunity? e.g. policy review process, evaluation, public demand?

16. Is there a potential policy champion?

17. Will there be sufficient political capital for success?

These questions can be answered at different levels. A quick scan can help develop the overall picture, but more detailed analysis is needed to clarify the details, identify what should be the exact nature of the reform and support the call for subsidy reform.

6.4.2 RESISTANCE TO CHANGE

Subsidies create or maintain economic activity and people become dependent on that activity. Changing income distribution between individuals, and their broader economic opportunities, is the driving force behind the political economy of subsidy reform. Those who stand to gain from the *status quo* or who lose from the reform have a significant incentive to lobby for the retention of the existing regime. Subsidies invariably tend to create a **culture of entitlement:** even if they are granted only for a set period of time, renewal is 'expected.'

What makes resistance to change so successful so often is that the **benefits of subsidies tend to be concentrated in the hands of specific well-organised groups whereas costs are spread widely across (poorly-organised) taxpayers and sometimes consumers** (OECD 2006a).

Subsidy removal can raise legitimate **concerns regarding affordability** e.g. when this would lead to higher prices of essential goods like drinking water. However, careful design of policy reforms can mitigate affordability issues and minimise social impacts. For example, the use of progressive water tariffs allows low charges for low usage and thus addresses the needs of lower income households (see Maltese example in Box 6.11). Transitional assistance is another option (see below).

In the long run, **reform can generate new economic opportunities**. In principle, more efficient allocation of resources creates a stronger enabling environment in which economic activity can flourish. In the short run, however, individuals and communities may find it difficult to re-orient economic decisions and livelihoods. This could be due to geographical isolation of for instance fishing, agriculture and resource-dependent areas with no immediate alternative opportunities for employment or economic diversification. It could also be due to technological lock-in; for instance, phasing out subsidies for private car transport will have little short term effect on car use if people have no reasonable alternative modes of transportation. **Identifying and understanding the very real short-term social impacts of dismantling subsidies is one of the most difficult aspects of reform** (OECD 2006a).

Institutional barriers may also play a role. Unsurprisingly, institutions and bureaucracies that manage subsidy schemes will rarely push for their removal, either because of vested interests or because they lack vision that things could be done differently. The sheer number of players can also create barriers. For instance, the exemption of aviation kerosene from excise taxes (stemming from an international agreement, the 1953 Chicago Convention on Civil Aviation) should clearly be removed to enable pollution charges. However, this would not only affect the vested interests of the airline companies but also require an international conference to seek new consensus among parties to the Convention or else the re-negotiation of a large number of bilateral treaties (van Beers and de Moor 2001).

The level of subsidies, their impacts and the potential benefits from reform are not always clear. Some subsidies are hidden and their impacts are not immediate or direct. There are often complex interactions between different subsidy schemes and with other policy tools. Sometimes, impacts are mitigated by policies or complementary measures. Careful **assessments** are therefore needed to disentangle the complexities arising from multiple policy goals and instruments in order to quantify current costs and potential benefits and to identify priorities and opportunities for reform. **Enhancing transparency** can facilitate such assessments – in fact, it is a crucial precondition for these assessments – and help spread their message (see Box 6.15 for recent EU regulation enhancing transparency on subsidies). By helping to debunk the myths surrounding subsidies and their reform, such assessments, when widely disseminated, can also be useful to overcome resistance by vested interests.

Box 6.15: Enhancing transparency of farm subsidies in the European Union

A 2006 financial regulation requires 'adequate ex-post disclosure' of the recipients of all EU funds, with agricultural spending transparency to begin in the 2008 budget. The Regulation has spurred major watchdog initiatives such as http://farm-subsidy.org, http://caphealthcheck.eu and www.fishsubsidy.org. These seek to closely monitor compliance by EU Member States and assess the quality of the released data. However, compliance of Member States with the regulation is still uneven.

6.4.3 ORGANISING REFORM

Experience with reforms to date shows that the design of the reform process is a critical success factor. It needs to take the political economy and other barriers into consideration and often hinges on five important conditions:

- **policy objectives** must be defined transparently and rigorously;
- the **distribution of benefits** and costs must be transparently identified;
- government must **engage broadly with stakeholders**;
- government should set **ambitious endpoints**, but, depending on circumstances, timetables for reform may need to be cautious; and
- **fiscal transfers** and/or other flanking measures are often required to facilitate the transition process (OECD 2007a).

The multiple policy objectives often associated with subsidy programmes need to be analysed carefully. Disentangling explicit and implicit objectives can help identify opportunities to introduce separate, better designed and more transparent instruments. During a recent reform of forestry subsidies in Finland, for example, a specific Forest Biodiversity Programme was created which provides regular payments for landowners in return for maintaining or improving specified biodiversity values of the forest. By separately targeting the biodiversity objective, the programme is more transparent, and its cost-effectiveness easier to assess, than general forestry subsidies with several objectives (OECD 2007a).

Information from analytical frameworks (e.g. the OECD's integrated assessment) can only build the case for reform if it is understandable by the general public and widely disseminated. **Increased transparency** is a major factor in the push to reform environmentally harmful subsidies (see Box 6.15 on EU transparency policy and Box 6.16 on German coal subsidy reform). Transparency is a key precondition for well-informed public debate on current subsidy programmes and can also make subsidy reform more appealing. Identifying who benefits from subsidies and highlighting their relative bargaining power can provide a powerful motivating force for change (OECD 2003a).

Governments need to build alliances for change and discourage behaviour that would reduce or distort change. Reform practitioners regularly underline **stakeholder engagement** as another key precondition for durable reform. Multi-stakeholder processes based on a deliberate outreach and communications strategy can help to reach consensus – or at least common understanding – on new approaches or options for reform. The overarching goal is less about convincing stakeholders who gain most from the status quo and more about using the planning and implementation process to minimise opposition to change and maximise forces in favour of it (OECD 2003a).

Box 6.16: Public support to coal mining in Germany

Direct subsidies to coal have been a major issue in Germany. A 1994 decision of the German Constitutional Court ruled that previous industry subsidy – a surcharge on the price of electricity – was unconstitutional. This led to the subsidy being paid directly from the state budget which made its cost to the economy clearer and contributed to pressure for reform. Subsidies were reduced from € 4.7 billion in 1998 to € 2.7 billion in 2005 and will be phased out completely by 2018.

Source: IEEP et al. 2007

There is also a critical need to establish a process to build cooperation and horizontal analysis between government departments and agencies whose mandates, policies and programmes may overlap within the subsidised sectors. Subsidy reform often requires a **'whole-government approach'** linking relevant institutional actors to ensure policy coherence (OECD 2003a).

Changes in the policy landscape can open **windows of opportunity** (see also Chapter 2), even if sweeping electoral victories of parties with a strong reform agenda are rare. Even in such cases, practitioners caution against jumping straight to the 'best' solution, for several reasons, including the limited capacity of governments to undertake major reforms on many fronts at the same time; and the limited capacity for short-term adaptation by affected communities. In practice, demonstrating actual benefits delivered through more gradual reforms can be more compelling than up-front projections of expected benefits (even if these are larger). For the same reasons, dramatic reforms may also increase the likelihood of policy reversal (OECD 2005).

Having said this, cases of fast and successful reform do exist (see Boxes 6.12, 6.13 and 6.17). Despite the earlier words of caution, a key advantage of eliminating or changing subsidies immediately, without prior warning, is that recipients cannot take advantage of the phase-out period to increase their entitlements, thus leading to associated environmental damage.

Usually however, political change is more gradual. Peer pressure, civil society and regional or international organisations can increase interest and participation. Mandatory requirements under regional or international treaties (e.g. WTO) can also provide useful leverage for change. Political leadership can use growing public and other support, wherever it exists, as a springboard to build a broad coalition for reform with **ambitious endpoints and a gradual but credible phase-in of changes over an extended time period**.

Policy packages for this purpose can include transitional payments to those most affected by the reform (see below) as well as changes to the regulatory environment of the industry to both ease the adjustment process and possibly improve long-term efficiency (see Box 6.17 for lessons learnt in New Zealand). When backed up with a credible long-term road map for reform, such packages may reduce opposition to policy changes. However, designing adequate sequencing can be difficult and big reform packages are often politically difficult to sell (OECD 2005).

Many packages include some form of **transitional assistance**, even while the reform of an existing policy situation does not by itself justify this – it is impossible and undesirable to compensate all members of society from harm caused by economic change. In practice, political economy considerations sometimes dominate discussions about the rationale of transition support programmes. However, simply buying out groups who lobby most effectively against reform carries the risk that the transition support will eventually replicate and perpetuate some of the initial subsidy's adverse effects. Moreover, it may actually reduce long-term public support for the reform. For these reasons, great care is needed in the design of transitional support. Those with the loudest voice are not necessarily those with the highest need.

Transitional support can increase the resilience of affected communities to economic change e.g. by helping producers who want to leave the industry to do so with dignity and financial standing, through grants, job training, buyouts or early retirement plans. It can also enhance the sector's human and social capital and thus improve the competitiveness or viability of those who stay in the sector (OECD 2005). Investment programmes can be helpful for attracting new industries to regions affected by the reform. Firm **sunset clauses** can help to ensure that transitional support does not nourish a sense of permanent entitlement.

Box 6.17: Removal of agricultural and fisheries subsidies in New Zealand

New Zealand was one of the first – and is still one of the few – OECD countries to have completely dismantled its system of agricultural price supports and other farm subsidies. These reforms were driven by concerns for the economic unsustainability of the subsidy programmes rather than for the environment.

The two decades prior to 1984 had seen a gradual acceleration in agricultural production grants and subsidies. In the 1960s agricultural support amounted to just 3% of farm income. By 1983 it was nearly 40% in the sheep sector alone and New Zealand's general macroeconomic situation had also deteriorated markedly. Increased agricultural output was generally worth less than the actual costs of production and processing.

In 1984 the new Government abolished tax concessions for farmers and minimum price schemes for agricultural products. Land development loans, fertiliser and irrigation subsidies and subsidised credit were reduced and then phased out from 1987, along with assistance for flood control, soil conservation, and drainage. Subsidy removal was combined with wider reforms across the economy (including floating of the currency, phased tariff liberalisation to lower input prices etc.). Their removal was an important contributing factor to improvement in the sector's circumstances.

Social impacts were not as great as widely predicted. Around 1% of farmers left the industry, considerably less than the projected 16%. Substantial environmental improvements were observed through decreased use of agricultural chemicals and in livestock as well as by taking marginal land out of production.

Source: Vangelis in OECD 2005

New Zealand also undertook a major reform of its fisheries policy in the early 1990s. Subsidies were eliminated virtually overnight. However, subsidy reduction alone would not have been enough to create a sustainable fishing sector and would have caused substantial financial and social distress. It would also have had a negative impact on stocks due to overfishing resulting from fishermen increasing effort in order to try and cover marginal costs. For these reasons, the reduction was combined with a major change in the management regime, i.e. the introduction of rights-based management and individual transferable quotas, combined with a minimum buy-out of existing rights. These measures gave those remaining in the sector a good chance of creating a profitable business environment, while allowing those who wished to leave to be bought out.

Source: Cox in OECD 2007

6.5 TARGETING SUBSIDY REFORM AT TOMORROW'S PRIORITIES

Over the last two decades, we have come to understand the scale of subsidies in different sectors, the extent and mechanics of their environmentally harmful effects and how cost-effective they are (or not) in achieving their goals. Some progress has been made in removing and/or reforming subsidies but with few exceptions, the progress is piecemeal and fragmented. **Globally, subsidy reform is unfinished business.**

Persistent myths surround subsidies and their reform and can block change. Many of these myths can and should be debunked:

- **Claim: subsidy reform will harm competitiveness.** Keeping subsidies is bad for a sector's long-term competitiveness as it becomes dependent on subsidy and this puts strains on public finances.
- **Claim: subsidy reform will result in job losses.** In the short-term, this can be the case for the specific sector. However, compensatory measures can address some adverse impacts and incentives can be put in place to attract investment. There are also possible employment gains from use of monies elsewhere: the actual net effect depends on relative labour intensities of the activity replaced compared to the new activity. In the long term, increased competitiveness via innovation (e.g. energy efficiency) or increased availability of resources (e.g. fish) should help support or create jobs.
- **Claim: subsidy reform will have negative implications for social equity.** This claim is often made about energy subsidies yet poorer households spend less on energy than middle income households. Yet there are more targeted and effective ways of helping the poor than subsidies that tend to benefit all users.
- **Claim: subsidy reform will lead to a loss of livelihoods e.g. for poor farmers and fishermen.** Empirical studies show that many existing subsidy programmes are not well-targeted at social objectives: even if the poor draw some benefit, most of it goes to the relatively rich.
- **Claim: many people do not wish to change their livelihood (e.g. from fishing or mining).** In some cases, this is indeed true but in others there is interest in other forms of employment. Acceptability is linked to options for employment substitution.
- **Claim: reforming environmentally harmful subsidies is almost impossible because of vested interests.** In reality, the picture is mixed. Evidence shows that reforming subsidies is possible and that negative effects on the economic and social system can be reduced or compensated or else be borne by people within acceptable limits.
- **Claim: subsidies are good for the environment.** Financial transfers that are well-targeted at environmental objectives and cost-effective can play an important role in improving incentives for conservation of ecosystems and biodiversity (see Chapter 5). Yet many existing subsidies are environmentally harmful: their prior or simultaneous removal or reform will improve the cost-effectiveness of environmental incentive payments. Moreover, even 'green' subsidies may not be well-targeted and/or not be cost-effective. Adjusting them for better performance will ultimately make their case stronger.

The G-20 Heads of State have recently committed to phase out and rationalise inefficient fossil fuel subsidies over the medium term while providing targeted support for the poorest. This commitment is to be commended as an important step towards effectively addressing the threat of climate change and should be implemented. It also needs to be replicated and extended to other subsidies with direct and important harmful effects on ecosystems and biodiversity.

Priority areas for reform, from a global ecosystems and biodiversity perspective, include the **removal of capacity- or effort-enhancing fisheries subsidies** and the **continued and deepened reform of production-inducing agricultural subsidies**, in particular in most **OECD countries**. Reasons include the size of their environmentally harmful effects and/or their sheer magnitude and the resulting strain on scarce resources, as well as high opportunity costs.

The WTO negotiations on fisheries subsidies and agricultural domestic support have significant potential, if successfully concluded, to support the accelerated removal of environmentally harmful subsidies. **Governments should redouble their efforts to successfully conclude the negotiations on the Doha programme of work.**

Depending on national circumstances, most OECD countries need to complement these global priorities with additional and prioritised reform efforts in other sectors. In addition to energy subsidies, especially on fossil fuels, these should address the following subsidies that harm biodiversity and ecosystem services:

- **transport subsidies** e.g. habitat fragmentation linked to subsidies for road building;
- **water subsidies** that result in unsustainable water consumption.

For **non-OECD countries**, the sectors mentioned are also interesting candidates for subsidy removal or reform but concrete priorities will obviously depend on national circumstances. Relevant factors include the importance of specific sectors, the existing subsidy landscape including the design of individual programmes, and how existing programmes interact with the broader policy and institutional framework.

The stimulus programmes that are now in place in many countries will require stringent budgetary consolidation in the future. Subsidy reform needs to be an important element of this process.

Box 6.18: Minimum criteria for subsidy programme design

- *Targeted:* Subsidies should go only to those who they are meant for and who deserve to receive them;
- *Efficient:* Subsidies should not undermine incentives for suppliers or consumers to provide or use a service efficiently;
- *Soundly based:* Subsidies should be justified by a thorough analysis of the associated costs and benefits;
- *Practical:* The amount of subsidy should be affordable and it must be possible to administer the subsidy in a low-cost way;
- *Transparent:* The public should be able to see how much a subsidy programme costs and who benefits from it;
- *Limited in time:* Subsidy programmes should have limited duration, preferably set at the outset, so that consumers and producers do not get 'hooked' on the subsidies and the cost of the programme does not spiral out of control.

Source: UNEP 2008a

Focusing on the short term, all countries need to:

- establish **transparent** and **comprehensive subsidy inventories**;
- **assess** their **effectiveness** against stated objectives, their **cost-efficiency** and their **environmental impacts**, and, based on these assessments;
- develop **prioritised plans of action** for subsidy removal or reform, for implementation at medium term (to 2020).

Windows of reform opportunity that arise within existing policy cycles should be proactively and systematically seized.

Looking beyond budgetary consolidation, **funds that become available from subsidy reform can also be used in areas of more pressing funding needs**. From the perspective of TEEB, critical needs are to **reward the unrewarded benefits of ecosystem and associated biodiversity**, in particular:

- **payments to biodiversity stewards for a range of ecosystem services** (see Chapter 5);
- provision of funds to **expand the protected area network** (corridors, marine protected areas, etc) and improve its management (see Chapter 8);
- **investment in ecological infrastructure** (e.g. restoration), notably where this helps in adaptation to climate change (e.g. flood control, sea level rise, storm surges – see Chapter 9) or poverty (see Chapter 1).

Care should be taken to ensure that these new programmes do not fall into the design traps of past subsidies (see Box 6.18). They should:

- be based on **clear, targeted and measurable objectives** and associated **indicators**;
- ensure **cost-effectiveness**, for instance by using smart economic mechanisms (e.g. reverse auctions);
- include **monitoring, reporting and evaluation provisions** and
- include **sunset and review** clauses to help avoid their continuation beyond their useful life.

Lastly, many parties are involved in the reform process. Too often, short term, national or private interests dictate the terms. Focusing on wider economic and social benefits and costs in a longer-term perspective is essential to reform the subsidy landscape and point economic signals in the right direction – to help current and future generations meet the challenges of the coming years.

Chapter 6 has shown the prevalence, scale and impact of subsidies and the need for their reform – both on economic efficiency grounds and to reduce pressure on natural resources, ecosystems and biodiversity. Commitment to a transparent inventory of subsidies and to developing and implementing a road map for their reform would be a critically important step to help address environmental issues and financial issues in a time of limited financial resources.

Chapter 7 discusses the potential to avoid degradation and loss of ecosystem and biodiversity by regulatory and market mechanisms. The analysis includes coverage of resource charges and the associated polluter pays and full cost recovery principles, issues which are closely related to the subsidies landscape discussed in Chapter 6.

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THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 7: Addressing losses through regulation and pricing

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Chapter 7

Addressing losses through regulation and pricing

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Key Messages of Chapter 7

Policies to date have not succeeded in curbing ongoing losses or degradation of biodiversity and ecosystem services, e.g. the loss of forests, fisheries and the pollution of air, marine and water resources. For the reasons outlined earlier in this report, the costs of these losses are still hidden or distorted. Polluters and resource users rarely meet the costs of the real damage caused by their activities and sometimes pay nothing at all.

Rewarding benefits and reforming subsidies (Chapters 5 and 6) are important components of policy reform but in isolation they will never be enough to halt continuing losses. A coherent strategy to make the full costs of loss visible and payable should form the backbone of new biodiversity policies.

Basic principles for halting ongoing losses
Policy design should be based on two key principles: the polluter pays principle and the full cost recovery principle. Many tools for this purpose already exist and more are coming on stream, but their potential is far from fully exploited. Such instruments encourage private and public actors to incorporate biodiversity values in their decisions and investments and can stimulate economic efficiency and technical innovation. They contribute to social and distributional equity and can increase the credibility and acceptability of public policies in force.

Regulating to avoid damage: environmental standards
Environmental regulation has long been and will remain central to addressing pressures on biodiversity and ecosystems. The use of prohibitions, standards and technical conditions has a proven track record and has delivered major benefits. A well-defined and comprehensive regulatory framework should be the baseline for policies to avoid damage and a precondition for introducing compensation mechanisms and market-based instruments.

Regulatory frameworks should support attribution of environmental liability to provide further orientation for the private sector and promote more efficient approaches both to prevention and remediation of damage by responsible parties.

Setting more accurate prices by the use of market-based instruments
A systematic proactive approach is needed to send accurate price signals about the true value of ecosystem services. Incentives can be adjusted by using opportunities to apply standards or introduce taxes, charges, fees, fines, compensation mechanisms and/or tradable permits. This should be part of a wider fiscal reform in favour of biodiversity (see also Chapters 5, 6 and 9).

Designing smart policy mixes
Combining policies provides the opportunity to adequately address different ecosystem services and different actors. Effective policy mixes need to take account of institutional background, capacity, traditions, affordability and the characteristics of the resource or service in question.

It is crucial to communicate the benefits of introducing regulation and market-based instruments to overcome political/social opposition. Flexible policy mixing can:
- stimulate greater efficiency through price signals and least cost solutions to environmental problems;
- through compensation tools, provide for no net loss in policies or even create net-gain solutions;
- generate additional public revenues that, if earmarked, can support pro-biodiversity measures.

Monitoring, enforcement and criminal prosecution
Effective enforcement is critical to give policies teeth and demonstrate the gravity of environmental crimes. Adequate funding for technical equipment and trained staff is essential to show policy makers' commitment to tackling biodiversity and ecosystem losses.

7 Addressing losses through regulation and pricing

"If we were running a business with the biosphere as our major asset, we would not allow it to depreciate. We would ensure that all necessary repairs and maintenance were carried out on a regular basis."

Prof. Alan Malcolm, Chief Scientific Advisor, Institute of Biology,
IUPAC -- THE INTERNATIONAL UNION of Pure and Applied Chemistry
http://www.naturalcapitalinitiative.org.uk/34-quotes/

Chapter 7 focuses on ways to increase accountability for the cost of damage to biodiversity and ecosystem services in order to curb further losses. **7.1 sets out key concepts** to underpin all policies, aligned with the polluter pays principle. **7.2** describes the role of **environmental regulation** and shows how economic information can be used to inform and target regulatory standards. **7.3** analyses **compensation schemes** designed to ensure no net loss or a net gain of biodiversity and ecosystem services. **7.4** discusses the scope and limitations of **market-based instruments** in delivering additional conservation gains and encouraging innovative approaches. **7.5** addresses the critical need to improve **enforcement** and international cooperation in the area of **environmental crime**. **7.6** concludes the chapter with design indicators for a **smart policy mix.**

7.1 BASIC PRINCIPLES FOR HALTING ONGOING LOSSES

"We should not limit our attention to protected areas. If we do we will be left with a patchwork quilt: pockets of nature in a desert of destruction."

José Manuel Durão Barroso
President of the European Commission 'Biodiversity Protection – Beyond 2010' conference in Athens, 27 April 2009

As highlighted throughout this report, policies to date have not managed to halt loss or degradation of ecosystems and biodiversity. We need **instruments that reflect and incorporate the cost of such losses** to turn this situation around. Many promising tools are available and can be more widely shared but their potential is not yet fully exploited.

Chapters 5 and 6 showed how payments for ecosystem services and reformed subsidies can help build up natural capital and create positive incentives for biodiversity action. However, their contribution will be undercut if economic activities continue to lead to releases of pollutants and ecosystem degradation. Measures explicitly designed to avoid ongoing losses are therefore a core component of the policy mix.

Decision-makers and resource users will only take such losses into account if confronted with the real costs involved. This report has already stressed the factors that conceal such costs: lack of information, lack of appropriate incentives, incomplete property rights, relatively few markets or regulation. We face a situation of market failure because most markets do not signal the true value of biodiversity and ecosystem services or show what their losses cost us.

This chapter focuses on a range of policy tools to incorporate such costs, showing their respective advantages and disadvantages and providing guidance for improved instrument design.

Strengthening instruments to make costs visible can have several advantages for policy makers:

- **using values transparently** can justify environmental regulation and help overcome political resistance (see Chapter 2). Showing what and how much society is losing can strengthen the hand of policy makers arguing for improved policies;
- confronting those who cause damage with the associated costs **can stimulate efforts to take preventive action, thus boosting efficiency** (e.g. by less water-intensive production, less fertiliser use, greater use of bio-degradable products, switching to low-carbon energy sources etc.);
- **making the polluter pay is more equitable:** it is quite simply not fair that a few benefit from resource use while society has to pay for the resulting damage (see Box 7.1). This also supports good governance and increases the credibility of the regulatory system by giving a clear signal that those causing damage are also responsible for addressing it;
- applying the **full cost recovery principle** to the user/polluter/emitter can set appropriate incentives and reduce burdens on public budgets (see Box 7.1);
- some instruments (e.g. taxes, fees and charges, auctioned licences) can **generate revenues for conservation** (see also e.g. PES/REDD in Chapter 5, Protected Areas in Chapter 8, investment in natural capital in Chapter 9).

Box 7.1: Fundamental principles for incorporating costs of biodiversity loss

Together with equity and social considerations, three closely-related principles should guide the choice and design of policy instruments:

The **polluter pays principle** (PPP) is anchored in the 1992 Rio Declaration on Environment and Development (UNEP 2009a) and embedded in a growing number of national environmental policies (e.g. most OECD countries and EU Member States). It requires environmental costs to be 'internalised' and reflected in the price of goods and services. To this end, the polluter has to take measures to prevent or reduce pollution and in some cases pay taxes or charges for pollution and compensate for pollution impacts. For ecosystem degradation, this means that the polluter should pay directly for clean up and restoration costs or pay a fine that would help offset damage costs.

The **user/beneficiary pays principle** is a variant of the PPP. Where an action provides a benefit e.g. use of natural resources, recipients should pay for the cost of providing that benefit. This could be used to argue that e.g. users of a clean beach should contribute towards beach cleaning expenses.

The **full cost recovery principle** provides that the full costs of environmental services should be recovered from the entity benefiting from the service. There is a growing trend internationally for this principle to be applied directly and explicitly to energy, electricity and water pricing which means that full costs are passed on to consumers.

Source: Adapted from ten Brink et al. 2009

7.2 REGULATING TO AVOID DAMAGE: ENVIRONMENTAL STANDARDS

"It is bad policy to regulate everything... where things may better regulate themselves and can be better promoted by private exertions; but it is no less bad policy to let those things alone which can only be promoted by interfering social power."

Friedrich List
German Economist (1789-1846)

7.2.1 IMPORTANCE OF A STRONG REGULATORY BASELINE

Regulation has long been – and still is – the most widely used instrument for environmental protection. It is used to **establish protection objectives, reduce pollution and hazardous events and trigger urgent environmental improvements**.

A clearly defined regulatory framework provides **orientation for the private sector**. Regulation needs to be conducive to business, compatible with commercial activities and set a level playing field to encourage capacity building, local training and compliance with best professional standards (see TEEB D3 Report for Business forthcoming).

A **strong system of regulation and governance is also essential** for the establishment of market-based policies such as trading schemes, biodiversity offsets and banking (see 7.4). Regulation is the reference point upon which market-based instruments can build and needs to be underpinned by adequate monitoring and enforcement arrangements (see 7.5).

Environmental regulation sets rules and standards across a range of areas (see Box 7.2).

Box 7.2: Scope and flexibility of environmental regulation

As in many other fields of law, the regulatory toolkit includes a battery of prohibitions, restrictions, mandatory requirements, standards and procedures that directly authorise or limit certain actions or impacts. The term **'command-and-control'** is often used as a generic term for regulatory instruments promulgated by a (government) authority (c.f. non-enforceable self-regulation and social norms).

There are three basic types of regulatory instruments for biodiversity and ecosystem services:

- **regulation of emissions:** usually involves emissions standards, ambient quality standards and technical standards (e.g. Best Available Techniques (BAT)); performance standards (e.g. air quality management); or management prescriptions for good practice (e.g. in agriculture);
- **regulation of products** set restrictions on the use of products (e.g. illegally logged timber, activities damaging to endangered species etc.) or establishes production standards (certification, best practice codes, etc.);
- **spatial planning** involves regulation of land uses that have direct implications for ecosystem services or habitats. Planning decisions in most countries are devolved to local or regional planning boards (see TEEB D2). Designation and establishment of protected areas is a specific regulatory tool based on spatial planning (see Chapter 8).

Source: André Künzelmann, UFZ

A tight regulatory framework defining the scope and extent of resource use is a precondition for halting losses. Because biodiversity has a public good character (see Chapter 4), it is the **responsibility of politicians** to define relevant targets and set up an adequate framework to ensure such targets are met.

We often underestimate the contribution that sectoral regulations can make to safeguarding biodiversity. In agriculture, for example, regulating fertiliser use can reduce nutrient run-off into soils and water, eutrophication in river systems, lakes and coastal areas and algae build-up on beaches. Regulations of this type thus support multiple ecosystem services and benefits (aesthetic, tourism and cultural values, reduced health impacts, provisioning and regulating services) and improve carbon storage in the soil (see examples in Table 7.1).

Table 7.1: Examples of sectoral regulations that can benefit ecosystem services

Regulated activity	Type of regulation	Affected ecosystem service	Regulated activity	Type of regulation	Affected ecosystem service
Water use	Drinking water Water / groundwater extraction Waste water treatment Water body condition Water pollution and quality	Fresh water Food Water purification Water regulation Natural hazard regulation Recreation and ecotourism Aesthetic values Water cycling Nutrient cycle	Agriculture	Required minimum practices Best practices Fertilizers Regulation on transgenic crops	Food Fiber Climate regulation Erosion control Pest control Disease regulation Recreation and ecotourism Soil formation Nutrient cycling
Air pollution	Ambient air quality standards Emission standards Off-gas treatment Fuel efficiency standards Lead ban motorfuels Exhaust emission standards	Food Fresh water Air quality regulation Climate regulation Natural hazard regulation Recreation and ecotourism	Forestry	Afforestation / Reforestation Best practices Timber harvest regulation Forest product licensing Hunting licensing Abstraction of non-timber-forest-products	Food Fiber Biochemicals Climate regulation Erosion control Natural hazard regulation Water regulation Aesthetic values Recreation and ecotourism Inspiration Water cycling Nutrient cycle
Land use	Spatial planning / zoning Mineral extraction Soil protection and contamination	Food Fiber Fresh water Biochemicals Water regulation Climate regulation Natural hazard regulation Erosion control Air quality regulation Aesthetic values Cultural Diversity Recreation and ecotourism Soil formation Water cycling Nutrient cycle	Fisheries	Catch licensing Nursery protetcion Mesh size	Food Genetic resources Climate regulation Recreation and ecotourism Nutrient cycle
			Nature Protection	Protected areas Protected Species Act Habitat Directive Birds Directive	Fresh water Genetic resources Biochemicals Natural hazard regulation Aesthetic values Inspiration Educational value Spritual and religious values

Key: Provisioning Services; Cultural Services; Regulating Services; Supporting Services

Regulation has already provided a catalyst for significant environmental improvements by reducing the release of pollutants that threaten ecosystem status and functions. Management of air quality, water and soils all rely heavily on this type of regulation (see Box 7.3). Chemicals regulation addresses risks associated with producing, distributing and using certain products or their compounds.

Where hazards to human health or the environment are potentially high, strong interventions are called for. In practice, strict regulation is often reactive and adopted in response to a catastrophe (e.g. US Oil Pollution Act 1990 adopted in response to the Exxon Valdez oil spill, see Chapter 4).

Regulation is not in itself expensive for public budgets but carries administrative costs in terms of monitoring and enforcement (see 7.5). Costs of implementation and compliance fall primarily on private resource users who must finance abatement or equivalent measures to reach the required standard. Regulation can also require monitoring activities (e.g. waste water effluent or river water quality downstream), at cost to the emitting source. This is consistent with the polluter pays principle.

Decision-makers and administrators already have far-reaching experience with regulation. Where institutional capacity for implementing regulations is already set up, it is often easier to expand regulation than to set up market-based approaches. Emission limits (e.g. for power stations emissions to air, quality of effluent discharge from industrial plant) can be tightened over time as it becomes clear that there is an environmental or health need. BAT standards lay down detailed prescriptions on type of technology, requirements of a particular technical solution, monitoring etc. Where such standards are available, it may be easiest to adapt them to local conditions, offering opportunities for learning and applying regulatory experience from other countries.

As noted, **regulation forms the baseline and catalyst for additional complementary measures**. Emissions trading instruments, for example, emerged against a background of air quality regulatory standards in the USA (Hansjürgens 2000). The first generation of instruments in the 1970s (i.e. netting, offset, bubble and banking policy) were based on credits that could be created if abatement went beyond a certain standard. Only additional emissions ‘saved’ by over-compliance could be used for compensation or trading. Similar rules apply for biodiversity offsets and/or banking (see 7.3).

Box 7.3: Regulatory success stories: tackling air pollution and promoting sustainable forestry

Germany: Forest damage from ‘acid rain’– mainly caused by SO_2 emissions from energy-producing combustion plants (*Waldsterben*) – created enormous pressure on politicians in the early 1980s. Germany therefore set a tight SO_2-emission standard at 400 mg/m^3 that all plants had to comply with by 1993. Following the enactment of the standard, the electricity sector embarked upon a major reduction program that led to sharp decline in SO_2-emissions (see table).

Year	1980	1982	1985	1988	1989	1990	1992	1995
SO_2-emissions (mg/m^3)	2154	2160	1847	582	270	290	250	154

Sweden: the decline of forests during the 1980s and 1990s led to the Swedish Forestry Act being updated in 1994. The new Act specifies that forests “shall be managed in such a way as to provide a valuable, sustainable yield and at the same time preserve biodiversity”. It provides for new standards to be established after (i) felling (ii) if forest land is unused and (iii) the forest condition is clearly unsatisfactory and sets quotas for maximum annual allowable cut to promote an even age distribution of forest stands. Recent statistics prove that the regulation has had positive results, especially the numbers of old or deciduous trees recovered in the past 20 years (increase of 10 to 90%, depending on diameter).

Sources: Wätzold 2004; Swedish Forestry Act; Swedish Forestry Statistics; The Work Done by the Swedish Forestry Organisation in Order to put the Environmental Goal on an Equal Footing with the Production Goal 1999

7.2.2 RULES FOR ENVIRONMENTAL LIABILITY

Environmental liability is an overarching term – covering prevention and remedial action – for the process by which responsibility for the cost of damage is explicitly assigned to those who cause that damage. Liability rules are based on the polluter pays principle and provide economic incentives to developers/users to incorporate the risk of a potential hazard and the value of remediation.

Environmental liability regimes operate by reference to regulatory frameworks that set standards for resource use. The basic rule is that those who damage the environment beyond a defined limit have to pay for necessary clean-up and/or restoration. Depending on the regime, they may also have to provide for the continued losses of ecosystem services pending restoration (or in perpetuity if restoration is not possible).

Earlier systems had an essentially pollution-based focus but several laws now address broader environmental damage in recognition of its public good character. Box 7.4 outlines the two main types of liability.

Liability rules require resource users to pay for the impacts of potentially hazardous activities. **The potential polluter therefore balances risks and costs** and decides what measures are appropriate to avoid a certain risk. Options include abatement (e.g. through better filters), recycling, less hazardous production techniques, rigorous risk management procedures and standards (e.g. international environmental management ISO standards and the European EMAS) and insuring against potential claims if insurance is available. **Liability rules provide economic incentives to reduce risk and can directly stimulate technical improvements.**

Box 7.4: Scope of environmental liability rules

Legal regimes provide for two main variations:

- **strict liability** does not require proof of culpability (i.e. *fault or negligence*) for damage. This is usually deemed more appropriate for inherently risky activities that present specific hazards e.g. the International Convention on Civil Liability for Oil Pollution Damage, nuclear accidents and, in some countries, damage caused by genetically modified organisms. Tightly-limited exceptions may be provided in the relevant legislation and may include e.g. cases where the operator proves that the activity/emission was expressly authorised by the competent authority and carried out to the required technical standard without fault;

- **fault-based liability** depends on the operator being proven to be *negligent* or at *fault*. This is usually the standard retained for other occupational activities that cause damage to the environment and its components.

Regulatory instruments can combine these approaches to cater for the different levels of risk presented by different types of activity. A prominent example of this **dual approach** is the EU Environmental Liability Directive (2004). This instrument focuses on damage to EU-protected habitats and species, EU water resources and land contamination that presents hazards to human health. It excludes matters regulated under international liability regimes as well as interests covered by traditional liability regimes (personal injury and damage to goods and property) which vary between countries.

Liability regimes may also confer rights on civil society, including environmental NGOs, to request competent authorities to take action and to apply to the courts for review of administrative action or inaction. This can provide an important mechanism for transparency and accountability (see 7.5).

Economic information can help introduce and implement liability rules by reducing uncertainties with respect to expected costs of hazardous risks and assisting resource users in defining abatement strategies. It can also help insurance companies not only to determine financial risks and product premiums but also to develop new products.

Liability regimes face some major constraints. **Problems often arise when the operator responsible for damage caused by accidents cannot be traced.** This results in 'orphan liability' cases or sites affected by the accident. Other problems relate to damage generated by repetitive actions and negligence that lead to significant cumulative damage (e.g. diffuse pollution). In such cases, transaction costs for assessing natural resource damage can be substantial. The same is true for the task of apportioning responsibility between individual polluters: conventional liability rules may not apply if e.g. the individual polluter's share of the damage is not enough to trigger liability. In such cases, it often makes sense for the state to provide directly for the restoration of the damage (see Chapter 9).

7.2.3 USING ECONOMIC ANALYSIS IN STANDARD SETTING

Economic valuation of ecosystem services can help to build up and extend a regulatory framework for biodiversity conservation. It can support arguments in favour of policies to avoid net losses and, by informing better regulatory standards, increase their credibility and acceptance.

Cost-benefit considerations were often not included, or only implicitly, when regulatory instruments were initially designed. This balancing act was rarely required because early regulations focused on preventing hazardous situations i.e. urgent concerns of human life and health. This is still the case for some environmental fields with respect to well-known hazards, e.g. carcinogenic substances, ambient air quality standards for particulates.

The urgency of including costs and benefits in decision-making has increased in recent years for several reasons:

- **many countries have an unseen potential for regulation.** Where institutions are weak and administrative capacities underdeveloped, identifying and valuing ecosystem services can feed information on development constraints and opportunities into national and local planning process. This can help raise awareness of the need for better regulation (see Box 7.5);

- many countries now apply the precautionary principle in relevant policy fields even where environmental risks are not hazardous to human life. **Balancing costs and benefits is even more important for precautionary policies than for prevention of known hazards** i.e. to provide justification for possible regulation. Stricter controls are often only accepted by stakeholders and the general public if it is clearly shown that the benefits outweigh the costs.

Box 7.5: Feeding catchment assessment data into the regulatory process, South Africa

A biodiversity hot spot area in the municipality of uMhlathuze was confronted with the classic 'development versus conservation' dilemma – with the local municipality mostly in favour of development as a result of the poor socio-economic climate. uMhlathuze opted to undertake a Strategic Catchment Assessment to highlight the ecosystem services that the environment provided free of charge to the municipality. The assessment estimated the value of environmental services provided by the catchment, e.g. nutrient cycling, waste management and water regulation, at nearly US$ 200 million per annum. Politicians known to be 'biodiversity averse' reacted positively once they realised the economic value of the ecosystem services provided and identified management actions to ensure the sustainable use of biodiversity resources and sensitive ecosystems.

Source: Slootweg and van Beukering 2008

7.3 COMPENSATING FOR LOSSES: OFFSETS AND BIODIVERSITY BANKS

7.3.1 WHY DO WE NEED COMPENSATION INSTRUMENTS?

Developments linked to economic growth often lead to habitat loss and degradation, pollution, disturbance and over-exploitation. These impacts can often be avoided or substantially reduced through measures at the design stage (see Chapter 4) and during ope- and adaptive management).

Even with avoidance and other measures, it is **in-evi-table that some developments will result in significant residual impacts. Compensating for such impacts is essential** to avoid ongoing cumulative losses of bio-diversity and ecosystem services. Offsets and biodiversity banks are the main instruments for this purpose. They are suited for use in habitats that can be restored within a reasonable time-frame and/or may benefit from additional protection (see Box 7.6). Offsets can play a key role in delivering 'no net loss' policies (Bean et al. 2008). They are implicitly required as part of an overall policy package where biodiversity policy targets aim to halt the loss of biodiversity (such as in the EU).

Box 7.6: Biodiversity compensation mechanisms

Biodiversity offsets: "measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development and persisting after appropriate prevention and mitigation measures have been implemented. The goal of biodiversity offsets is to achieve no net loss, or preferably a net gain, of biodiversity on the ground with respect to species composition, habitat structure and ecosystem services, including livelihood aspects".

Biodiversity banking: a market system, based on biodiversity offsets, for the supply of biodiversity credits and demand for those credits to offset damage to biodiversity (debits). Credits can be produced in advance of, and without ex-ante links to, the debits they compensate for, and stored over time. Such banks include habitat banks and species banks, and are often known as conservation banks.

Biodiversity banking resembles carbon trading to some extent but is more complex because
(i) there is no such thing as a unit of biodiversity as there is for carbon;
(ii) the location of biodiversity damage and/or compensation matter can present constraints; and
(iii) while there are policy instruments and regulations supporting carbon trading, regulations controlling biodiversity loss are weak and therefore demand for biodiversity trading is low.

Source of definitions: BBOP 2009

Offsets and habitat banking work by triggering actions that provide measurable benefits for biodiversity (credits) comparable to the damage (debits). This equivalence can involve the same kind of habitat or species (like-for-like) or different kinds of habitats and species of equal or higher importance or value.

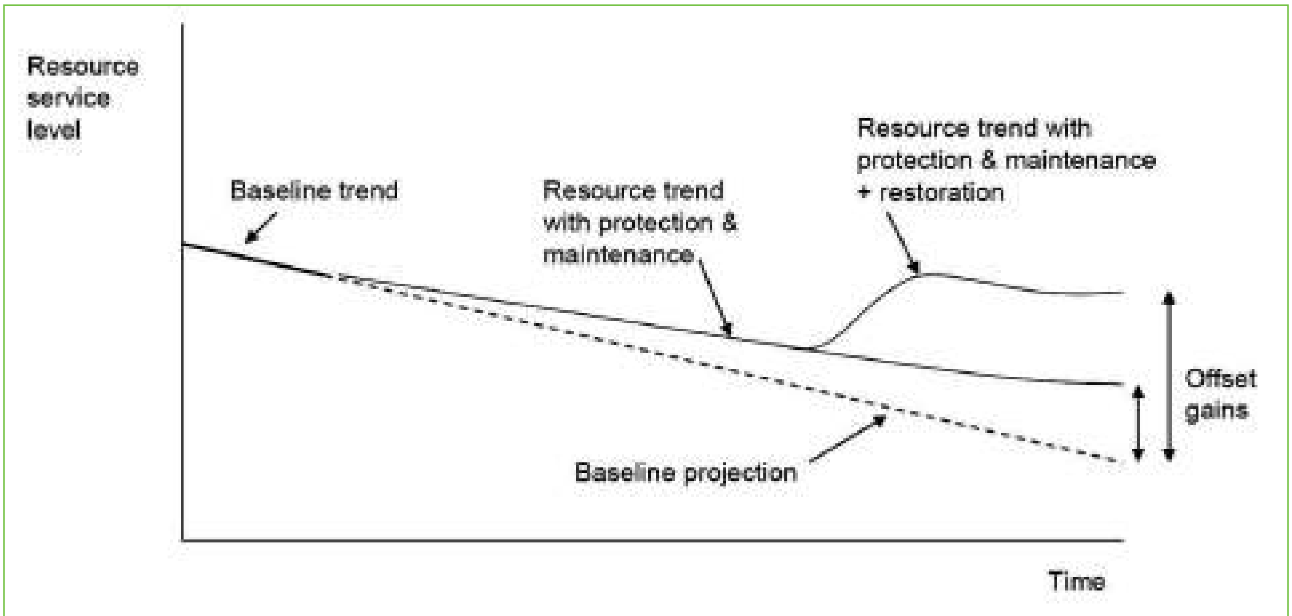
Offsets can focus on protecting habitats at risk of loss or degradation (i.e. risk aversion offsets) or restoring previously damaged or destroyed habitats. The example in Figure 7.1 shows how a habitat can be subject to ongoing measurable losses due to cumulative impacts, which can be extrapolated to an anticipated baseline rate of loss. If a development project protects a larger proportion of equivalent habitat than it destroys, it can provide an 'offset benefit' by reducing the rate of loss in comparison to the baseline. Restoration may provide an additional more tangible benefit, leading to a no net loss situation.

Biodiversity banks create a market-based instrument by turning offsets into assets (credits) that can be traded (see definition in Box 7.5 above). Offsets on their own involve actions that arise from (but do not always occur in) a sequential logic: planning of a project or activity; identification of likely residual damage; biodiversity offset for residual damage. Banking allows these actions to take place without prior connection – and thus in any order. The biodiversity credit can be made before the scale of the debit has been assessed and be stored until it is needed to compensate for a project causing damage.

Banking gives rise to credits that were not created in response to specific (occurred, happening or planned) debits and are thus influenced by past and future conditions (e.g. demand for compensation). Biodiversity banking therefore offers features of supply and demand over time, including speculation and discounting of values.

Biodiversity banks have the **potential to be efficient market-based mechanisms. They have been developed by businesses and public-private partnerships** that have managed to mobilise private funds. Banks and trusts are keen to invest and support this type of activity, especially when markets that allow for credit trading are also created. The financial sector has seen the opportunities for further business creation and development of another 'green' investment product that can be targeted to this niche market. However, many banking and offset schemes are expensive and can entail high up-front and long-term investment. The involvement of public or financial stakeholders is sometimes needed to provide support for complicated and large scale projects.

Figure 7.1: Illustration of potential offset gains (credits) secured by protecting and restoring a threatened biodiversity component (risk aversion)



Source: own representation, Graham Tucker

The following drivers create demand for compensation mechanisms:

- **clear policy requirements for no net loss or a net gain of biodiversity;**

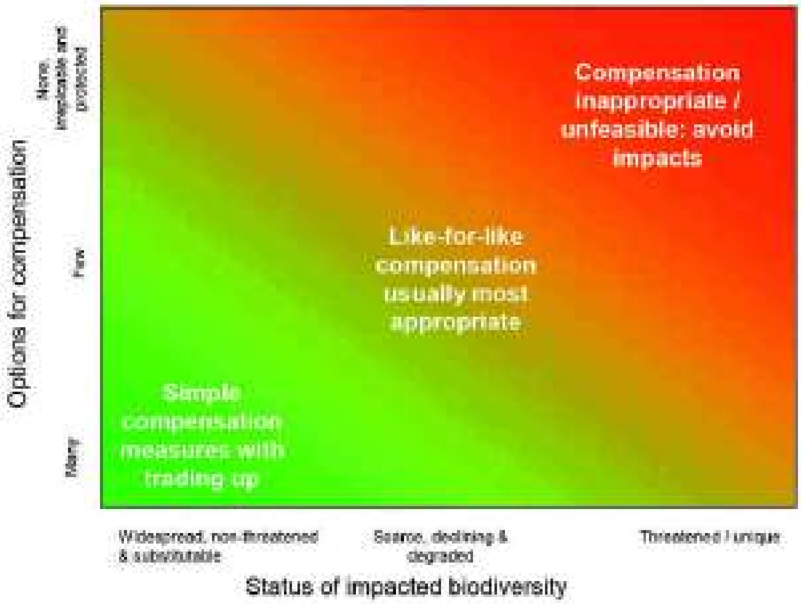
- **legislation that requires compensation** for residual impacts to achieve no net loss or a net gain of biodiversity (e.g. as for Natura 2000 sites under the EU Habitats Directive). Such measures are normally strictly regulated and must be project-specific offsets that are like-for-like, usually within or close to the project development site;

- **planning and impact assessment procedures** (like the EIA and SEA Directives in Europe) that create a requirement for offsets by identifying significant residual adverse effects through application of the mitigation hierarchy. Impact assessments are much more effective when implemented within a clear policy framework requiring no net loss or a net gain: this places the onus on proponents of developments to demonstrate how such a result will be achieved;

- **commercial considerations** (e.g. management of business risks and liabilities; access to investments; accreditation requirements; public relations; corporate social responsibility goals that encourage 'voluntary' compensation measures). For example, the mining company Rio Tinto uses offsets to compensate for unavoidable residual impacts and thereby meet its "aim to have a net positive impact on biodiversity" (Rio Tinto 2004).

However, it is important to note **that many biodiversity components and ecosystem services are unique and irreplaceable and cannot be effectively compensated through offsets**. Compensation measures are best suited to addressing moderate residual impacts on biodiversity components that are replaceable and can be conserved or restored using known techniques within a reasonable timeframe (see Figure 7.2). They are also appropriate for impacts which seem minor in isolation but are significant on a cumulative basis. For impacts on widespread biodiversity, trading up (through activities to promote more important biodiversity) is likely to be acceptable in most cases. However, where impacts are of relatively small magnitude, project-specific compensation can have prohibitive transaction costs. In such cases, it may be possible to develop simple generic schemes (e.g. possibly through standard in-lieu payments to trusts that distribute funds to biodiversity banks or other biodiversity projects).

Figure 7.2: Appropriateness of compensation in relation to the importance of impacted biodiversity and availability of reliable compensation options



Source: adapted from BBOP 2009

POTENTIAL BENEFITS OF OFFSETS AND BIODIVERSITY BANKING

Well-designed **biodiversity offsets and banks can provide additional benefits beyond the achievement of no net loss** from individual developments. Net biodiversity gains are most feasible in regions where past impacts have resulted in landscapes dominated by artificial or cultural habitats with relatively low biodiversity and where remaining areas of semi-natural or natural habitats are small, fragmented and degraded. In such cases, offsets can:

- balance development and conservation, while delivering more conservation efforts than the 'status quo';
- introduce additional finance for conservation and mainstream biodiversity into business and regional planning;
- reverse some past losses of restorable threatened habitats and increase the size of remaining small habitat patches, thereby increasing the viability of species populations and resilience to pressures such as climate change;
- reduce habitat fragmentation by re-creating habitats in appropriate locations that restore connectivity;
- secure more reliable biodiversity outcomes than mitigation measures, especially if biodiversity banks are established in advance;
- prove more cost-effective than avoidance and mitigation measures, especially where banks benefit from economies of scale and competitive market forces. Cost reductions may increase the likelihood that measures are implemented beyond strict legal requirements;
- provide a mechanism that enables the cumulative impacts of low-level impacts to be addressed in a cost-effective and practical manner.

CONSTRAINTS AND POTENTIAL RISKS OF OFFSETS AND BIODIVERSITY BANKING

Significant constraints on offsets and banks need to be considered to avoid risks to biodiversity if compensation measures are inappropriately applied. Probably the most fundamental constraint is that such measures must provide long-term added value (i.e. not just benefits that would have occurred without new actions). Measures must also be based on outcomes going beyond those under existing/foreseen policy and legislative requirements.

In some situations (see Figure 7.1) significant benefits may be obtained by stopping ongoing degradation and avoiding losses from e.g. agricultural improvement, deforestation, wetland drainage and pollution. This can be done through by entering into agreements with individuals (e.g. contracts or covenants) who give up the right to convert habitat in return for payment or other benefits. However, offsets of this kind can only deliver benefits where there are significant areas of remaining habitat that meet three conditions:

- worth maintaining;
- unprotected and likely to remain so in the future (to ensure additionality);
- subject to significant and predictable levels of loss or degradation.

In practice, options for risk aversion compensation may therefore be limited in areas with already high levels of protection for important habitats. Furthermore, even when protection of one area of habitat is successful, this can simply lead to the threat being displaced to another area, resulting in no impact on the overall rate of loss (often referred to as 'leakage').

Given these constraints, **many offsets and biodiversity banks focus instead on habitat restoration or re-creation** (see Chapter 9). This requires proposed offsets to provide a high level of certainty that their intended conservation outcomes will be achieved (or at least that they are high compared to alternative mitigation measures). In practice, the creation or restoration of many habitats is extremely difficult, particularly natural and ancient habitats that have developed over thousands of years.

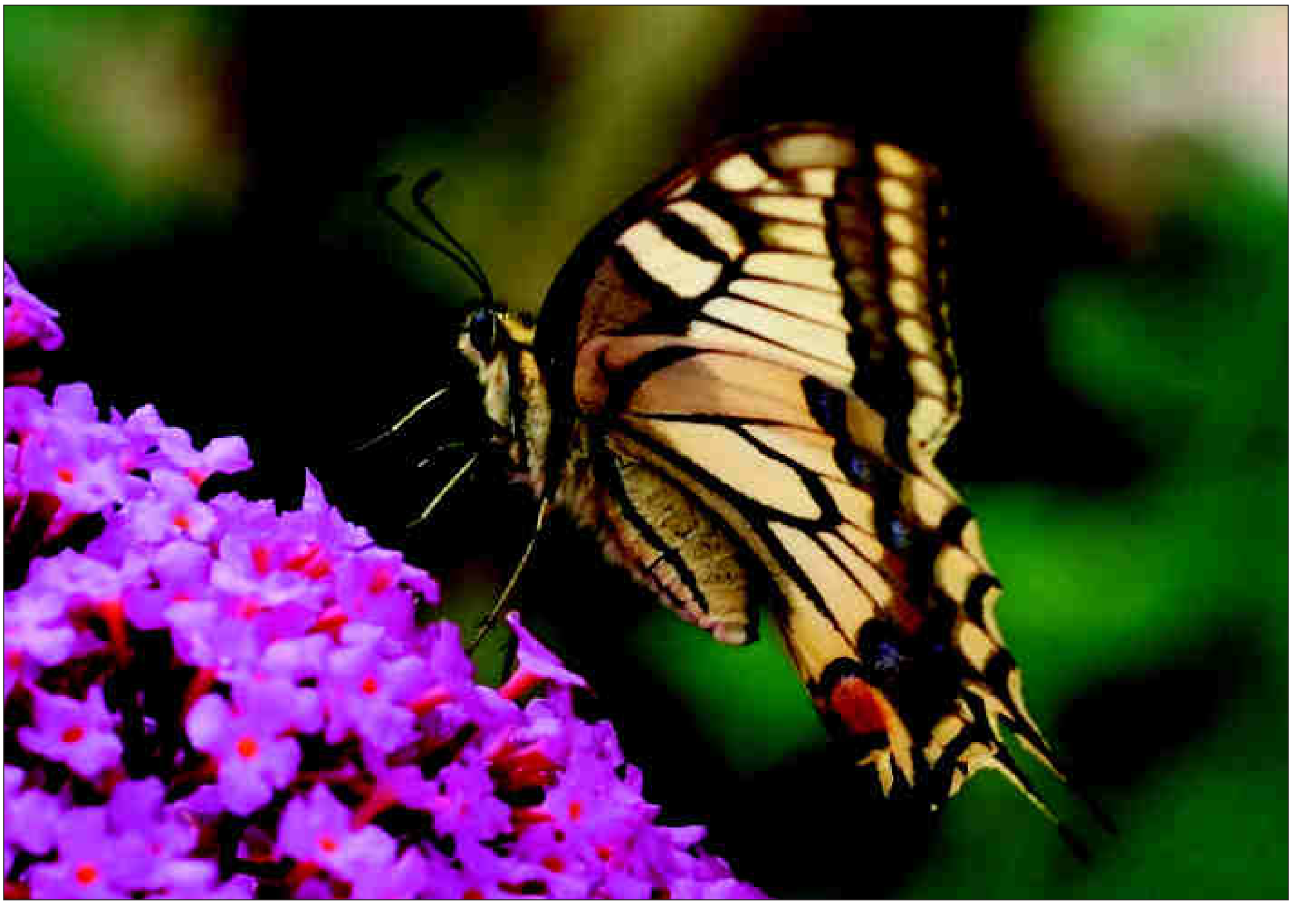
Another important principle is that **reliability of compensation outcomes should increase in relation to the importance of the habitat/species affected** (Figure 7.2). Stringent avoidance and mitigation measures should be taken to avoid residual impacts on very rare or otherwise valuable habitats, where these are considered more reliable than restoration or other offset measures.

In this respect, biodiversity banks have a distinct advantage if they store credits (restored or enhanced habitats) in advance of possible impacts: this reduces uncertainty and concerns over the feasibility and likely quality of compensation, even if some long-term uncertainty remains. However, the commercial risks and long timescales involved in creating many habitat banks are likely to restrict their establishment and the supply of credits.

This summary again highlights the need for a strong regulatory baseline to establish policies for biodiversity offsets and banking systems. Without this, there are significant risks that project proponents will use offsets to avoid other more costly measures and project delays. Proponents have a financial incentive to underestimate potential impacts, overestimate the reliability and benefits of offsets (or other mitigation measures if these have lower costs) and avoid implementation of agreed measures. It is therefore critical to develop offset and habitat banking systems alongside appropriate regulation and adequate administrative capacities. A robust regulatory framework makes it possible to ensure that biodiversity impacts by programmes or projects are properly assessed and that appropriate compensation measures are properly implemented, monitored and managed for at least as long as the period of residual impacts; which often means in perpetuity.

7.3.2 WAYS TO MAXIMISE BIODIVERSITY BENEFITS AND MINIMISE RISKS

The potential benefits and risks of offsets and biodiversity banking have been widely recognised (e.g. Bean et al. 2008; Carroll et al. 2007; ten Kate et al. 2004). The Biodiversity and Business Offsets Programme (BBOP) has developed a set of design principles in consultation with stakeholders (see most recent version in Box 7.7).



Source: Jutta Luft, UFZ

Box 7.7: BBOP Principles on Biodiversity Offsets

1. ***No net loss:*** A biodiversity offset should be designed and implemented to achieve in situ measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity.

2. ***Additional conservation outcomes:*** A biodiversity offset should achieve conservation outcomes above and beyond results that would have occurred if the offset had not taken place. Offset design and implementation should avoid displacing activities harmful to biodiversity to other locations.

3. ***Adherence to the mitigation hierarchy:*** A biodiversity offset is a commitment to compensate for significant residual adverse impacts on biodiversity identified after appropriate avoidance, minimisation and on-site rehabilitation measures have been taken according to the mitigation hierarchy.

4. ***Limits to what can be offset:*** There are situations where residual impacts cannot be fully compensated for by a biodiversity offset because of the irreplaceability or vulnerability of the biodiversity affected.

5. ***Landscape Context:*** A biodiversity offset should be designed and implemented in a landscape context to achieve the expected measurable conservation outcomes taking into account available information on the full range of biological, social and cultural values of biodiversity and supporting an ecosystem approach.

6. ***Stakeholder participation:*** In areas affected by the project and by the biodiversity offset, the effective participation of stakeholders should be ensured in decision-making about biodiversity offsets, including their evaluation, selection, design, implementation and monitoring.

7. ***Equity:*** A biodiversity offset should be designed and implemented in an equitable manner, which means the sharing among stakeholders of the rights and responsibilities, risks and rewards associated with a project and offset in a fair and balanced way, respecting legal and customary arrangements. Special consideration should be given to respecting both internationally and nationally recognised rights of indigenous peoples and local communities.

8. ***Long-term outcomes:*** The design and implementation of a biodiversity offset should be based on an adaptive management approach, incorporating monitoring and evaluation, with the objective of securing outcomes that last at least as long as the project's impacts and preferably in perpetuity.

9. ***Transparency:*** The design and implementation of a biodiversity offset, and communication of its results to the public, should be undertaken in a transparent and timely manner.

10. ***Science and traditional knowledge:*** The design and implementation of a biodiversity offset should be a documented process informed by sound science, including an appropriate consideration of traditional knowledge.

Source: BBOP 2008

These principles are generally applicable to all compensation measures, but care needs to be given to their interpretation and application. In particular, Principle 3 is often misinterpreted. A key objective of its mitigation hierarchy is to reduce the risk of biodiversity loss from developers taking easy least-cost actions, i.e. using offsets and biodiversity banking as a 'licence to trash'. On the other hand, authorities insisting on extremely expensive mitigation measures (e.g. tunnels or viaducts) may not obtain good value for money. It is also clearly inappropriate to expect project proponents to take preventive measures for low-level impacts if much greater benefits could be obtained by simple compensation measures that trade up to provide higher biodiversity benefits.

The term 'appropriate' is therefore central to the mitigation hierarchy principle. The specific aim should be to **compare the conservation benefits of the potential mitigation and compensation measures to identify the combination that delivers the highest reliable benefit**. The question of reliability must be considered in accordance with the precautionary principle. Uncertainty can affect all types of mitigation and compensation measures depending on the circumstances: some mitigation measures may be more reliable than compensation measures or vice versa. The weight given to the reliability of measures should increase with the importance and irreplaceability of the habitats and species that may be impacted. For biodiversity of high conservation importance, measures should therefore focus on avoidance actions (assuming they are most likely to be reliable) rather than risky compensation options.

An advantage of established biodiversity banks, noted above, is to reduce uncertainty over the amount and quality of compensation that will be realised, given that credits already exist and can be measured directly in terms of their ecological value and ecosystem benefits. However, it is still important to assess the ongoing value of the benefits (e.g. in relation to climate change or other external pressures) as well as their additionality.

7.3.3 EXPERIENCE OF COMPENSATION TO DATE

There is growing evidence that, **when appropriately designed and effectively regulated, offsets and biodiversity banks can be efficient market-based instruments** (MBI) that help businesses compensate for the residual unavoidable harm from development projects.

Over 30 countries now require some form of compensation for damage to biodiversity or have established programmes requiring offsets. Countries with legal requirements for offsets include Brazil, South Africa, Australia and the United States, which probably has the most advanced example of a biodiversity mitigation market (Bean et al. 2008; Carroll et al 2007). Box 7.8 provides examples of practice to date in two countries.

Box 7.8: Biodiversity compensation and offsets in Australia and the United States

Australia's habitat banking system is known as BioBanking. It provides that where land use conversion and associated biodiversity loss are inevitable, alternative sites can be restored or put in conservation. This acts as an incentive measure to encourage biodiversity conservation on private land and provide compensation for biodiversity loss at other locations. No economic data are available yet as the programme is still in an early stage.

United States: More than 400 wetland banks have been established, creating a market for wetland mitigation worth more than $3 billion/year. There are also more than 70 species banks which can trade between $100 million and $370 million in species credits each year.

Source: Bayon 2008; DECC 200

The EU has strict legal requirements for compensation measures for 'unavoidable impacts' on protected areas of European importance (i.e. Natura 2000 sites). Some EU Member States (e.g. France and Germany) have additional legislation and policies requiring or enabling offsets and habitat banking. Further information on offsets, including references and best practice guidance, is available at the BBOP website (http://bbop.forest-trends.org/).

7.4 SETTING MORE ACCURATE PRICES: MARKET-BASED INSTRUMENTS

'Taxes are the price of a civilized society'

Franklin D. Roosevelt upon introducing the first US income tax in the 1940s.

'Maybe environmental tax reform is the price of a sustainable society?'

Jacqueline McGlade (EEA) speech at the 8th Global Conference on Environmental Taxation (Munich, 18 October 2007).

7.4.1 CHANGING INCENTIVES IN DECISION-MAKING

Market-based instruments (MBI) can be designed to change the economic incentives available to private actors when deciding upon resource use and contribute to more effective and efficient management of biodiversity and ecosystem services.

MBI (e.g. taxes, charges, fees and fines, commercial licences as well as tradable permits and quotas) send economic signals to private actors. They can be adjusted to discourage activities harmful to biodiversity and ecosystem services by increasing the tax or charge on the use of certain services or by requiring users to purchase tradable permits. Targeted increases of this kind can provide a catalyst to develop more environmentally-friendly alternatives.

In principle, the same is true for direct environmental regulation (see 7.2 above). However, MBIs give private actors more choice (i.e. whether to pay the higher price or find an alternative) depending on what is more cost-efficient for them.

Source: André Künzelmann, UFZ

MBIs work in two ways: by controlling prices or controlling quantities.

Taxes, fees and charges are price-based instruments which determine a price that has to be paid when an ecosystem is used, e.g. charges for water abstraction or sewage fees, entry prices for a national park, a carbon tax, deposit–refund systems or waste fees (see Box 7.9 and also Box 7.11 below).

Box 7.9: Use of volume-based waste fees to reduce waste generation in Korea

In 1995, Korea introduced a Volume-Based Waste Fee (VBWF) where residents pay for solid waste services by purchasing standard waste bags. In principle, the full cost of collection, transport and treatment should be included in the VBWF bag price. However, to avoid negative side effects of a sudden increase in waste treatment costs (e.g. illegal dumping), each municipality sets a different rate depending upon its financial circumstances and treatment costs. Disposal of waste without using VBWF bags or illegally burning waste is subject to a 1 million won (US$ 1,000) negligence fine.

The VBWF programme has had far-reaching effects. From 1994–2004, it led to a 14 % reduction in the quantity of municipal solid waste generated (corresponding to a 20% decline in waste generation per capita) and an increase of 15% in the quota of recycled waste (up to 49%).

Categories	1994	1996	1998	2000	2002	2004
Total waste generation (tons / day)	58,118	49,925	44,583	46,438	49,902	50,007
- thereof recycled	8,927	13,085	15,566	19,167	21,949	24,588
- thereof land filled	47,116	34,116	25,074	21,831	20,724	18,195
Per capita (kg / day)	1.30	1.10	0.96	0,98	1.04	1.03

Source: Korean Ministry of Environment 2006

Tradable permits schemes are quantity-based instruments that restrict the absolute extent for using a resource. They create an artificial market for a resource by:

- determining the number of rights to use a resource (e.g. tons of timber to be cut per year);
- allocating the rights (e.g. to cut one tonne of timber) to the users (e.g. logging companies or local landholders) via auction or free of charge; and
- facilitating trading of rights between potential users (e.g. between different logging companies or the sale of logging rights from local landholders to commercial loggers).

The permit price is set by supply and demand. The best-known example of permit trading is to control air pollution (e.g. CO_2 or SO_2) but the concept has been successfully adapted to a range of resources and goods e.g. to manage fish stocks (see Box 7.10), regulate water abstraction (see Box 7.12) or limit urban sprawl and preserve open space (see Box 7.14). Further applications are being discussed, notably forest carbon trading (see Chapter 5 for the REDD-Plus mechanism), water quality trading or habitat trading (see Hansjürgens et al. forthcoming).

Box 7.10: Experience with Tradable Fishery Quotas in New Zealand

New Zealand's fishing industry has grown exceptionally fast in the last century: by 2004 the seafood sector was the fifth largest export earner occupying over 10,000 workers. To ensure sustainable management of fish stocks, the government has introduced a system of tradable fishing quotas under the Fisheries Act 1986. Every year the Fisheries Ministry sets a new Total Allowable Catch (TAC), based on biological assessment of the stock, which is handed out as 'individual tradable quotas' to fishing companies. Companies are free to decide whether to use their quota (catch fish) or to sell or buy remaining quotas depending on their profits per catch.

The results are so far quite positive: most fish stocks have been rebuilt and the country's fishing grounds are some of the very few to achieve the conservation target of less than 10% stock collapse.

Sources: Ministry of Fisheries NZ 2005; Yandle and Dewees 2008; Worm et al. 2009

Market-based instruments can be designed to address very different environmental concerns (see examples in Table 7.2). Depending on the ecosystem or ecosystem service, there are **different entry points for pricing resource use**. Prices can either be levied on:

- input goods (e.g. water charges, stumpage fees, fuel taxes or land conversion fees);
- processes and associated emissions (emission trading for pollutants like SO_2, NO_X or CO_2); or
- output (e.g. mineral oil tax; waste fees; waste water charges or pollution taxes; fertiliser or pesticide taxes).

Economics suggests that prices work better if they are directly based on emissions or close complements because this makes abatement measures more effective in terms of mitigating such emissions or harmful products (Hansjürgens 1992).

The term 'MBI' is sometimes used for other instruments that may improve market conditions, including market friction reduction policies (e.g. liability rules, see 7.2), information programmes like labelling (Chapter 5) or subsidies (Chapter 6).

Table 7.2: Examples of different uses of MBIs to protect biodiversity and ecosystems

Name	Country	Object	Purpose	Mechanics	Success	Further Information
Landfill Tax Credit Scheme	UK	Terrestrial ecosystems	Re-pricing	Tax scheme and funding	£1 billion of contributions paid from landfill operators to environmental projects	Entrust (2009): How the LCF works, URL: http://www.entrust.org.uk/home/lcf/how-it-works
Acid Rain Programme	USA	Air-quality management	Re-pricing	Tradable permits for the emission of sulphur	Reduction of SO_2 by 52% compared to 1990	US EPA (2009): Emission, Compliance, and Market Data, URL http://www.epa.gov/airmarkets/progress/ARP_1.html
Garbage Collection Fee	Japan	Waste reduction	Re-pricing	Garbage fee (e.g. in Tokyo 0,43 US$ per 10 litre)	Significant reduction of garbage in the participating cities	http://www.unescap.org/drpad/vc/conference/ex_jp_14_jgc.htm
Reforestation Charge	Liberia	Forest protection	Re-pricing	Charges on felled trees (5 US$ per m³ reforestation charge)	Helps to prevent the unsustainable use of forests	FAO (2009): Description of the forest revenue system, URL: http://www.fao.org/docrep/007/ad494e/AD494E06.htm
Tradable Hunting Permit	Mexico	Protection of big horned sheep	Re-pricing	Hunting quotas for the big-horned sheep in every community	Hunting for animals does not endanger the existence of the whole population	Biller (2003)
Nitrogen Oxide Charge	Sweden	Air-quality management	Re-pricing	Charge of SEK 40 (3.9€) per emitted kilogram Nitrogen Oxide	Emission of Nitrogen Oxide reduced from just over 300 tonnes (1990) to 200 tonnes in 2003	Naturvardsverket (2006)
Taxes on pesticides	Sweden	Groundwater management	Re-pricing	Tax of 20 SEK/kg (in 2002) on pesticides	65 % reduction in the use of pesticides	Sjöberg, P. (2007)
Tradable permits on water pollution Hunter River	Australia	Catchment	Re-pricing	Each mine is allowed to discharge a percentage of the total allowable salt load, which is calculated in relation to conductivity levels	Exceeding of permitted quotas decreased from 33% to 4% after implementation	Kraemer et al. (2003)
Environmental Taxes and Water Taxes	Colombia	Catchment	Re-pricing	Pollution and water use is taxed	The level of BOD (the amount of oxygen required to biologically decompose organic matter in the water) dropped by two third in 4 years	Kraemer et al. (2003)
Guabas River Water User Association	Colombia	Watershed management	Re-pricing / Revenue-raising	Water users downstream pay fees (per litre of water received) into a fund for watershed management activities	Revenues (about US$ 600,000 annually) used for projects to protect and regenerate degraded forests, reforest with native species, and for community organization	Landell-Mills (2002) ; Echavarría (2002)
Fees for Mountain Gorilla Tracking	Uganda	Forest habitat protection	Revenue-raising	Visitors have to pay a US$500 permit to go Gorilla Tracking	Population of gorillas is slowly increasing also due to the improved management (e.g. more guards).	Uganda Wildlife Authority (2009): Gorilla permit booking, URL: http:// www.uwa.or.ug/gorilla.html; Zeppel (2007)
Water Conservation Fund	Ecuador	Biosphere Park management / financing	Revenue-raising	Own Financing of watershed reservoir	Over $301,000 were spent on water management projects in 2005, securing the important functions of the Reservoir	The Nature Conservancy (2007)
Entrance fees for the Galapagos Islands	Ecuador	Protected Area management / financing	Revenue-raising	Entrance fee for the Protected Area: 6$ for Ecuadorians / 100$ for other tourists	Revenues (> US$3 million annually) help to improve the management of the National Park	Vanasselt (2000)

7.4.2 WHAT CAN MARKET-BASED INSTRUMENTS CONTRIBUTE?

Market-based instruments (MBI) to price resource use have **particular strengths in four areas:** They can, if set at sufficient rates, make the polluter pay more explicitly than regulation and put the full cost recovery principle into effect. Experience shows that environmental goals may be reached more efficiently with potential for cost savings – however, actual cost savings depend on instrument design and implementation as well as the ecosystem service in question. Lastly, pricing instruments can generate public revenues that can be used to finance biodiversity-friendly policies.

IMPLEMENTATION OF THE POLLUTER/USER PAYS PRINCIPLE

Direct regulation and the use of MBIs are both in accordance with the polluter pays principle but **only market-based instruments make the values attached to resource use explicitly visible**. MBIs confront actors with at least part of the environmental and social costs their actions cause (i.e. costs that were previously externalised and thus not considered in private decision-making) and lead to explicit payments. Tax bills or permit prices are more transparent and more easily mainstreamed into private accounts than investments in technical adaptations to comply with environmental regulations.

Boxes 7.11-7.13 present successful examples of using different MBIs for specific goals.

Box 7.11: Contribution of product taxation to reducing biodiversity loss

Product taxes are important drivers of ecosystem change. **Fertiliser taxes or taxes on excess nutrients** provide an incentive to increase efficiency in fertiliser use for crops and thereby reduce negative externalities. Application of various schemes saw decreases in product use (and subsequent reduction of levels in soil and water) of 20-30% in the Netherlands, 11-22% in Finland, 15-20% in Sweden and 15% in Austria. (Ecotec 2001).

In 2002, Ireland introduced a **tax on plastic bags**; customers now pay 33 cents per bag at checkout. Plastic bag consumption dropped by 80% from 1.2 billion to 230 million bags in the first year, generating tax revenues (US$ 9.6 million) earmarked for a green fund. The tax also halted a major import as only 21% of plastic bags were manufactured in Ireland (New York Times, 2 Feb 2008).

Papua New Guinea has significant foreign receipts through exporting crocodile skins, mainly to Japan. To promote sustainable resource use, **taxes levied on exports** provide an important source of funding for control and monitoring operations by the Department of Conservation (Hunt, 1997).

The Eritrean government implemented a series of **fiscal reforms in the energy sector**, including subsidies to kerosene, promotion of energy-efficient fuel-wood stoves and dismantling of duties on imported solar technology. The goal was to encourage people to consume less fuelwood, thus addressing deforestation and forest degradation problems in the country (UNDP 2001).

Box 7.12: Experience of water use rights in reducing water consumption in China

China's first water use rights system with tradable water use quotas was launched early in 2002 (Zhangye City, Ganzhou District, Gansu Province) as part of a national water saving project. Water use in the pilot area was readjusted based on local ecological and social conditions: high-efficiency water users were given preference for distribution of use rights, and per capita water use was determined based on proximity to water resources. Water use rights certificates were distributed to counties and irrigation districts, and subsequently to townships, villages and households.

In Minle County, each irrigation district distributed water rights certificates to households based on land area and a water resource deployment scheme which was checked, ratified and strictly enforced. Water used for irrigation was reduced to 1,500–1,800 m3/ha/year, significantly lower than the previous year.

Source: Forest Trend 2009

DESIGNING MBIS FOR FULL COST RECOVERY

Market-based instruments have the potential to **make the polluter/user carry the full cost** of pollution/resource use, provided that charge/tax rates are set high enough or the number of permits is adequately restricted. This is a key difference with regulatory approaches which require compliance to a set standard and leave resource use up to this limit free of charge i.e. there is no incentive to reduce pollution below the standard. Under MBIs like taxes, the tax is imposed on all emissions (e.g. every tonne of carbon, every litre of discharged water) and thus increases incentives to reduce resource use. However, tax rates, fees or charges will only reflect the true economic value of the resource in question if the MBIs are explicitly designed and set at an adequate level to secure full cost recovery (see Box 7.13).

Source: André Künzelmann, UFZ

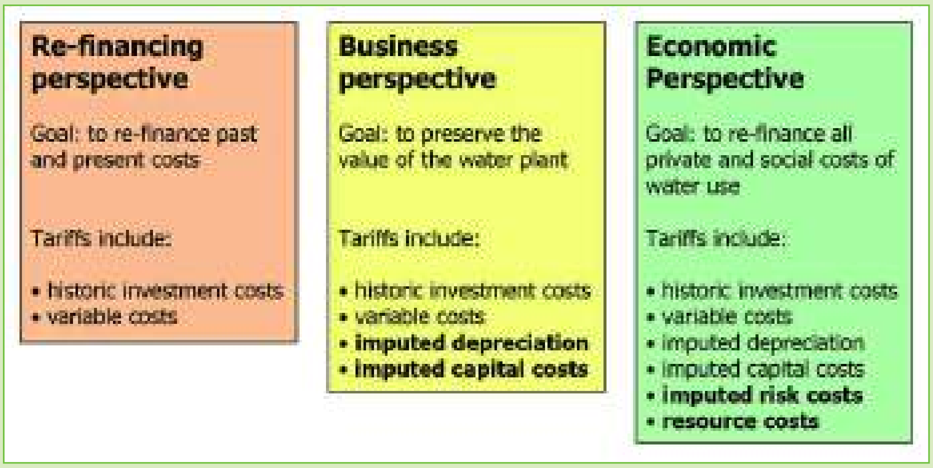
Scuba diver at the top of '1000 Steps' beach and dive site on Bonaire.

Box 7.13: Full cost recovery as a tool to reduce overexploitation: examples from water pricing

In some countries water charges have historically been - and in some cases still are - very low. This reflects the view that provision of basic services like water is a duty of government, with access considered a right. In such cases, end-users often pay less than the full costs. This has led to resource overexploitation, wastage, groundwater depletion, pollution, soil salinisation and biodiversity loss.

Adequate pricing of water to end-users can improve price signals and encourage increased efficiency in water use (OECD 2006), leading to reduced investment needs for infrastructure (both water supply and downstream waste water treatment) and lower overall costs. Both effects can reduce environmental pressures significantly.

Under a full cost recovery approach, users should pay for the full cost of water abstraction, supply infrastructure, preservation of the water plant's value and all private and social costs associated with the provision of water (see figure below).



Many **EU Member States** (e.g. Netherlands, UK) have moved towards full cost recovery for water, involving significant changes in water pricing for most newer Member States. In the Czech Republic, for instance, water pricing gradually increased from €0.02/m3 before 1990 to €0.71/m3 in 2004. Between 1990 and 1999, water withdrawals decreased by 88% (agriculture), 47% (industry) and 34% (public water mains). All houses were provided with metering: consumption of drinking water decreased by about 40%, from 171 litres per day/capita in 1989 to 103 litres in 2002 (UNDP, 2003). In 2003 it was about 10% below the EU average (Naumann 2003). It should be emphasised that there was no sudden imposition of full cost recovery: implementation was gradual in order to avoid social impacts and take affordability issues into account.

Sources: Naumann 2003; UNDP 2003; Hansjürgens 2004; OECD 2006; IEEP et al. 2007

In **Mexico**, annual water withdrawal represents just 43% of the average total renewable water per year, but availability varies by region and water scarcity has increased in most regions over the last ten years. A water pricing system with two different tariffs was therefore introduced. The first tariff involves a fixed price per cubic metre used, which varies between water supply zones. The second uses an increasing block-rate structure to take account of different forms of water use and previously-unmet infrastructure costs. Prior to this programme, water prices covered only about 20% of operation, maintenance and replacement costs. Water tariffs now cover more than 80% of these costs, contributing to a more sustainable use of water by irrigation, industrial and municipal water use.

Source: Dinar 2000; Guerrero and Howe 2000

POTENTIAL COST SAVINGS THROUGH MBIS

Incorporating costs and using market forces has the potential to make MBIs **more cost effective than standard setting by direct regulation**. Where this is the case, it arguably offers the opportunity for more ambitious conservation goals to be set and reached (using a given budget) or that substantial cost savings can be achieved.

In the area of land development, a well-known example for achieving conservation goals without public expenditure concerns the local Tradable Development Rights programmes implemented across the USA (see Box 7.14). Similar programmes are run in New Zealand, Italy and France (OECD 1999a).

Other areas of environmental protection also provide evidence of potential cost savings that could be realised. A study of MBI use for biodiversity over 20 years in the USA showed that cost savings exist in practice (US EPA 2001). In terms of projections, evidence is mainly available for the use of tradable emission rights to regulate air pollutants. Studies based on econometric estimates and survey methods found savings of 43-55% compared to use of a uniform standard to regulate the rate of a facility's emissions (Burtraw and Szambelan forthcoming). The European Emissions Trading Scheme is expected to cut the cost of meeting Kyoto targets for EU Member States. Potential cost savings of a global emissions trading scheme compared to a protocol without trade have been estimated as significant: 84% at world level and 56% for the EU (Gusbin et al. 1999). However, any assessment of cost effectiveness is of course specific to the instrument, problem and context. Some MBIs have been set at very low rates and cannot subsequently be scaled up, due to public opposition or lack of political will (see 7.4.3).

Box 7.14: Tradable Development Rights to control urban sprawl and preserve open space: the case of Montgomery County (Maryland, USA)

The rural and mainly agricultural northern part of this county has cultural and environmental significance beyond its base economic importance. It enhances the quality of life for residents and visitors in the densely-developed Washington DC/Baltimore corridor by providing opportunities for access to locally-grown produce and recreation. A combination of low building density and adapted farming and forestry practices have protected the natural air and water filtration abilities of the ecologically diverse landscape.

In 1981, to prevent urban sprawl and preserve contiguous blocks of open space in this fast-growing county, a tradable development rights scheme (TDR) was introduced. Rights are handed out to landowners in a 'sending zone' in the rural north in exchange for them downsizing the authorised development density of their land. TDR can be bought by developers in 'receiving zones' who face high development pressure and want to exceed the authorised development density of such zones.

The Montgomery County TDR scheme is considered one of the most successful in the USA. By 2008 it had preserved over 50,000 acre of prime agricultural land and open space by transferring more than 8,000 development rights, accounting for 75% of all preserved agricultural land in the county (Pruetz and Standridge 2009). Because the programme is fully private, the savings in public expenditure for the amount of land preserved is estimated at nearly $70 million (Walls and McConnel 2007).

Sources: Walls and McConnel 2007; Pruetz and Standridge 2009

GENERATION OF PUBLIC REVENUE THROUGH MBIS

Public revenues can be generated not only by pricing instruments but also through tradable permit schemes where the State auctions the rights. Such revenues can constitute quite substantial parts of a public budget: estimates for the Seychelles show that biodiversity-related taxes, levies and permits made up one third of total public revenues in 1997 (Emerton et al. 1997). Revenues generated can increase the effectiveness of biodiversity-related instruments by providing extra funds for protective measures e.g. payments for environmental services or incentives like tax relief or endowments to enhance pro-biodiversity practices by land owners (see Chapter 5).

Examples can be found in many countries that earmark environmental taxes for biodiversity policies or use taxes to set up funds (see Box 7.15).

MBI-generated revenues can also play a key role in helping countries to meet their Millennium Development Goal commitments. Governments can consider using taxes to finance their social and physical infrastructure, provide a stable and predictable fiscal environment to promote growth and share the costs and benefits of development more fairly. Fiscal policy and administration also shape the environment in which economic activity and investment take place. Consultation on taxation between governments, citizens and other stakeholders can contribute to improved efficiency, accountability and governance.

Box 7.15: Creating synergies: using MBI revenues to finance biodiversity policies

Examples of pricing systems to generate revenues to restore/manage biodiversity are available from around the world:

- Australia introduced a water extraction levy for the Murray River basin and earmarked the revenues for wetland restoration and salt interception schemes (Ashiabor 2004);
- Mexico increased gasoline tax by 5.5% in October 2007. 12.5% of proceeds will go to support investments in the environment sector, including protected area management (Gutman and Davidson 2007);
- entrance fees to national parks are important revenue sources for countries with limited public money for nature conservation e.g. fees to the Biebrza National Park in Poland (OECD 1999b);
- charging special fees for specific activities in protected areas is also common e.g. diving fees in marine reserves in the Philippines (Arin and Kramer 2002). Tourists are interested in preserving sites they come to visit: the increase in fees paid is only a small fraction of their trip's total cost;
- in the USA, duck hunters are required to purchase Federal Duck Stamps. 98% of revenue generated by stamp sales goes directly to the purchase/lease of wetlands, targeting vital breeding habitats within the National Wildlife Refuge system. The system raises around $50 million/year (http://www.fws.gov/duckstamps/; see also Dunbar w/o).

Sources: OECD 1999b; Arin and Kramer 2002; Ashiabor 2004; Gutman and Davidson 2007; Dunbar (w/o)

7.4.3 LIMITATIONS OF MARKET-BASED INSTRUMENTS

Despite the potential described above, **use of resource pricing tools to safeguard biodiversity and ecosystem services is underdeveloped in most countries**. Although there are many market-based approaches globally, the share of environmental taxes as a percentage of total tax receipts is small and even decreasing in some countries (see Figure 7.3). Fully-implemented levies on harmful products are rare. The level of tax receipts from environmental taxes was about 6.4% of GDP in the EU in 2006; it has been recognised that this could usefully be significantly increased (Bassi et al. 2009), but also that political resistance is still substantial.

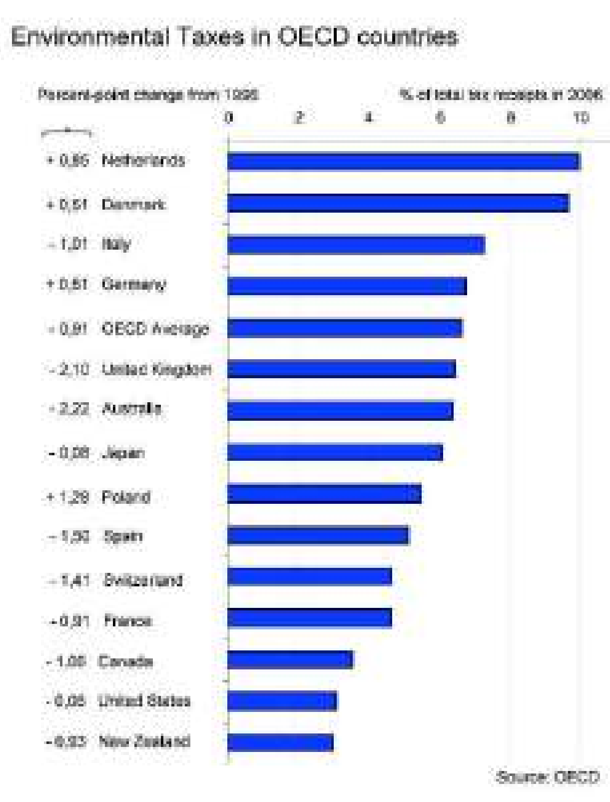
At pan-European level, a comparative study by the Council of Europe of tax systems specifically targeting biodiversity suggests that tax incentives are underdeveloped as a mechanism and do not make a targeted contribution to strengthening ecological networks: they are generally fragmented and **poorly integrated into biodiversity policy toolkits** (Shine 2005).

Market-based instruments are not appropriate in every situation and for every ecosystem. By leaving actors free to choose between reducing resource use or paying the price, they cannot reliably secure site-specific conservation goals to safeguard threatened ecosystems or species. Moreover, since inflation may erode the dissuasive effect of taxes, fees or charges over time, rates have to be continuously reviewed and adapted. When setting up permit trading schemes, determining the 'safe load' (i.e. number of permits to be issued) requires a detailed analysis of the ecosystem at stake. Experience suggests that incentive-based solutions rely on trying one thing, failing and then trying another (Bayon 2004). For these reasons, MBI should only be applied where trial-and-error is appropriate i.e. where failures do not lead to severe and unacceptable damages.

The **introduction of MBIs is often associated with high political costs**. In many countries raising taxes is likely to raise more political resistance from affected interest groups than complex technical requirements set by environmental standards. Administrative requirements are also quite high, especially for operating permit markets. There may be also ethical and equity issues at stake. Some see a charge, a tax or a quota as a paid right to pollute or to degrade the environment which may be ethically questionable. Such instruments can be perceived as unfair as the rich can more easily pay than the poor.

Policy makers and public agencies therefore play a vital role in creating the legal framework necessary for MBI to operate effectively. This means that tradable permit markets for use of ecosystem services are difficult – if not impossible – to implement in countries with weak institutions and regulatory regimes. The aim should not to develop MBI as a substitute for direct regulation, but to create smart policy mixes that provide more flexibility for targeted actors to achieve environmental goals (see 7.6). Such policy mixes can minimise abatement costs to pave the way for more ambitious conservation goals.

Figure 7.3: Environmental taxes as a percentage of total tax receipts in 2005



Source: http://media.economist.com/images/columns/2008w14/Environment.jpg

7.4.4 ROLE OF ECONOMIC INFORMATION IN INSTRUMENT DESIGN

Economic values can feed into the design of market based instruments e.g. to set the rates or number of permits necessary to address the loss of ecosystems and biodiversity.

Understanding the costs of loss can **trigger new pricing instruments**. Valuation provides facts and evidence of ongoing damage and sheds light on negative effects of current consumption patterns. These cost calculations can greatly help policy makers to establish instruments to make the user pay, as they justify the need for price-based approaches and support awareness raising.

Such information can also **facilitate the design of price instruments** for capturing the values of public goods. To implement full cost recovery approaches to cover associated environmental costs, the full costs obviously need to be known. Economic assessments will thus need to play an increasingly important role in e.g. future water pricing policies.

Economic information can **be used directly to determine the tax rate or price** e.g. for fees, charges and trading rules to enable markets for tradable permits to run properly. A good example can be found in India, where the Supreme Court used the results of an economic valuation study to set mandatory compensation payments for conversion of forested land to other uses (see Box 7.16: this case study is also cited in Chapter 4).

Box 7.16: Using economic valuation to determine compensation rates in India

In 2006 the Indian Supreme Court set compensation rates for conversion of different types of forested land to non-forest use, with much higher damage assessment multiples (5x for sanctuaries, 10x for national parks) for any conversion of such biodiversity-rich protected areas. It drew on an economic valuation study of Indian forests by the Green Indian States Trust (GIST 2006) which estimated the value for six different classes of forests (see table below) of timber, fuelwood, non-timber forest products and ecotourism, bio-prospecting, ecological services of forests and non-use values for the conservation of some charismatic species, such as Royal Bengal tiger or the Asian lion. Converters pay compensation to an afforestation fund to improve national forest cover. In 2009 the Supreme Court directed Rs. 10 billion (~ US$ 215 million) to be released from the fund every year towards afforestation, wildlife conservation and creating rural jobs (Thaindian News, 10 July 2009).

Eco-Value Class	Forest Type	Very Dense Forest	Dense Forest	Open Forest
I	Tropical Wet Ever- and Semi Evergreen; Tropical Moist Deciduous	22,370	20,100	15,700
II	Littoral and Swamp	22,370	20,100	15,700
III	Tropical Dry Deciduous	19,000	17,200	13,400
IV	Tropical Thorn and Tropical Dry Evergreen	13,400	12,100	9,400
V	Sub-Tropical Broad Leaved Hill, Sub-Tropical Pine and Sub-Tropical Dry Evergreen	20,100	18,100	14,100
VI	Montane Wet Temperate, Himalayan Moist and Dry Temperate, Sub Alpine, Moist and Dry Alpine Scrub	21,300	19,200	15,000

All values per ha, transformed to US$ and rounded.

Sources: GIST 2006; Thaindian News 10 July 2009

Non-market valuation studies can help **set an adequate price level for entrance fees**. Visitors' willingness to pay may be higher than first thought by protected area administrators. One study provided support for sustainably financing the Bonaire National Marine Park in the Caribbean (see Box 7.17). Another study – focused on the Polish Baltic Sea – showed that a substantial number of coastal users were willing to support the idea of a tax to protect the Baltic Sea from eutrophication (Zylicz et al. 1995).

Box 7.17: Analysing willingness-to-pay to adjust fee structures in the Antilles

The National Parks Foundation is a non-governmental non-profit foundation commissioned by the island government to manage the Bonaire National Marine Park (BNMP), one of the world's premier diving sites. The Foundation gets its income from park admission fees, users of commercial and private moorings, donations and grants, including a government grant for the Education Coordinator's salary. A successful visitor and user fee system, introduced in the early 1990s, was amended in the light of economic valuation studies and now provides more than 90% of self-generated revenues for BNMP. A contingent valuation survey (Dixon et al. 1993) showed that the willingness-to-pay of scuba divers for annual BNMP tags clearly exceeded the relatively modest US$ 10 fee instituted in 1992. This led to a price increase in BNMP dive tags to US $ 25 in 2005: in addition, all users now have to pay entrance fees.

Source: Dixon et al. 1993; Slootweg and van Beukering et al. 2008; Stinapa Bonaire 2009

To summarise, available experience suggests that MBI – if properly designed, implemented, monitored and enforced for compliance – are powerful tools to manage and protect ecosystem goods and services. **As environmental pricing regimes and permit markets develop, it is important to learn lessons from their implementation**. In particular, it is necessary to study whether, and under what institutional and regulatory conditions, existing markets for one resource could be applied more widely within and between countries. Being able to show that it works in a neighbouring country is sometimes the best argument for launching the instrument at home.

Source: Janderk

Scuba diver at the top of '1000 Steps' beach and dive site on Bonaire.

7.5 MONITORING, ENFORCEMENT AND CRIMINAL PROSECUTION

Building awareness across society and political commitment at all levels is a fundamental step towards improving environmental performance and compliance.

In parallel, monitoring, enforcement and criminal prosecution of non-compliant behaviour are essential for any environmental policy to become effective. Environmental crimes often yield high profits for perpetrators, while risks of detection are too low and punishment is not severe enough to deter illegal practices. Change will require adequate funding for monitoring activities, international cooperation on law enforcement and the provision of viable and legal alternatives for certain groups.

7.5.1 ENVIRONMENTAL CRIME: A LOCAL AND GLOBAL PROBLEM

Individuals and businesses will more likely comply with an environmental standard, fulfil a compensation re-quirement or pay a tax if the incentives are right, including a meaningful risk that any illegal behaviour will be detected and appropriately punished. Where government efforts to track down crimes and enforce the law are perceived as weak, this will be taken by some as a tacit acceptance that regulatory requirements do not need to be respected. Good governance and credibility are therefore critical to law enforcement.

Box 7.18 outlines the range of activities and sectors concerned by environmental crime.

Box 7.18: What are environmental crimes?

Environmental crimes include any actions – or failure to act - that breach environmental legislation. They can range from relatively minor offences to serious offences that cause significant harm or risk to the environment and human health. The best-known categories include the illegal emission or discharge of substances into air, water or soil, illegal trade in ozone-depleting substances, illegal shipment or dumping of wastes, illegal trade in wildlife, illegal logging and illegal fisheries but there are many others, including illegal building, land conversion and water extraction.

The impacts of environmental crime can be felt from very local through to global level. Offences with a trade-related or pollution dimension are particularly likely to have a cross-border aspect which can widen the number of impacted people. Not paying attention to this dimension can have implications for a country's trading status and the ability of its businesses to develop new opportunities. Several initiatives to improve international governance and collaboration on monitoring and enforcement are therefore under way.

Many drivers need to be considered, from poverty (i.e. lack of alternatives) to corruption and organised crime. The economics of wildlife crime, for example, show that trade of illegally harvested biodiversity is extremely profitable, generating billions of dollars. The same magnitude of profits can be made by polluters who defy environmental standards and permit conditions. There is a huge need to change people's attitude towards environmental crimes.

POLLUTION AND OTHER DAMAGING ACTIVITIES

Serious pollution-related offences include the handling, transport, trading, possession and disposal of hazardous waste or resources in breach of national and/or international law. They have a clear and direct impact on human health, biodiversity and provision of ecosystem services due to the hazardous nature of the substances in question and can have **knock-on transboundary or wider impacts**. Illegal actions can thus have **far-reaching consequences going beyond the damage caused by the initial act**, often over a considerable period of time. Moreover, businesses that violate applicable laws have an unfair economic advantage over law-abiding ones.

We easily overlook what seem to be minor offences but these too have a significant cumulative impact on biodiversity, cause disturbance to species or lead to ecosystem degradation. Examples include the destruction of breeding places or nests; ongoing pollution of water resources through excessive discharges of chemicals, dangerous substances and wastes; and non-compliance with conditions laid down by administrative permits (see Box 7.19).

As noted in 7.2, regulatory frameworks set rules and standards to avoid or minimise the risk of damage. These, along with best practices adopted in different sectors, are **widely incorporated into environmental management procedures implemented by reputable operators around the world**. Whilst accidents can always happen, negligent practices and/or failure to comply with applicable rules and standards foreseeably increase the likelihood of damage to the environment and/or human interests. The main sectors concerned include the oil storage and transport sector, oil distilleries, chemical manufacturing and storage, the waste treatment and water services sectors, as well as agriculture.

Environmental liability rules, coming on stream in some parts of the world, provide a mechanism for relating the harmful activity to the polluter (where identified) and securing restoration and compensation (see 7.2). Environmental criminal law goes a step further by defining what constitutes illegal conduct, whether it is deliberate and setting penalties (monetary, imprisonment or both). However, its enforcement is always cumbersome as relevant activities are often widespread and surveillance on the spot cannot reliably take place. Corruption in certain countries further adds to the problem. Too often monitoring comes into play only after the damage has occurred and its effects on the ecosystem are apparent. Such monitoring rarely makes it possible to trace a polluting incident back to the polluter with the degree of certitude required for penal actions.

Box 7.19: Wider impacts of pollution and dumping

Oceans are fast becoming a garbage dump. In Australia, surveys near cities indicate **up to 80% of marine litter originating from land-based sources** (sea-based sources are in the lead in more remote areas). Cigarette products, paper and plastic bags headed the Top 10 List of Marine Debris items for 1989-2007. Plastic, especially plastic bags and polyethylene terephthalate (PET) bottles, is the most pervasive type of marine litter around the world, accounting for over 80% of all litter collected in several regional seas assessed.

One key step is to review the level of fines for ocean dumping to increase the level of deterrent where necessary. In the USA, for example, the cruise ship Regal Princess was fined $ 500,000 in 1993 for dumping 20 bags of garbage at sea (UNEP 2009b).

Dumping of mining waste: The Panguna copper mine in Papua New Guinea dumped 130,000 tons per day of tailings into the Kawerogn/Jaba river system (a total of 600 million tons). The damage spread over 30 kilometres from the source and all life disappeared from the river due to the metal and leach acids. The conflict over the mine also inflamed a civil war which lead to its eventual closure (Young 1992). Although this particular case has been dealt with, mining remains one of the most polluting and controversial activities with potentially severe effects on biodiversity and ecosystem services.

Sources: UNEP 2009, ten Brink et al., Young 1992

ILLEGAL USE OF RESOURCES AND WILDLIFE CRIME

Offences related to natural resource use and wildlife can take many forms and take place at many levels. Most countries have long regulated direct taking, trade and other activities affecting valued resources, species and their derivatives where these could collectively lead to over-exploitation or irreversible damage. These rules and associated permit requirements (e.g. to prevent over-collection of wild plants and poaching of animals) are very familiar to environmental administrations, even if detection of offences and subsequent enforcement present major logistical difficulties.

Box 7.20: The economics behind environmental crimes

A whole economy is associated with illegal poaching and hunting. Related profits can be substantial and easily exceed the financial penalties imposed were the crime to be detected. By way of example:

- Cambodian farmers can reap 250 times their monthly salary through the sale of one dead tiger;
- in Papua Province, Indonesia, a shipload of illegal timber yields profits of roughly $92,000, while the penalty is only US $6.47: the rewards are over 14,000 times greater than the risks;
- in Brazil, illegal loggers in the Atlantic Forest can make $75 per tree they harvest but face a deterrent of only US$6.44;
- in Mexico's Selva Maya Forest, poachers obtain a net average of $191.57 per trip but face a deterrent of only $5.66;
- in the Philippines, illegal dynamite and cyanide fishing in the Calamianes Islands earn fishermen an average of $70.57 per trip. The value of the deterrent is only $0.09.

Smuggling wildlife, including many endangered species, is the third largest and most profitable illegal cross-border activity after arms and drugs. Due to increasing demand for animal parts, tigers and other big animal populations (elephants, rhinos) have declined drastically since 1950. Growing demand from Asia for ivory is driving the black market where it now sells for $750 per kilogram, up from $100 in 1989 and $200 in 2004.

Source: Akella and Cannon 2004

We should not neglect the fact that some illegal activity is generated by poverty in developing countries. For example, **illegal hunting** can be triggered by increasing demand for bush-meat from indigenous people through to global buyers. Poorer people are selling bush-meat to collectors and restaurants, meat suppliers and poachers as a means of survival.

As noted throughout this report, many rural and indigenous populations depend on ecosystem goods and services for their livelihoods, cultural identity and even survival. Access to common resources and harvesting is a de facto right. Conflicts of interest are often inevitable and foreseeable where regulatory restrictions or bans are extended to resources used by such groups.

The guiding principles for policy makers set out in Chapter 2 are particularly relevant when negotiating new controls in this field. More broadly, where environmental crime exists, it needs to be addressed through the provision of income-producing alternatives and education. Linking conservation strategies with poverty alleviation is an absolute must for developing countries.

Global illegal trade in wildlife species has grown into a multibillion-dollar business. Species most at risk are plants of edible, medicinal or decorative use, emblematic animal species for their skins and trophies and exotic species (e.g. reptiles, amphibians, fish/corals and birds) collected as pets, ornamentals and for their eggs or venom. Existing black markets, as problematic as they are, mirror the values underlying biodiversity and specific ecosystem services (see Box 7.20).

International treaties may help to protect endangered and threatened species but enforcement is difficult and penalties lack teeth. The 1973 CITES treaty (Convention on International Trade in Endangered Species) protects 900 species from being commercially traded and restricts international trade for 29,000 species that may become threatened. However, a major constraint on global implementation is that even though over 170 countries are party to CITES, implementation and enforcement are inadequate at national level.

7.5.2 NEW APPROACHES NEEDED TO TACKLE CRIME

The economic values of biodiversity and wildlife driving illegal activities can shed light on possible policy responses. Public spending for improved monitoring and detection may be a worthwhile investment as well as providing viable alternatives of livelihoods for local people. Being a global problem, international collaboration to fight environmental crimes is an essential step towards greater efficiency and effectiveness.

Better enforcement of existing regulations is key to stopping illegal activities. Poor enforcement often results in more breaches of legislation affecting all the threats identified above (pollution, dumping, illegal wildlife trade, etc). Stronger enforcement can be assisted by high-tech tools that facilitate crime detection and identifying the source (detection of illegal logging activities, DNA tests on poached animals, pollution alerts and monitoring, satellite tracking of fishing vessels). However, detection is not an enforcement measure and more needs to be done to strengthen implementation. A study by Akella and Cannon (2004) suggests that strengthening crime detection in isolation has often been ineffective; it is more promising to **address the entire enforcement chain - detection, arrest, prosecution, conviction and penalties - in an integrated way**.

Applying meaningful penalties and sanctions is critical to address all types of environmental crimes: only if penalties are high enough will they deter people and businesses from undertaking illegal activities. In EU Member States, environmental offences are subject to similar penalties as traditional crimes (fines, prison, community sentences) but in practice, fines are by far the most common sanction and it is extremely rare to see prison sentences imposed. However, there is now a general trend towards more severe sentencing and a recent study has revealed that the number of prosecutions for environmental crimes is increasing (Huglo Lepage and Partners 2003, 2007).

A promising avenue for further progress is the **participation of citizens** in monitoring and management activities. Environmental NGOs are often in a good position to monitor conditions on the ground, investigate breaches of legislation and raise the alarm about environmental crimes at national or global level. Several do this very effectively in cases of e.g. forest destruction, dumping from minefields or marine pollution. Other NGOs provide technical support for tracing, detecting and investigating wildlife trade crimes.

There are now good examples of how citizens can engage actively in protecting wildlife and reporting bad practices, which can also help with improving prosecution rates (see Box 7.21).

Box 7.21: Investigating bats crime in the United Kingdom

All UK bats and their roosts are protected by law. The Bat Conservation Trust's Investigations Project was established in 2001 as a two-year project in collaboration with the Royal Society for the Protection of Birds to monitor bat-related crime. 144 incidents were reported to the Investigations Project but it was acknowledged that this was likely to be just the tip of the iceberg. Building development and maintenance accounted for 67% of incidents. In addition, 87% of all incidents involved destruction or obstruction of a roost threatening the bat population of an area. The work of the BCT led to the criminal prosecution and penalisation of several offenders (recent fines include £3,500 for destruction of 2 roosts by a developer).

Source: Bat Conservation Trust 2009

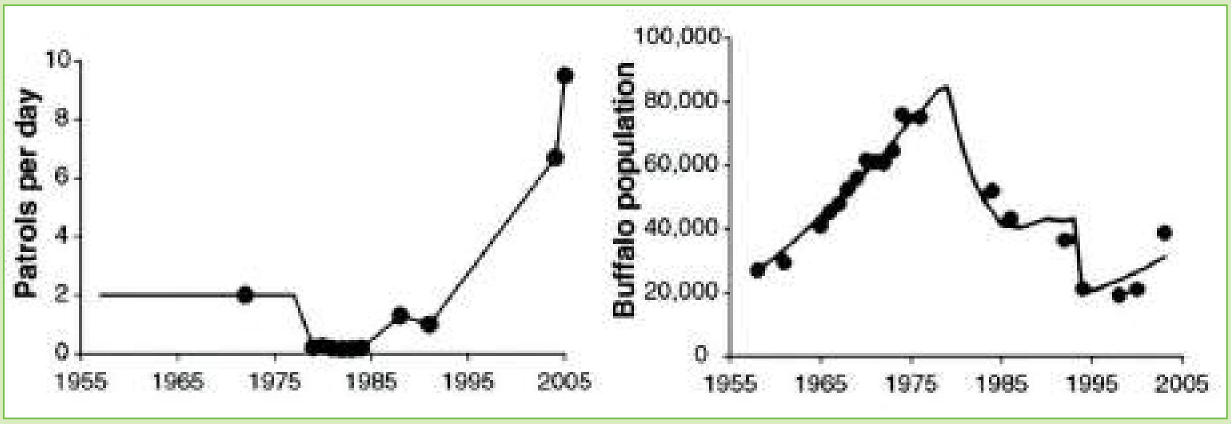
As part of a coherent approach to address drivers of illegal activities, creating income alternatives and reforming unjust laws will help to improve compliance.

To prevent illegal poaching, a starting point is to educate local people about the hunting rules in force and at the same time **provide viable alternatives for jobs and livelihoods**. Experience with ex-poachers in Thailand suggests that they now make more money taking eco-tourists into the forest (and protecting bird populations against poachers) than they did by poaching hornbills themselves (Wildlife Extra 2009; Thaipro 2003).

Demand for illegal wildlife products needs to be halted. For this to happen, we urgently need to change people's perceptions about wildlife products and help consumers to understand the scale of the catastrophe in terms of population declines (see TEEB D4 for Consumers/Citizens for more details). Trade bans and efforts to control borders and customs are frequently suggested tools. However, these are controversial: it has been argued that proactive management of trade in endangered wildlife makes more sense than last-minute bans that can inadvertently stimulate (Rivalan et al. 2007).

Box 7.22: Enforcement at Serengeti National Park

Scientists from the University of Washington have shown that in the Serengeti, which has a 50-year-record of arrests and patrols, a precipitous decline in enforcement in 1977 resulted in a large increase in poaching and decline of many species. Conversely, expanded budgets and anti-poaching patrols since the mid-1980s have significantly reduced poaching and allowed populations of buffalo, elephants and rhinoceros to rebuild. After the improved patrols in the Serengeti proved effective Tanzania initiated a community conservation program in 2000. Outside of established reserves, using tourism or hunting expeditions to generate economic benefits for local communities is the cornerstone to enlisting their help in protecting wildlife.



Source: Wildlife Extra 2008; Hilborn et al. 2006

Sustainable use of wildlife has also been recognised as a possible solution (see Box 7.22). Safari hunting could offer a significant and durable source of financing to offset some of the costs of maintaining Africa's wild lands and protected areas. However, some scientists have called for a better quantitative assessment of whether trophy hunting is both ecologically sustainable and economically competitive over the long term relative to other land uses (Wilkie et al 1999).

In today's global economy, there is more than ever a **need for an international strategy** to deal with environmental crime. Continued cooperation under international treaties to harmonise environmental standards and monitoring requirements is indispensable, together with mutually supportive collaboration on criminal prosecution. The INTERPOL Working Groups on Pollution Crime and on Wildlife Crime (Interpol 2009) provide an excellent example of what can be done.

7.6 MAKING IT HAPPEN – POLICY MIXES TO GET RESULTS

Policies that make the polluter take the full cost of loss into account are a key element of responses to the biodiversity challenge. Policy mixes are crucial for this purpose – they can combine the advantages of different instruments and deliver positive synergies, if properly designed and if institutional and cultural factors are not neglected.

Policies to avoid ongoing losses form the backbone of the policy response. Minimising emissions from point sources (e.g. factories) and diffuse sources (e.g. pesticides) and tackling resource over-use are essential to halt losses and maintain ecosystem services and functions.

Policy makers already have a useful toolkit at their disposal. Pollution control, resource use minimisation and land use management can best be achieved on the basis of a strong regulatory framework. Regulation, especially setting standards, has achieved great successes: many environmental problems that were pressing in the past (e.g. contamination of water bodies, high concentrations of pollutants in the atmosphere) have been significantly reduced through this type of instrument. There is considerable scope for further use of regulation to address environmental problems directly. However, a **strong regulatory framework can also provide more:** it is a **basic precondition for introducing other instruments** such as offset requirements, biodiversity banking or ecologically-focused taxes.

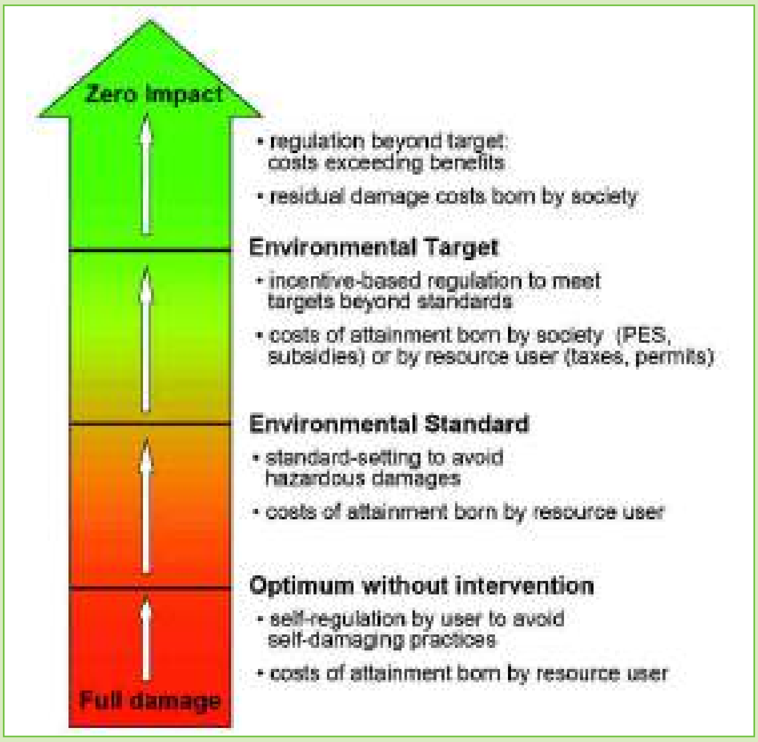
No single policy instrument is enough to tackle the wide range of activities, sources and sectors affecting biodiversity and ecosystem services provision. Market-based instruments are crucial to keep the costs of action low as they encourage actors to develop and implement the cheapest abatement options. The real challenge is to create **smart policy mixes combining the advantages of regulation and flexible market-based instruments** to reach the full potential of the polluter pays and full cost recovery principles (see Figure 7.4).

Policy mixes offer opportunities to address various ecosystem services and various actors at the same time. The optimal policy mix will depend on the state of the resource or ecosystem in question and the number and variety of actors affected. By way of example:

- in the field of hazard prevention, strong environmental regulation is important (e.g. banning highly toxic substances that may be released into the environment);
- for sustainable management of renewable resources, market-based solutions such as permit trading or introducing taxes merit serious consideration;
- even for a single resource, a combined approach is often suitable e.g. in fisheries policies, no-take zones such as marine protected areas might be appropriate to provide undisturbed spawning grounds while fish catch might best be managed through individual tradable quotas.

Market-based instruments can deliver significant social benefits as they stimulate consideration of different abatement costs among resource users and development of **least-cost solutions**. However, these appro-aches are insensitive to distributional concerns and often neglect the needs of the poor and vulnerable. Governments around the world already use a significant share of their revenues to equalise incomes and regulate market activity to ensure wider access to goods and services by such groups. For this reason, smart policy mixes need to go beyond simple cost recovery mechanisms to include appropriate **distributional measures**.

Figure 7.4: Stylised policy mix to address environmental impact



Environmental policy based solely on regulation involves the cost of compliance with a set standard. These costs are already borne by polluters but resource use below the chosen standard is free of charge which means that the associated environmental damage has to be borne by society. Neither the polluter pays principle nor the principle of full cost recovery are applied to their full extent.

If a market-based instrument (e.g. a tax) is introduced covering the entire resource use, this policy mix (of regulation and market-based instrument) leads to a stronger attribution of costs to the polluter. This strengthens incentives for change in the polluter's behaviour.

Reaching a situation of zero impact is economically not desirable in most cases as it often implies that the costs of environmental protection exceed its benefits (i.e. damages prevented). From an economic perspective this is an inefficient point where environmental policy is 'over-shooting'.

Policy design also needs to consider the **institutional preconditions necessary for implementation** (see also Chapter 2). Setting up an emission trading market may be much more ambitious than requesting a minimum standard for filtering emissions at every smokestack. Tax regimes or charging systems (e.g. to reduce water consumption) will only become effective if payments can actually be enforced. Offsets (e.g. for environmental impacts caused by urban development) will only be able to secure no net loss if their effectiveness is monitored over the long term.

Information on the economic costs of biodiversity loss and degradation of ecosystem services can be helpful to support policy makers wishing to propose a new instrument, reform an existing one or build capacity to better implement an existing instrument that is not yet reaching its potential. Economic insights can also help with **instrument choice** (i.e. which combination is more likely to create cost-effective solutions) and in **policy implementation** (e.g. high damage costs suggest high penalties). Building on local knowledge and cultural and institutional contexts can further extend the range of innovative policy mixes (see TEEB D2: Report for Local Policy Makers and Administrators).

Every country is different and what works in one country will not automatically work in another. On the other hand, **learning from success stories and experience elsewhere provides opportunities to adjust and adapt policy tools to national conditions**. A range of approaches combining regulatory and market based solutions should be actively promoted in tandem with the recommendations and guidance in Chapters 5, 6, 8 and 9. The creativity of national and international policy makers is needed in designing smart policy responses to tackle the tremendous biodiversity challenge that confronts us and the generations to come.

Chapter 7 has shown the critical need to strengthen and target a **smart policy mix of instruments** aligned, as far as possible, with the **polluter pays** and **full cost recovery** principles. A strong regulatory framework and good governance is the baseline from which more innovative and ambitious compensation and market-based mechanisms can be developed. Improved application of liability and enforcement regimes is essential to make existing and new policies deliver effective and equitable results.

Chapter 8 discusses the **potential of protected areas** to add value to biodiversity and ecosystem services with associated gains for local and wider communities.

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THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 8: Recognising the value of protected areas

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Chapter 8

Recognising the value of protected areas

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Key Messages of Chapter 8

There are already over 120,000 designated protected areas covering around 13.9% of the Earth's land surface. Marine protected areas still cover only 5.9% of territorial seas and 0.5% of the high seas (Coad et al. 2009) but are increasing rapidly in number and area. **The ecosystems within protected areas provide a multitude of benefits and the global benefits of protection can by far outweigh costs.** However, benefits from protection are often broadly disbursed, long term and non-market while the costs of protection and the earning potential from non-protection choices are often short-term and concentrated. Policy actions are needed to address the distribution of benefits and costs. Such policies are vital to make protected areas a socially and economically attractive choice and to maximise their contribution to human well-being at all scales.

Recommendations

In order to conserve biological diversity and maintain the wide range of ecosystem services of protected areas, complete the establishment of **comprehensive, representative and effectively managed systems of national and regional protected areas** and, as a matter of urgency, **establish marine protected areas**. When appropriately designed and managed, these can play an important role in supporting the maintenance and recovery of fish stocks as well as a wide range of other services.

Integrate protected areas into the broader land- and seascape and enhance/restore ecological connectivity among/between sites and their wider environment. This helps to increase ecosystem resilience, increasing their ability to mitigate environmental risks e.g. by supporting ecosystem-based adaptation to climate change.

With the help of economic valuation, establish effective policies and mechanisms for the **equitable sharing of costs and benefits** arising from the establishment of protected areas (e.g. Payment for Environment ervices, REDD+) and create appropriate incentives to overcome opportunity costs for affected stakeholders where this is justified by broader benefit.

Secure stable financial resources to implement and manage protected areas e.g. by designing appropriate and innovative funding instruments and ensuring adequate international funding, particularly to support the needs of developing countries. We need to understand better the scale and implications of the current protected areas financing gap.

Increase policy coherence to **create 'win-win' situations and establish an enabling environment** for effective establishment and management of protected areas. Important synergies with other policies include (i) recognising the opportunities of ecosystem-based adaption to climate change (e.g. the role of protected areas); (ii) further exploring how marine protected areas can help in recovery of fish stocks, increase food security and offer benefits to coastal protection; and (iii) reducing risks related to natural hazards (e.g. water scarcity) by investing in protected areas.

Worldwide, nearly 1.1 billion people – one sixth of the world's population – depend on protected areas for a significant percentage of their livelihoods (UN Millennium Project 2005). Therefore, it is important to **ensure the participation of local communities and support local livelihoods**, e.g. by using appropriate governance models for protected areas and ensuring that appropriately established and managed protected areas contribute to poverty reduction and local livelihoods.

8 Recognising the value of protected areas

"Protected areas promise a healthier future for the planet and its people. Safeguarding these precious areas means safeguarding our future."

Nelson R. Mandela and HM Queen Noor (2003)

Chapter 8 focuses on the role of protected areas in underpinning global human welfare and ways to improve their effectiveness. **8.1** provides an overview of their **current status** (definition, categories, coverage) and outlines the value and socio-economic potential of ecosystems preserved by protected areas. **8.2** analyses specific **benefits and costs associated with protected areas** and presents the results of comparisons at global, national and local levels. **8.3** and **8.4** provide insights on how **economic valuation of protected area costs and benefits** can provide useful tools to support their implementation, e.g. by building an attractive case for protection and helping to obtain sustainable and long-term financing. **8.5** addresses the broader context and the importance of **multi-level policy support and effective institutional frameworks** to secure lasting results. **8.6** draws together **key conclusions** and presents an enabling framework for protected areas in the future.

8.1 PROTECTING AREAS FOR BIODIVERSITY AND PEOPLE

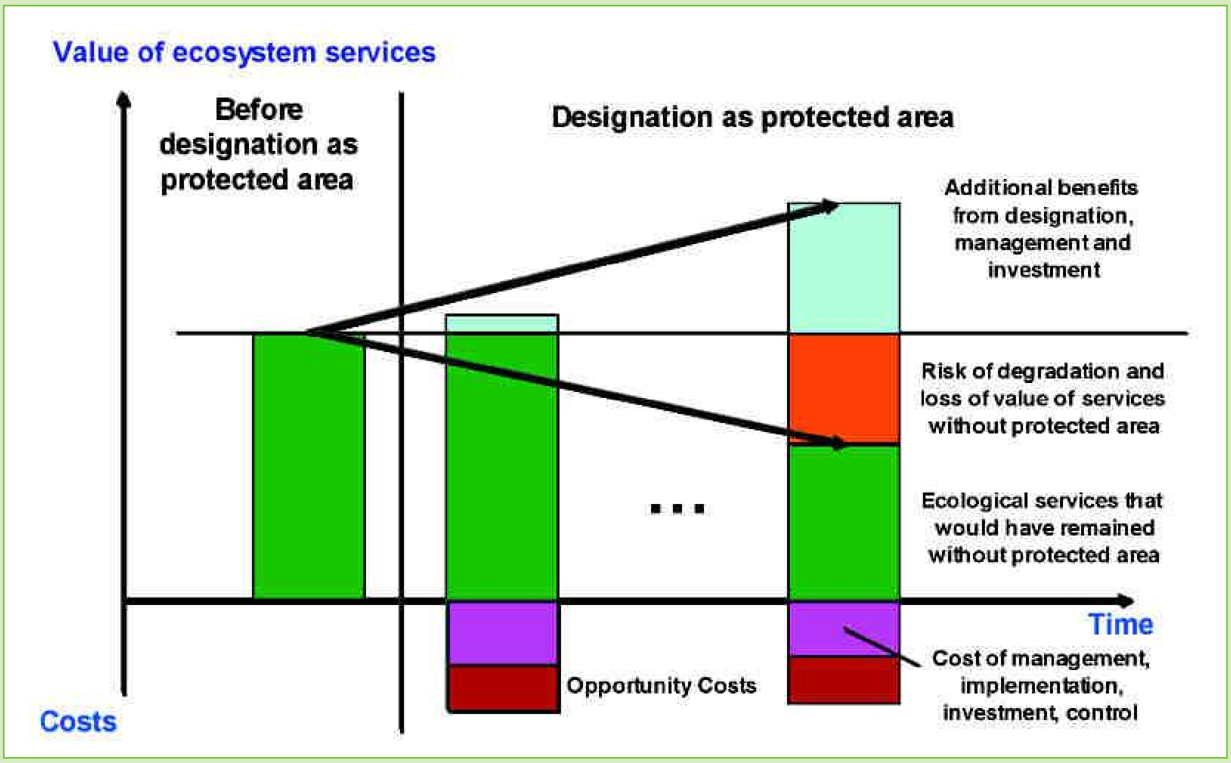
8.1.1 THE VALUE OF PROTECTED AREAS

Protected areas, often considered as the last safe havens for paradise lost, are central to global efforts to conserve biodiversity. Yet they not only safeguard our invaluable biodiversity capital but can also play a key role in maintaining our economic and social well-being (Kettunen et al. 2009; Mulongoy and Gidda 2008; Dudley et al. 2008; Balmford and Whitten 2003). Worldwide, nearly 1.1 billion people – one sixth of the world's population – depend on protected areas for a significant percentage of their livelihoods (UN Millennium Project 2005).

Ecosystems under effective protection help underpin global human welfare by e.g. maintaining food security, mitigating environmental risks and helping adaptation to climate change (see 8.2.1). Their establishment does not mean that an area loses its socio-economic significance - quite the opposite. Protected area designations contribute to preventing the degradation of ecosystems and their valuable services and can increase the value of services provided by sites.

Naturally, some ecosystem services provided by a site are likely to remain even without designation. The **total value of a protected area** can therefore be divided into two components: the added value of designation

Figure 8.1: Schematic for analysing the value of protected areas over time



Source: Patrick ten Brink, own representation (symbolic value of protected area status; value of subsequent avoided degradation due to measures on and off site; increased value due to management and investment) and the value of services maintained without designation (see Figure 8.1).

In practice, it can be difficult to distinguish the added value of designation from the total value of a protected ecosystem, especially over time. This Chapter presents selected examples to present the marginal or additional protected area values: where only total values are available, this is made explicit.

8.1.2 THE DIVERSITY AND RANGE OF PROTECTED AREAS

There are already over 120,000 designated protected areas[1] covering around 13.9% of the Earth's land surface. Marine protected areas still cover only 5.9% of territorial seas and 0.5% of the high seas (Coad et al. 2009) but are increasing rapidly in number and area. Box 8.1 presents the two most widely-used definitions.

Protected areas are a flexible mechanism that can be designed to deliver multiple benefits for both biodiversity and people (see 8.2). Their six internationally recognised categories (see Figure 8.2 below) show just how diverse their management objectives and structures may be.

Although most people associate them mainly with nature conservation and tourism, well-managed protected areas can provide **vital ecosystem services**, such as water purification and retention, erosion control and reduced flooding and unnatural wild fires. They buffer human communities against different environmental risks and hazards (e.g. Dudley and Stolton 2003; Stolton et al. 2006; Mulongoy and Gidda 2008; Stolton et al. 2008a; see also Chapter 9 and TEEB D0, Chapter 7) and support food and health security by maintaining crop diversity and species with economic and/or subsistence value. They also play an important role in ecosystem-based approaches to climate change adaptation and contribute to mitigation by storing and sequestering carbon (see 8.1.3).

Box 8.1: Definitions of protected areas

There are two protected area definitions, from the Convention on Biological Diversity (CBD) and the IUCN World Commission on Protected Areas: both convey the same general message. These definitions encompass several other international classifications, such as natural World Heritage sites and biosphere reserves established by UNESCO.

CBD definition: "A geographically defined area which is designated or regulated and managed to achieve specific conservation objectives".

IUCN definition: "A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008).

Protected areas are often an important part of **local cultural heritage and identity**, in addition to their recreation, education, health and tourism benefits to millions of people worldwide. Conferring protected area status gives formal recognition to these values and creates favourable conditions for their conservation and long-term management.

As many rural communities depend on protected forests, pastures, wetlands and marine areas for **subsistence and livelihoods**, protected areas contribute directly to the global agenda for sustainable development, poverty reduction and maintaining cultures (Dudley et al. 2008; Mulongoy and Gidda 2008). Many existing and proposed protected areas, particularly in developing countries, overlap with areas of high rural poverty (Redford et al 2008). They increasingly feature in national Poverty Reduction Programme Strategies as **potential sources of economic development** that can contribute to human well-being and poverty reduction (subsistence, cultural and spiritual, environmental services, political) (e.g. Blignaut and Moolman 2006). Protected areas have become important vehicles for supporting self-determination of many indigenous peoples and local community movements, who have either self-declared or worked with governments to develop protected areas to secure traditional lands and protect biodiversity.

Depending on their category and design (see Figure 8.2), protected areas may allow for some controlled economic activities to take place within the designated area. Some, particularly private reserves and state national parks, may function as profit-making activities in their own right. Several protected area types, notably UNESCO biosphere reserves and protected landscapes, can act as models for sustainable development in rural areas. Not all protected areas are expected to generate income to help local communities, but where the opportunity exists they can make an important contribution to livelihoods (e.g. Mmopelwa and Blignaut 2006; Mmopelwa et al. 2009; see examples in 8.3).

Protected areas also impose costs on society, arising from restricted access to resources and foregone economic options (e.g. James et al. 2001; Colchester 2003; Chan et al. 2007; Dowie 2009). These costs must be recognised alongside the benefits (see 8.2 and 8.4 below).

8.1.3 CHALLENGES AND OPPORTUNITIES FOR POLICY MAKERS

Protected area agencies need to prove that the benefits from protected areas merit the costs, convince stakeholders of these benefits and ensure that costs are equitably distributed. The potential to deliver such benefits depends on the mechanisms for meeting the chosen objectives. Planning, design, the legal foundation, management, orientation, skills, capacity and funding are key.

Although the aim is usually to protect such areas from unsustainable human use, in practice they face many challenges and many perform at sub-optimal levels. Pressures come both from distant sources (e.g. long-range pollution, climate change) and from near or within the site (e.g. poaching, encroachment, unsympathetic tourism, abandonment of traditional management) (see Box 8.2). Economic valuation of benefits and costs, used in conjunction with an understanding of social and cultural issues, can provide information needed to overcome some of these challenges (see 8.3).

Many legally designated protected areas are so-called ‘paper parks’ i.e. they have no means of enforcing such protection. While designation can itself provide a measure of protection and is a valuable first step, areas without appropriate management are often at risk of degradation. Lack of capacity and resources, weak political support, poor understanding of social interactions, absence of community consultation and problems in empowering stakeholders can reduce their effectiveness, undermining the supply of ecosystem services as well as conservation.

Some pressures stem from the way that a protected area is set up. If local communities or indigenous peoples lose substantial rights to their territories and resources without agreement or compensation, they may have little choice but to continue ‘illegal’ activity in the newly protected area. Other pressures arise because natural resources like timber and bushmeat attract criminal activity. Weak management capacity often hinders adequate responses.

The type and level of threats varies enormously with national or regional socio-economic conditions: pressures from encroachment and collection of natural resources can be particularly high in areas of poverty. Building effective protected areas in a poor country is particularly challenging and needs different approaches to those possible in countries where most people are relatively wealthy. In developed countries, many protected areas are dominated by semi-natural or even highly human-influenced ecosystems (e.g. arable farmland): in such cases, maintaining traditional low-intensity land use practices is often the key requirement for biodiversity conservation. Because such land uses are threatened by intensification or in some cases by land abandonment (Stoate et al. 2001; Anon 2005; EEA 2006), funding is often required to maintain such practices.

We still have no comprehensive global picture of pressures on protected areas although a global study focusing on direct pressures is being undertaken to provide a fuller picture (see Box 8.2). In addition, the World Heritage Committee draws up the World Heritage in Danger list for UNESCO World Heritage sites at most risk.

Figure 8.2: Internationally-recognised system of protected area categories

The IUCN typology of protected area management types and governance approaches distinguishes six categories of management objective and four governance types (Dudley 2008).

IUCN category (primary management objective)	**IUCN Governance type**										
	A. Governance by governments			B. Shared governance			C. Private governance			D. Governance by indigenous peoples and local communities	
	Federal or national ministry or agency in charge	Local ministry or agency in charge	Management delegated by the government (e.g. To an NGO)	Transboundary protected area	Collaborative management (various pluralist influences)	Collaborative management (pluralist management board)	Declared and run by private individual	Declared and run by non-profit organisations	Declared and run by for-profit individuals	Declared and run by indigenous peoples	Declared and run by local communities
I – Strict nature or wilderness protection											
II – Ecosystem protection and recreation		**A**		**G**							
III – Protection of natural monument or feature											
IV – Protection of habitats and species			**E**	**G**	**B**					**C**	
V – Protection of land-scapes or seascapes								**D**			
VI – Protection and sustainable resource use					**F**						

The examples below give a flavour of the diversity (letters are marked on the matrix above).

A. Girraween National Park, Queensland Australia. Owned and managed by the state government of Queensland to protect ecosystems and species unique to the area.

B. Dana Nature Reserve and Biosphere Reserve, Jordan. Managed by the state in cooperation with local communities to reduce grazing and restore desert species.

C. Alto Fragua Indiwasi National Park, Colombia. Proposed by the Ingano people on their traditional forest lands and managed according to shamanic rules.

D. Se ovlje Salina Natural Park, Slovenia. Important area of salt works and wetland, funded as a private reserve by Slovenia's largest mobile phone company. The park also forms part of the EU Natura 2000 network.

E. Sanjiangyuan Nature Reserve, China. Since 2006 part of the reserve has been managed by villagers from Cuochi, who may patrol and monitor an area of 2,440 km^2 in exchange for a commitment to help ensure that resource use is sustainable (Basanglamao and He Xin 2009).

F. Rio Macho Forest Reserve, Costa Rica. An extractive reserve under mixed ownership (70% government, 30% private) zoned for protection, tourism and sustainable use of forest products and agriculture.

G. Maloti-Drakensberg Transboundary Protected Area: including Natal-Drakensberg Park (Kwazulu Natal, South Africa, category II) and Maloti-Sehlabthebe National Park (Lesotho, category IV).

H. Iringal Village Community Conserved Area, India. Established voluntarily by villagers to protect nesting sites of Olive Ridley Turtle (not yet officially recognised as a protected area and thus not marked on the matrix).

Box 8.2: Main direct pressures posing risks to protected areas

A global meta-study coordinated by the University of Queensland examined over 7,000 assessments of protected area management effectiveness (Leverington et al. 2008) and identified the following key direct pressures on protected areas (in descending importance):

- hunting and fishing;
- logging, wood harvesting and collection of non-timber forest products;
- housing and settlement;
- recreation – mostly unregulated tourism;
- activities nearby, including urbanisation, agriculture and grazing;
- grazing and cropping;
- fire and fire suppression;
- pollution;
- invasive alien species; and
- mining and quarrying.

The study does not identify underlying causes e.g. hunting may be driven by poverty or inequality in land tenure. It also does not address the implications of climate change which will increase pressures on many protected areas and may eliminate viable habitat for some species or shift it outside current reserve boundaries (Hannah et al. 2007).

Most identified pressures stem from economic activity, demonstrating the value of resources found in protected areas. In some but not all cases, different management models might allow some exploitation of these resources within protected area management models.

Protected area systems are not yet necessarily representative of the biodiversity within a country: numerous gaps in species and ecosystem protection remain (Rodrigues et al. 2006). Many protected areas are located in areas with relatively low levels of biodiversity, such as ice caps, deserts, mountains, while some richer ecosystems and habitats remain largely unprotected e.g. only 2% of lake systems are in protected areas (Abell et al. 2007).

Despite increasing threats to the marine environment, progress in establishing marine protected areas (MPAs) has been very slow, particularly for the high seas (0,5% coverage; Coad et al. 2009). Yet research shows that **MPAs can be an effective conservation strategy for a range of species, particularly fish** (see examples in 8.2.1). It has been estimated that conserving 20-30% of global oceans in MPAs could create a million jobs, sustain fish catch worth US$ 70–80 billion/year and ecosystem services with a gross value of roughly US$ 4.5–6.7 trillion/year (Balmford et al. 2004). However, the extent to which MPAs can deliver benefits for biodiversity and fisheries obviously depends on careful design and effective management. Predicted recovery of fish populations may also take time so that benefits become visible only after a number of years.

For protected areas to function as ecological networks, a more systematic and spatially broader approach to their establishment and management is needed. The CBD Programme of Work on Protected Areas (see 8.5 below) recognises that this requires a more holistic way of viewing protected areas than in the past and highlights opportunities for protected area agencies and managers to work with other stakeholders to integrate protected areas into broader conservation strategies.

Well-managed protected area networks also offer critical opportunities to adapt to and mitigate climate change. Climate change will put new pressures on biodiversity and increasingly modify ecosystems outside protected areas. This will add to the demands on protected area systems, probably including their natural resources, and increase their role in supporting the maintenance of resilient and viable populations, e.g. species of economic importance. In addition, some plants and animals will need to move their range, calling for more connectivity between protected areas than is currently available. Ways to achieve this connectivity include changing management in the wider landscape and seascape, restoring ecological connections between protected areas and expanding the protected area system itself (IUCN 2004; Huntley 2007; Taylor and Figgis 2007; Harley 2008; CBD AHTEG 2009).

Protected areas store and sequester carbon and can help counter climate change by retaining or expanding carbon-rich habitats (forests, peat, wetlands and marine ecosystems like mangroves, sea grass, kelp etc.) and soil humus. They also help people adapt to climate change by maintaining ecosystem services that reduce natural disaster impacts (coastal and river protection, control of desertification), stabilise soils and enhance resilience to changing conditions, Protected areas support human life by protecting fish nurseries and agricultural genetic material and providing cheap, clean drinking water from forests and food during drought or famine. All the above can create significant win-wins for biodiversity conservation and socio-economic resilience to climate change (Dudley and Stolton 2003; Stolton et al. 2006; Stolton et al. 2008a; Dudley et al. forthcoming; see also Chapter 9).

8.2 WEIGHING THE BENEFITS AND COSTS OF PROTECTED AREAS

This section draws on state of the art research to examine two sets of questions fundamental to the impact of protected areas on human well-being:

- **Do benefits outweigh costs?** If so, in which contexts and at what scales? These questions address the rationale for investing in the effective management and potential global expansion of protected areas.

- **Who benefits and who bears the costs?** Over what timeframe are benefits and costs experienced? For which benefits do markets exist and where can they be created? These questions address equity concerns and can guide decisions on location and management of protected areas by governments and private actors on the ground.

We have chosen examples to illustrate benefits and costs for their clarity and methodological rigour in quantifying particular services or costs (see 8.2.1 and 8.2.2). The main focus is on examples that capture marginal rather than total benefits (i.e. they quantify the additional service flows from protection, rather than the total value of services). These examples are case-specific and do not indicate average levels of benefits or costs across all protected areas.

To understand how benefits and costs compare (8.2.3), we then rely on two other sources of information: (i) a smaller set of site and country level studies which evaluate the benefits and costs of protected areas together to enable them to be compared appropriately; and (ii) global evaluations of protection benefits/costs that provide average or summary values and thus make comparisons appropriate. Lastly, 8.2.4 describes additional factors that influence whether protection will be perceived as a good choice, independent of strictly economic considerations.

8.2.1. PROTECTED AREA BENEFITS

Section 8.1 provided an overview of the importance of protected areas for human livelihoods and well-being. The food, clean water, jobs, medicines, drought relief, and other services that ecosystems within protected areas provide are particularly important to the poor (WRI 2005, see Box 8.3 below). Broader benefits to society as a whole come from services such as carbon sequestration and storage, hazard mitigation and maintenance of genetic diversity.

This section gives concrete examples of some of the most important protected area functions, whilst noting that specific benefits from individual sites will vary depending on location, ecosystem and management strategy.

Supply clean water: Well-managed natural forests provide higher quality water with less sediment and fewer pollutants than water from other catchments. Protected areas are a key source of such water worldwide. One third of the world's hundred largest cities draw a substantial proportion of their drinking water from forest protected areas e.g. this service has saved (cumulatively) the city of New York at least US$ 6 billion in water treatment costs (Dudley and Stolton 2003). Venezuela's national protected area system prevents sedimentation that would reduce farm earnings by around US$ 3.5 million/year (Pabon-Zamora et al. 2009a[2]).

Reduce risk from unpredictable events and natural hazards: Protected areas can reduce risks such as landslides, floods, storms and fire by stabilising soil, providing space for floodwaters to disperse, blocking storm surges and limiting illegal activity in fire prone areas. In Vietnam, following typhoon Wukong in 2000, areas planted with mangroves remained relatively unharmed while neighbouring provinces suffered significant losses of life and property (Brown et al. 2006). In

Sri Lanka, flood attenuation provided by the 7,000 ha Muthurajawella Marsh near Colombo has been valued at over US$ 5 million/year (Schuyt and Brander 2004; for other examples see Chapter 9).

Maintain food security by increasing resource productivity and sustainability: Protected areas provide habitat and breeding grounds for pollinating insects and other species with economic and/or subsistence value such as game, fish, fruit, natural medicines, and biological control agents and can also support food and health security by maintaining genetic diversity of crops (Box 8.4). In the United States, the agricultural value of wild, native pollinators - those sustained by natural habitats adjacent to farmlands - is estimated at billions of dollars per year (adapted from Daily et al. 2009).

Well designed 'no take' zones in MPAs can function similarly (Gell and Roberts 2003). A review of 112 studies in 80 MPAs found that fish populations, size and biomass all dramatically increased inside reserves, allowing spillover to nearby fishing grounds (Halpern 2003). Eight years after designation of Kenya's Mombasa Marine National Park, fish catches around the park had reached three times the level of those further away (McClanahan and Mangi 2000). MPAs can also rebuild resilience in marine ecosystems and provide insurance against fish stock management failures (Pauly et al. 2002).

Support nature based tourism: Natural and cultural resources in protected areas (e.g. biodiversity, landscape and recreational values, scenic views and open spaces) are an important driver of tourism, the world's largest industry. Over 40% of European travellers surveyed in 2000 included a visit to a national park (Eagles and Hillel 2008). Such tourism can be an important source of local earnings and employment. In New Zealand, economic activity from conservation areas on the west coast of South Island led to an extra 1,814 jobs in 2004 (15% of total jobs), and extra spending in the region of US$ 221 million/year (10% of total spending), mainly from tourism (Butcher Partners 2005). In Bolivia, protected area tourism generates over 20,000 jobs, indirectly supporting over 100,000 people (Pabon-Zamora et al. 2009b).

Box 8.3: Protected areas support for local livelihoods

Lao PDR: Nam Et and Phou Loei National Parks. The 24,000 people who live in and around the parks use them for wild plants, fodder for animals, wild meat, construction materials and fuel. In 2002 these uses amounted to 40% of total production per family, with a total value of nearly US$ 2 million/year (Emerton et al. 2002).

Zambia: Lupande Game Management Area. In 2004 two hunting concessions earned the 50,000 residents revenues of US$ 230,000/year which was distributed in cash and to projects such as schools (Child and Dalyal-Clayton 2004).

Nepal: Royal Chitwan National Park. A Forest User Group in the buffer zone earned US$ 175,000 in ten years through wildlife viewing and used this to set up bio-gas plants. It operates a microcredit scheme providing loans at low interest rates (O'Gorman 2006).

Cambodia: Ream National Park. Fish breeding grounds and other subsistence goods from mangroves were worth an estimated US$ 600,000/year in 2002 with an additional US$ 300,000 in local ecosystem services such as storm protection and erosion control (Emerton et al. 2002b).

India: Buxa Tiger Reserve. 54% of families living in and around Buxa derive their income from non-timber forest products (NTFPs) harvested in the reserve (Das 2005).

Vietnam: Hon Mun Marine Protected Area. About 5,300 people depend on the reserve for aquaculture and near-shore fishing. Gross fisheries value is estimated at US$ 15,538 per km^2 (Pham et al. 2005).

Box 8.4: Maintaining food security: crop wild relatives and protected areas

Recognition of wider benefits can influence choices about location and management of protected areas. In situ conservation of crop wild relatives (CWR) helps to provide fresh crop breeding material and maintain food security (Stolton et al. 2008a: see examples on map). CWR are concentrated in relatively small regions often referred to as *centres of food crop diversity*. Habitat protection in 34 ecoregions containing such centres is significantly lower than average: 29 had less than 10% protection and 6 less than 1% protection (Stolton et al.2008b). Some are also undergoing rapid losses in natural habitat, thus putting CWR at risk.

Source: Conservation Magazine 2008 Vol. 9 (4)

Contribute to climate change mitigation and adaptation: 15% of global terrestrial carbon stock is contained in protected areas with a value understood to be in the trillions of dollars (Campbell et al. 2008). With deforestation accounting for an estimated 17% of global carbon emissions (IPCC 2007), maintenance of existing protected areas and strategic expansion of the global protected area system can play an important role in controlling land use related emissions. Intact ecosystems inside protected areas may also be more robust to climatic disturbances than converted systems.

Protect cultural and spiritual resources: These values are poorly accounted for by markets[3] but can nonetheless be immensely important to society. In Brazil's Sao Paolo municipality, residents have expressed willingness to pay more than US$ 2 million/year to preserve the 35,000 ha Morro do Diablo State Park, which protects a key fragment of Brazil's Atlantic forest (Adams et al. 2007). Visitors to South Korea's Chirisan National Park value the conservation of a single species – the Manchurian black bear – at more than US$ 3.5 million/year (Han and Lee 2008). Sacred sites are probably humanity's oldest form of habitat protection, representing a voluntary choice to forego other land uses in favour of larger spiritual benefits (Dudley et al. 2009). Indigenous groups and other traditional owners living in protected areas often have fundamental ties to traditional lands and resources (Beltran 2000).

Preserve future values: Protected areas are crucial if future generations are to enjoy the natural places that exist today. Equally important, the rate at which society is now recognising previously unappreciated ecosystem services suggests that nature's currently unknown option value may be immense. The contribution of standing forests to controlling climate change was little appreciated outside scientific circles just a decade ago - today, as noted above, we understand how colossal their carbon storage may be. When we include the potential for important new discoveries, e.g. in medicine, crop resilience, biomimicry and other areas, preservation of option values are a significant argument in their own right for creating and managing protected areas at a major scale.

8.2.2. PROTECTED AREA COSTS

Ensuring the provision of benefits from protected areas requires society to incur costs. These can include financial costs of management; social and economic costs of human wildlife conflict, restricted access to resources or displacement from traditional lands; and opportunity costs of foregone economic options. As with benefits, costs depend significantly on location, planning processes and management strategy (see sections 8.2.3 and 8.3). The main categories of cost are outlined below.

Management costs: Designation confers some protection on the site and the ecosystem services it provides (Bruner 2001 et al.; Adeney et al. 2009) but appropriate management is also necessary to ensure effective provision of benefits (WWF 2004; Leverington et al. 2008)[4]. Spending on protected area management is inadequate globally (James et al. 2001; Pearce 2007; Esteban 2005). In developing countries most costs are not covered, leaving many protected areas attempting to address complex contexts without basic equipment or staff (e.g. Galindo et al. 2005; Wilkie et al. 2001; Vreugdenhil 2003; see 8.4). In developed countries, funding is often required to maintain low-intensity land use practices via different payment schemes (see 8.1.3). Expansion and strategic integration of protected areas into the wider landscape to maintain key services would increase management needs further (Balmford et al. 2002; CBD AHTEG 2009).

Human wildlife conflict: Where wildlife is found in areas used for human activities, conflicts can be significant. Costs can range from frequent but low-level crop raiding by monkeys through loss of entire harvests and significant property damage by herds of elephants to actual loss of life (Distefano 2005). In Zimbabwe, livestock predation by carnivores from protected areas was estimated to generate losses of approximately 12% of household income (Butler 2000). The need to defend crops can trigger further costs in the form of foregone activities, ranging from farming to school attendance by children.

Loss of access to natural resources: Protected area creation and management can reduce or block access to economically and culturally important resources, bringing significant losses. In Cameroon, resource use restrictions imposed on residents by the creation of Bénoué National Park led to the loss of about 30% of agricultural income and 20% of livestock-derived income (Weladji and Tchamba 2003; see also Harper 2002).

Displacement: A significant number of people have been directly displaced by protected areas. While there is debate about scope, it is clear both that such displacement has been a real problem in a number of cases, and also that its social and economic costs can be disastrous (Adams and Hutton 2007; Brockington and Igoe 2006; Agrawal and Redford 2007). This was the case in the Democratic Republic of Congo when the Bambuti Batwa people were evicted from their ancestral lands during the creation of the Kahuzi-Biega National Park (Nelson and Hossack 2003).

Opportunity costs: Choosing to create and manage protected areas requires foregoing alternative uses. For private actors, key opportunity costs include the potential profit from legitimate resource uses. For national governments, such costs come from foregone tax revenues and revenues from state-run extractive enterprises. Governments also have an obvious interest in the private opportunity costs borne by their citizens.

Even though protected areas tend to occupy land with lower agricultural potential (Gorenflo and Brandon 2005; Dudley et al. 2008), their opportunity costs often remain significant. The private opportunity cost for all strictly managed protected areas in developing countries has been estimated at US$ 5 billion/year (James et al. 2001). Protected area expansion to safeguard a range of services and adapt to climate change would also clearly imply significant opportunity costs, probably more than US$ 10 billion per year over at least the next 30 years (James et al. 2001; Shaffer et al. 2002).

8.2.3. DO PROTECTED AREA BENEFITS EXCEED COSTS?

Benefits and costs of protection vary significantly depending on geographic scale (Table 8.1, Figure 8.4). This section compares benefits to costs at three scales: to the global community from all protected areas worldwide; to countries from their national protected area systems (noting significant differences between developed and developing countries, already highlighted above); and to local actors living in and around individual sites. As mentioned, we base our analysis on two types of study suitable for evaluating net benefits: (i) studies that quantify both benefits and costs for the same site or region using comparable methodologies and (ii) studies that present global average or total values.

Table 8.1: Examples of protected area benefits and costs accruing at different scales

	Benefits	Costs
Global	- Dispersed ecosystem services (e.g. climate change mitigation/adaptation) - Nature-based tourism - Global cultural, existence and option values	- Protected area management* (global transfers to developing countries) - Alternative development programmes* (global transfers to developing countries)
National	- Dispersed ecosystem services (e.g., clean water for urban centres, agriculture or hydroelectric power) - Nature-based tourism - National cultural values	- Land purchase * - Protected area management (in national protected area systems) * - Compensation for foregone activities* - Opportunity costs of forgone tax revenue
Local	- Consumptive resource uses - Local ecosystem services (e.g. pollination, disease control, natural hazard mitigation) - Local cultural and spiritual values	- Restricted access to resources - Displacement - Protected area management (private land owners, municipal lands) - Opportunity costs of foregone economic activities - Human wildlife conflict

* These cost categories in effect transfer costs from the local to national level, or from the national or international level. Section 8.3 provides more information on these and related options.

GLOBAL BENEFITS VS. COSTS

Starting with a word of caution, global values necessarily rely on assumptions, generalisations and compilations of findings from valuation methodologies that are not perfectly comparable. Their conclusions should be regarded as indicative rather than precise. On the other hand, significant methodological progress has been made in addressing some major challenges (e.g. Balmford et al. 2002; Rayment et al. 2009). Furthermore, the scale of the difference between benefits and costs appears to be so large globally that even if analyses are incorrect an order of magnitude, the basic conclusions would be unchanged. Such a degree of inaccuracy is unlikely.

According to the most widely cited estimates, an expanded protected area network covering 15% of the land and 30% of the sea would cost approximately US$ 45 billion per year, including effective management, compensation for direct costs, and payment of opportunity costs for acquiring new land. The ecosystems within that network would deliver goods and services with a net annual value greater than US$ 4.4 trillion. This suggests that **investment in protected areas would help maintain global ecosystem service benefits worth 100 times more than the costs of designating and managing the network**. The operation, maintenance and investment in these natural assets makes economic sense (Balmford et al. 2002[5]; see also Chapter 9 on investing in natural capital).

A complementary perspective is available from the findings of the Stern Review on the Economics of Climate Change (Stern 2006) and other recent work which permit comparison of protected area benefits to costs in areas of active deforestation in developing countries:

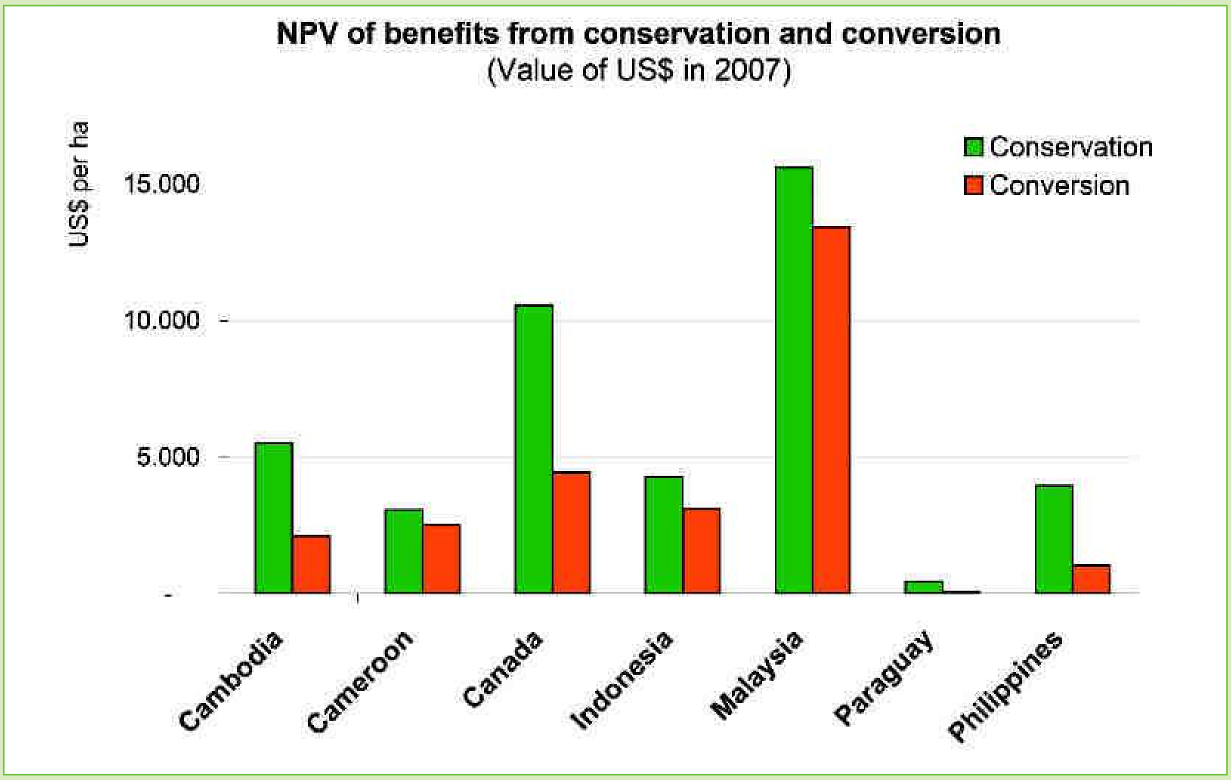
- Stern estimates that for areas being actively cleared, the average annual opportunity cost from foregone agricultural profits and one-off timber harvests is approximately US$ 95/ha;
- seven studies of human wildlife conflict reviewed by Distefano (2005) show average income losses of around 15%, suggesting additional direct costs of perhaps US$ 15/ha/year[6];
- average management costs are reported to be around US$ 3/ha/year (James et al. 1999), yielding an estimate of total annual costs of perhaps US$ 115/ha/year;
- on the other hand, average total benefits per hectare/year from a wide range of ecosystem services provided by tropical forests are estimated at around US$ 2,800/ha/year[7] (Rayment et al. 2009)[8].

Taken together, these studies suggest that even in areas of active deforestation, global protected area benefits will most often greatly outweigh costs[9].

It is also useful to compare total benefits delivered by protected ecosystems with those from converting natural ecosystems to agriculture, aquaculture or other primary production. Balmford et al. (2002), Papageorgiou (2008) and Trivedi et al. (2008) synthesise findings from eight studies that compare the benefits delivered by intact ecosystems with benefits from such conversion (Figure 8.3). All studies include market goods and ecosystem services provided by both conservation and conversion, to ensure that production landscapes are not unfairly disadvantaged by the incorrect assumption that they provide no ecosystem services. This comparative analysis again suggests that protection is an excellent investment globally. **Including major market and non-market values, the global benefits from protection appear to be on average 250% greater than benefits from conversion[10].**

Source: NASA Earth Observatory. URL: http://earthobservatory.nasa.gov/images/imagerecords/1000/1053/tierras_baja_pie.jpg

Figure 8.3: Total benefits of conservation compared to benefits from conversion for seven case study sites in different countries.



Sources: Bann (1997), Yaron (2001), van Vuuren and Roy (1993), van Beukering et al. (2003), Kumari (1994), Naidoo and Ricketts (2006), and White et al. (2000), as reviewed by Balmford et al. (2002), Papageorgiou (2008) and Trivedi et al. (2008). A case from Thailand (Sathirathai (1998) is excluded from the graph for purposes of scale. 'Conservation' includes sustainable production of market goods and services including timber, fish, non-timber forest products, and tourism. 'Conversion' refers to replacement of the natural ecosystem with a system dedicated to agriculture, aquaculture, or timber production. Both scenarios include ecosystem services.

NATIONAL BENEFITS VS. COSTS

Some key benefits from protection accrue largely to the global community (e.g. carbon sequestration, existence or option values, see Balmford and Whitten 2003) or to companies and individuals from other countries (nature-based tourism, see Walpole and Thouless 2005). In contrast, protected area costs are mostly national or local.

Even if carbon sequestration, existence values and tourism values are assumed to accrue only to the global community and are completely removed from the comparisons in the eight studies reviewed above (Figure 8.3), remaining national benefits still average more than 50 times total costs. This suggests that **at the national scale, ecosystem service benefits continue to greatly outweigh the cost of protecting them**, making national investment in protected areas on balance a sound economic choice. A substantial body of case evidence also supports this conclusion. For instance:

- in Brazil's Amazon, ecosystem services from protected areas provide national and local benefits worth over 50% more than the return to smallholder farming (Portela and Rademacher 2001) and draw three times more money into the state economy than would extensive cattle ranching, the most likely alternative use for park lands (Amend et al. 2007);

- in Madagascar, investment in managing the national protected area system and providing compensation to local farmers for the opportunity costs of foregone farm expansion would pay for itself and generate an additional return of 50% from tourism revenues, watershed protection, and international transfers to support biodiversity (Carret and Loyer 2003);

- in Scotland, the ecosystems protected by Natura 2000 sites provide benefits to the Scottish public worth more than three times than associated costs, including direct management and opportunity costs (Jacobs 2004).

On the other hand, it may not be in the national best interest to protect some globally valuable areas in the absence of markets or other transfers to support provision of key services. In Paraguay's Mbaracayu Biosphere Reserve, for instance, 85% of benefits are generated by carbon sequestration. Although the Reserve is of net benefit globally, the value of ecosystem services that accrue nationally[11] is significantly lower than potential income from foregone agricultural conversion (Naidoo and Ricketts 2006), making the reserve a net cost to the country.

LOCAL BENEFITS VS. COSTS

Many key services from protected areas benefit local actors most, from sustainable resource use to disease control to local cultural or spiritual values. Values like watershed protection are of benefit locally, but often also at a larger scale. Although management costs are mainly paid at national or international level (Balmford and Whitten 2003), costs of lost access to resources and wildlife conflict are often extremely localised (Naughton-Treves 1997; Shrestha et al. 2006). The opportunity cost of conversion to non-natural systems tends to be borne in part locally (e.g. where protected areas prevent local actors from clearing land) and in part by commercial, typically non-local actors who clear land for shrimp farms, large scale ranching and similar uses (see Figure 8.4).

As with the larger scale comparisons, there is evidence that local benefits provided by ecosystems within protected areas can outweigh costs. In Costa Rica, communities affected by protected areas have less poverty, better houses and better access to drinking water than communities living farther away (Andam et al. 2008). However, there are also cases where local costs clearly outweigh benefits, particularly where groups are displaced or lose access to key resources (e.g. Harper 2002; Colchester 2003).

Particularly at the local scale, whether or not protected areas are a net benefit or a net cost depends significantly on their design, management and on policies to share costs and benefits, as well as the service provision of the site and on the local socio-economic context and opportunity costs (see section 8.3 below). The following general points on local benefits and costs therefore include reference to different management choices:

Ecosystem services can underpin local economies: Clean water, pollination and disease control are often fundamental to local well being. In Indonesia, people living near intact forests protected by Ruteng Park have fewer illnesses from malaria and dysentery, children miss less school due to sickness and there is less hunger associated with crop failure (Pattanayak and Wendland 2007; Pattanayak et al. 2005).

Protected areas can support sustainable local use: In Cambodia's Ream National Park, estimated benefits from sustainable resource use, recreation and research are worth 20% more than benefits from current destructive use. The distribution of costs and benefits favours local villagers, who would earn three times more under a scenario of effective protection than under a scenario without management (De Lopez 2003).

Sustainability frequently brings short-term local costs: St Lucia's Sufriere MPA has significantly increased fish stocks since its creation, providing a sustainable local benefit. However, this required 35% of fishing grounds to be placed off limits, imposing a short term cost on local fishermen in the form of reduced catch (Lutchman 2005).

Locally-created protected areas can protect values defined by local people: Community protected areas can conserve resources and services locally defined as worth more than the opportunity cost of their protection. Local people and governments can also collaborate to create protected areas to maintain key values at both levels. In Indonesia, the 100,000 ha Batang Gadis National Park was created by local initiative in response to flash flooding caused by upland deforestation (Mulongoy and Gidda 2008).

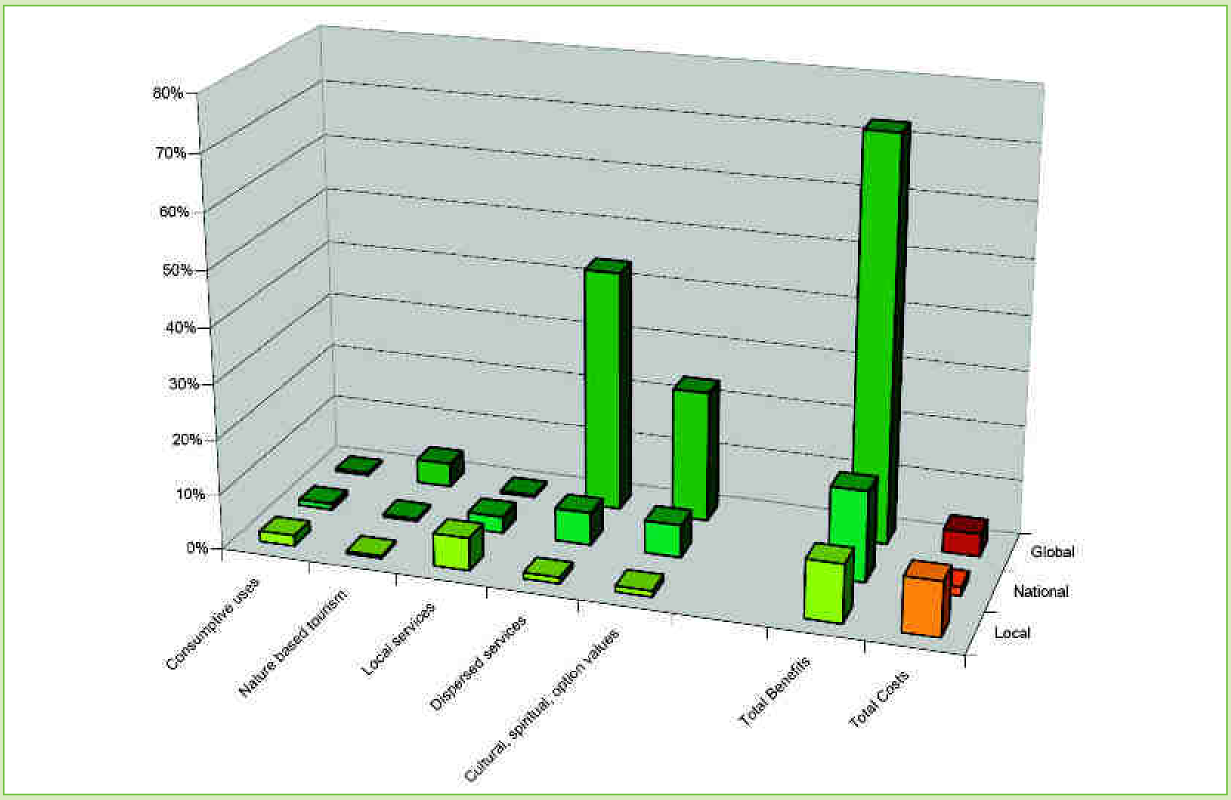
Failure to recognise local rights and uses can result in major costs: Evicting people to make way for protected areas can be devastating. Lost access to natural resources can also have serious negative impacts. Conversely, real participation in protected area planning and management can help ensure local rights are respected, benefits are maintained or enhanced and effective conservation is achieved (Potvin et al. 2002). Such involvement has not been systematically sought but there is growing evidence of its importance. In Fiji, for instance, the participatory creation and management of Navakavu Locally Managed Marine Area led to higher sustainable fish consumption by local families and more community cooperation in resource management (Leisher et al. 2007).

8.2.4. WHY ARE COSTS OFTEN PERCEIVED AS GREATER THAN BENEFITS?

If protected areas can provide such important benefits to society at all levels, why are they under threat of degradation and why are they often perceived mainly in terms of costs? Key reasons include the following:

Costs are more palpable than benefits: Resource degradation typically offers clear and immediate returns in the form of marketable products, tax revenues, or subsistence goods. Crop raiding or livestock predation can also cause sudden, palpable losses. In contrast, many benefits from conservation have no market value, are less

Figure 8.4: A schematic illustration: the distribution of benefits and costs of protected areas



This graph illustrates that the distribution of costs and benefits is spread accross and varies between different geographic scales (adapted from Balmford and Whitten 2003). The magnitudes (%) are illustrative and not based on actual monetary data. Balmford and Whitten emphasize that at global scale, benefits in general far outweigh the costs. We underline here that at site level the situation is more ambiguous: sometimes benefits outweigh costs and vice versa. Thus, even though the overall return on investment in protected areas is high, a close look at the distribution of the costs and benefits is required. The magnitude of global benefits suggests that if we had cost sharing mechanisms in all protected areas to ensure that local benefits exceeded local costs - it would still leave the global community with a large net benefit. Please see section 8.4 below for more information on these aspects.

well understood and therefore poorly appreciated, and deliver benefits to a wider and more dispersed group of beneficiaries and over a longer time period.

Private benefits from production often make protection unattractive for on-the-ground decision-makers: For private actors, converting natural areas to production frequently offers net benefits even if such conversion represents a net local cost (Chan et al. 2007). In Thailand, for instance, the total private return from converting mangroves to shrimp farms has been estimated at US$ 17,000/ha: such returns make deforestation attractive to individual decision-makers despite losses to local society of more than US$ 60,000/ha in decreased fisheries productivity, reduced storm protection, and the elimination of a key source of timber, fuel and other forest products (Sathirathai 1998). While the benefit-cost comparison depends on the specific ecosystem, socio-economic context, market prices, subsidy levels and other factors, similar results are found in a range of contexts (see also Sathirathai and Barbier 2001; Barbier 2007; Hanley and Barbier 2009 as well as Chapters 1 and 10).

Source: Getty Images – PhotoDisc®

Beneficiaries do not adequately share costs: Globally, protected areas have not yet taken full advantage of fee charging mechanisms to help cover costs (Emerton et al. 2006; see Chapter 7). More significantly, most of the benefits they provide are classic public goods, from which people benefit independent of their individual actions and which receive little support from society in the absence of policy or related interventions. At national level, the most common solution – government support for protected areas using tax revenue – is often hampered by an inadequate appreciation of benefits. At international level, there is an even poorer appreciation of the imperative to share costs even though distribution analysis of benefits suggests that global cost sharing is economically rational. Mechanisms to facilitate such cost sharing at a major scale are also lacking.

8.3 IMPROVING EFFECTIVENESS THROUGH ECONOMIC EVALUATION

As outlined in 8.1, **a key challenge for protected areas is to ensure that they can actually meet their objectives**. Hundreds of new areas have been designated over recent decades but many fail to provide effective conservation and lack functioning management structures to secure support from administrators and neighbouring communities. External pressures, local conflicts, lack of financial resources and poor capacity are frequent obstacles. Inappropriate institutional structures and unclear land rights often exacerbate the problem.

At the national level, policy makers can promote an enabling framework for effective protected areas in several ways:

- shape funding priorities for conservation and funding mechanisms for protected areas to ensure that existing models provide the right incentives and sufficient financial stability for effective management;
- influence the legal framework, operational goals and administrative structure of national protected area systems to enable locally adapted management arrangements and more flexible resource use regimes to reduce the risk of conflicts;
- raise their political profile to influence public perceptions and encourage business involvement in conservation;
- share information and best practices internationally and facilitate coordination and cooperation between government agencies and other stakeholders.

An economic perspective on ecosystem services can make this task easier for policy makers as regards advocacy, decision support and handling social impacts (see below).

Results of economic valuation need to be appropriately interpreted and embedded in sound management processes. Valuation studies are always based on a number of underlying assumptions (see 8.3.2 below) which must be clearly understood to use and correctly interpret valuation results. This is particularly important where the results are employed for decision support e.g. determining the framework and tools for protected area management. Whilst monetary values can help to translate ecological concerns into economic arguments, the latter should always be considered within the bigger picture of sound protected area governance and management (e.g. participation of local communities and engagement of broader public) which requires political support.

8.3.1 VALUING ECOSYSTEM SERVICES FOR ADVOCACY

Ecosystem service valuations can be a powerful tool to communicate protection as an attractive choice central to sustainable development strategies.

Globally, it has been estimated that ecosystems within protected areas deliver US$ 100 worth of services for every US$ 1 invested in management to maintain provision and increase delivery of ecosystem services i.e. the annual ratio of the flow of services to operation, maintenance and investment costs is 100:1 (adapted from Balmford et al. 2002). More precise estimates can be developed at national level (see also Chapter 9).

Demonstrating the importance of ecosystem services that sustain economic growth is particularly important. Where rapid industrial development based on exploitation of natural resources is a high national priority, valuations can illustrate that functioning ecosystems are critical to this long-term growth. Conversely, degrading ecosystems and vital services jeopardises economic development by raising costs and customer concerns. In Ethiopia, the remaining mountain rainforests host the last wild relatives of coffea arabica plants: the high economic value of their genetic diversity is a strong argument for strengthening conservation efforts in these landscapes undergoing rapid transformation (Hein and Gatzweiler 2006). Similar evidence is available from the Leuser National Park, Indonesia (see Box 8.5).

8.3.2. VALUING ECOSYSTEM SERVICES FOR DECISION SUPPORT

Valuing ecosystem services can support sound decision-making by helping to assess the costs and benefits of different options e.g. where a protected area should be located, comparison between different resource use regimes. It can also provide useful answers to broader questions such as: what are the cost-effective choices for enlarging our national networks? What sectoral policies, use regimes and general regulations do we need for landscapes surrounding protected areas and for resource use inside their borders? What priorities should national conservation strategies focus on? Answers to these and similar questions can benefit from even partial/selective valuation (Box 8.6).

Valuations can inform the debate amongst those responsible for a protected area and those affected by it, making visible the real trade-offs and economic consequences involved in the various options under consideration. They support transparent estimates of the consequences of different conservation strategies in terms both of costs incurred and ecosystem services secured. Valuations can at least partly translate ecological considerations into more widely understood, less technical arguments and substantially contribute to a more informed public debate about conservation priorities.

Valuation studies do not provide ready solutions to difficult questions. They should inform, not replace, critical debate that draws on a broader range of ecological and political information based on research and on experience. Where trade-offs imply strong conflicts among key actors, these cannot be resolved by valuation studies.

Box 8.5: Using economic arguments to support conservation in Indonesia

The Aceh Province (north Sumatra) has one of the largest continuous forest ecosystems remaining in south-east Asia. The forest sustains local community livelihoods by retaining water in the rainy season, providing continuous water supply throughout the dry season, mitigating floods and erosion and providing timber and non-timber products. Since 1980, the Leuser National Park has sought to protect this rich natural heritage. However, the national army, present in conflict-ridden Aceh during the 1990s, was itself involved in logging and commercial resource exploitation to generate revenues for its operations. Appeals to government officials to respect the park's unique biodiversity were not effective.

Faced with the Park's rapid degradation, its Scientific Director commissioned a valuation study of the impact of biodiversity loss on the province's potential for economic development (van Beukering et al. 2003). This analysed the benefit of the Park's ecosystems for water supply, fisheries, flood and drought prevention, agriculture and plantations, hydro-electricity, tourism, biodiversity, carbon sequestration, fire prevention, non-timber forest products and timber as well as their allocation among stakeholders and their regional distribution.

The study found that conserving the forest and its biodiversity would provide the highest long-term economic return for the Province (US$ 9.5 billion at 4% discount rate) as well as benefits for all stakeholders, particularly local communities. Continued deforestation would cause ecosystem service degradation and generate lower economic return for the Province (US$ 7 billion). There would be short term benefits mainly for the logging and plantation industry but long term negative impacts for most other stakeholders.

Source: van Beukering et al. 2003; Jakarta Post 2004

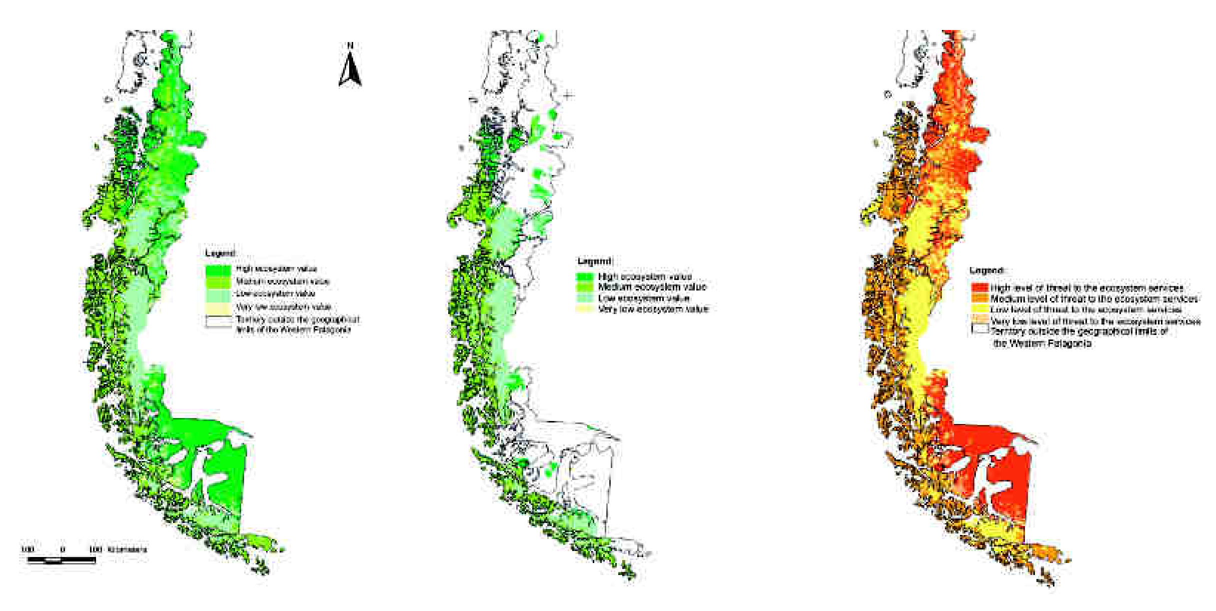
The scope and design of valuation studies affects their outcomes. Valuation can only ever assess a subset of benefits associated with protected areas. This is a point of concern: by focusing on what we can easily measure, we may neglect what we cannot assess e.g. cultural and spiritual values. Valuations require several choices to be made about e.g. the ecosystem services we focus on, the number of years we consider and the assumptions we make concerning the future state of the ecosystem. Such choices imply that we can have two different study designs producing different results, without one being wrong and the other one right.

Box 8.6: Valuation for decision support: regional conservation planning in Chile

In Western Patagonia, 47% of the territory is under legal protection – raising the question of whether such areas are in the right place to protect the region's biodiversity and natural heritage. Chilean researchers assessed the capacity of territorial units to provide a broad range of ecosystem services and generated an ecosystem value per unit (Map 1). They overlaid this map with the current boundaries of Patagonia's protected areas (Map 2) and also analysed factors threatening the provision of ecosystem services, drawing on multi-criteria evaluation and expert judgement, constructing a spatially explicit analysis of threat intensity (Map 3). These threats ranged from global issues (e.g. reduction of the ozone layer) to impacts of local salmon farming.

The comparison of all three maps indicated that (i) despite their vast extent, existing protected areas covered only a very limited percentage of territory with high ecosystem value; (ii) the highest threat level was found in areas with high ecosystem value outside protected areas.

The study enables regional conservation planners to examine the assumptions which underlie the composite variables of ecosystem value and threat intensity. If they agree with the authors' approach, they can draw on these insights to complement and/or correct their approach e.g. to re-allocate conservation funds and prioritise management actions appropriately at regional level.



1) Ecosystem values

2) Ecosystem values inside protected areas

3) Threats to ecosystem services

Sources: Adapted from Martinez-Harms and Gajardo 2008

Valuations imply value judgments, so policy makers need to agree on the design of a study and be aware of its implications when considering its possible use for decision support. To overcome such challenges, some agencies – such as the New Zealand Department of Conservation – have chosen to focus on ecological measurements as a surrogate for measuring ecosystem services. This alternative method is based on the assumption that works to maintain and restore ecosystems, based on ecological criteria, will lead to maintained and restored ecosystem services. There is evidence that this method works for at least some ecosystem services (McAlpine and Wotton 2009; see also Chapter 3.2 of this report which shows how a combination of qualitative, quantitative and monetary values can most usefully present the value of a given site).

8.3.3. VALUING ECOSYSTEM SERVICES TO ADDRESS SOCIAL IMPACTS

Valuation helps to analyse the social impacts of conservation by enabling us to track the distribution of costs and benefits associated with provision of ecosystem services and maintenance of ecosystem functions. Studies can make visible the situations where benefits are partly global but costs (maintenance effort, use restrictions) are borne by the local population and thus highlight the equity implications of a protected area (see Box 8.7). Such studies, scaled up to national system level, can help policy makers orient conservation efforts according to social impacts and set different objectives for different areas. This enhanced transparency and comparative analysis can improve negotiation efforts and compensation schemes, even if dedicated anthropological studies are better suited to describe the complex social dimension of conservation efforts and their impacts on people's livelihoods.

Making local costs visible stimulates efforts to harness benefits at local level. Many protected areas have considerable scope to enhance local benefits and minimise local costs. Local losses can be greatly reduced through growing awareness of new and traditional techniques for discouraging crop/ livestock raiding e.g. physical enclosures to protect livestock at night, use of guard dogs and planting of repellent crops (Distefano 2005). Finding alternative sources of local income to compensate for use restrictions is more challenging but essential for the long-term success of any protected area. These may include conservation easements, payments for ecosystem services (see Chapter 5) and tourism. These funding sources not only need significant start up funds but also – and perhaps more importantly – strong political leadership and high-level support.

Valuations support the use of cost-efficient compensation mechanisms. Where local costs of protected areas cannot be met by alternative sources of income, well-designed compensation programmes can fill the gap (Box 8.7). Identifying costs, benefits and their distribution at a finer scale reduces the risk of compensating either too little (questionable conservation outcomes) or too much (wasting scarce resources). All such mechanisms need functioning governance structures and simple procedures to limit both the risk of fraud and administrative costs.

Box 8.7: Compensation through insurance against elephant damage in Sri Lanka

Rapid population growth and several decades of violent conflict have increased poverty and exacerbated one of Sri Lanka's major rural problems – the Human-Elephant-Conflict (HEC). With elephants consuming 150kg of food every day, crop raiding is a serious problem. In densely inhabited areas, defence strategies, such as watch towers and firecrackers have not led to acceptable long-term solutions.

To explore management alternatives, scientists conducted a survey of HEC impacts in 480 local households and used contingent valuation to estimate willingness to accept compensation. A second survey of Colombo residents revealed that their willingness to pay (WTP) for elephant conservation exceeded the level of funding needed to compensate damage in rural areas.

In addition to several concrete policy recommendations, the study led to the first insurance scheme covering elephant damage in Sri Lanka. In 2007, Ceylinco Insurance presented a scheme that is partly corporate social responsibility and partly profit-driven. Ceylinco charges a small addition to the premium payments of existing life/vehicle policy holders. This money is paid into a trust which funds compensation payments. This effectively transfers the financial burden of conservation to urban, city-dwelling people who do not have to risk their lives and livelihood living in areas with large numbers of elephants.

Farmers also have to pay a nominal fee to participate in the scheme. The payments are Rs 300,000 (around US$ 6000*) for death, Rs 200,000 (around US$ 4000) for death of spouse, Rs 50,000 (around US$ 1000) for property and Rs 25,000 (around US$ 500) for crop loss. There are other benefits like built-in child policies and educational cover for farmers' children. The most progressive element is that land ownership is not a consideration for qualification. Many farmers suffering elephant damage are slash-and-burn (shifting) cultivators who encroach on government lands. This is likely to encourage the government to reconsider the problems of rural landless peasantry.

Valuing conservation costs in terms of affected rural livelihoods has made visible the social implications of protecting elephants. Valuing willingness to pay for elephant conservation has shown the potential for financing the insurance scheme.

Source: PREM 2006; Indian Environment Portal 2007

* exchange rate 1 Rs = 0.02 US$ (2006 rates)

8.4 SECURING SUSTAINABLE FINANCING FOR PROTECTED AREAS

This section focuses on financing protected areas and the role of ecosystem service valuation in fundraising. In most countries, information on financial needs and the funds available for planning, design, establishment and effective management of protected areas is fragmentary. **However, it is generally accepted that creation and management costs can be substantial and that there is a considerable shortfall between the needs and financial resources allocated to protected areas** (see 8.2 above). This is particularly true for developing countries where most biodiversity is concentrated and conservation demands are high.

Economics and valuation can play a very important role in improving protected area financing. Better awareness of financial gaps can help mobilise resources through existing and new mechanisms to improve and expand the coverage of protected area systems and stabilise future funding.

8.4.1. IS THERE A FINANCING GAP FOR PROTECTED AREAS?

Cost estimations for global protected areas vary significantly between different studies. They depend on assumptions used (e.g. elements included in the total costs, type of management required – strict reserves managed mainly for science and wilderness areas may require less investment than national parks or habitat/species management areas[12]), size and location of protected areas (terrestrial/marine, developed/developing country due to differences in labour, opportunity costs and land acquisition costs etc.) and whether resources are needed to manage existing protected areas or to expand the network.

Cost estimates identified in the literature range from **US$ 1.2 billion/year** for a fully efficient (existing) protected area network in developing countries only (James et al. 1999) to **US$ 45 billion/year** for a global marine and terrestrial network that covers 30% of marine area and 15% of terrestrial area (Balmford et al. 2004, see below). Values within the above range have been calculated from other researchers (Vreugdenhil 2003; Bruner et al. 2004; European Commission 2004) under various scenarios of protected area expansion and for different regions. For example, the European Commission report focuses on the costs of Natura 2000, the EU network of areas managed for specific conservation objectives, which are estimated to € 6.1 billion for the EU-25 countries only (excluding Bulgaria and Romania).

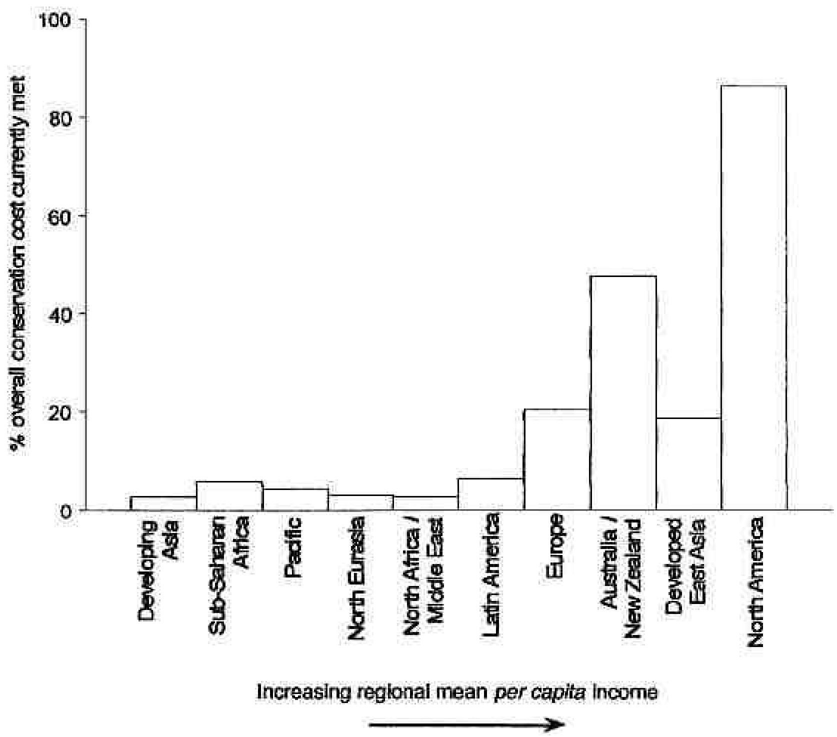
The current protected area system is far from adequate but the studies show that further expansion will entail significant costs. Bruner et al. (2004) suggest that a system covering some of the highest global priority land sites in developing countries could increase annual management costs in these countries to US$ 4 billion/year and incur land acquisition costs of up to US$ 9 billion/year over a 10 year period, depending on the level of ambition and acquisition opportunities. UNEP-WCMC surveys (1993 and 1995) put the global cost of protecting 15% of the world's land area (of which 10% would be strictly protected) at up to US$ 25 billion/year. Estimated overall costs rise significantly if MPAs are included. Coverage of 30% of marine ecosystems, mainly in the tropics, as well as 15% of terrestrial areas could cost the above noted figure of US$ 45 billion/year over 30 years, including management and opportunity costs (Balmford et al. 2004): for projected benefits of this expansion, see 8.2.3).

Turning to actual expenditure, an estimated US$ 6.5-10 billion/year is currently spent on supporting the global protected area system (Gutman and Davidson 2007[13]). This breaks down into US$ 1.3-2.6 billion (public expenditure by developing countries for biodiversity protection), US$ 1.2-2.5 billion (Official Development Assistance from developed countries for protected areas in developing countries, NGO contributions and business spending) and US$ 4-5 billion allocated by developed countries to support their own protected areas networks.

Country-specific examples highlight the scale of the financing gap for existing protected areas. In Ghana, Ecuador and Peru, current spending has been estimated to account for between 35 and 50% of funding needs (Ankudey et al. 2003; Galindo et al. 2005; Ruiz 2005). In Bolivia, the budget covers 70% of needs (Molina et al. 2003) whereas in Cameroon and across the Congo Basin, budgets cover only 20% of needs (Culverwell 1997; Wilkie et al. 2001). Data provided by governments in 2006 indicates that the estimated annual gap in six South American countries (Brazil, Bolivia, Colombia, Chile, Ecuador (Galapagos) and Peru) totalled US$ 261 million and that in Indonesia, the gap is around US$ 100 million/year (Watkins et al. 2008).

If we consider the medium-range cost estimate for the efficient functioning of the existing global network of US$ 14 billion/year (James et al. 1999 and 2001) and compare them with current levels of available global funding for biodiversity (Gutman and Davidson 2007), it could be said that **the world community is investing between 50 and 75% of what would be needed to effectively manage the existing network of protected areas**. However, this general statement is no longer valid if we break down the assessment by the world's regions (Figure 8.5). The figures then show that protected area systems in more developed regions (North America, Australia/New Zealand) receive far more support compared with the gaps experienced in poorer and less developed regions (developing Asia, Africa). The percentage would be even lower if the need to fund an expanded global protected area system to cover representative ecosystems were taken into account. Note that, while this is the most recent estimate available, the numbers will have changed since publication, particularly in Europe as the Natura 2000 network has been established.

Figure 8.5: Financing gaps by region for existing protected areas



Source: Balmford et al. 2003

8.4.2. MOBILISING FUNDS: EXISTING SOURCES AND INNOVATIVE MECHANISMS

Biodiversity financing from different international sources and funds is estimated to be around US$ 4 to 5 billion a year, with some 30-50% going to finance protected areas (Gutman and Davidson 2007). Official Development Assistance (ODA) from high-income countries provides up to US$ 2 billion/ year: this is mostly in the form of country-to-country bilateral aid, with the rest in the form of multilateral aid managed by the Global Environment Facility (GEF), other UN agencies, the International Development Agency and multilateral development banks. The percentage spent on biodiversity conservation has remained consistently low over the past 15 years (2.4-2.8% of total bilateral ODA: UNEP/CBD/WG-PA/1/3 and OECD/DAC) despite awareness-raising efforts within the CBD and through IUCN-World Conservation Union. The severe competition for available funds with other aid demands (e.g. poverty alleviation, rural infrastructure, water provision projects, education and health) is obviously a constraint for increasing expenditure on biodiversity-related activities.

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Funding by non-profit organisations (mainly channelled through international conservation NGOs, private and businesses-related foundations) **probably contributes more than US$ 1 billion/year to international biodiversity protection** but relevant information and data are fragmentary (Gutman and Davidson 2007). Information on NGO spending suggests that funds allocated to protected areas and biodiversity may be even higher. **As with ODA, non-profit funding for biodiversity conservation has grown sluggishly during the past decade:** constraints include levels of public awareness, choices between different environmental priorities and the state of the economy. Competition with other international priorities, such as climate change that have gained higher political and business support, creates the impression that biodiversity is losing ground.

Market-based sources of protected area income could contribute between US$ 1-2 billion annually (Gutman and Davidson 2007). These include international tourism, in particular ecotourism; markets for environment-friendly products such as organic, certified and fair trade product (see Chapter 5). These funding sources have grown quickly in the last twenty years and raised high expectations, but their direct contribution to protected areas needs to be determined.

The three categories of funding listed above can come from public and private sources, be generated within or outside the protected area (Emerton et al. 2006) and be targeted at actions that will take place at the local, national, regional or global level.

Financing for protected areas can also be obtained via new innovative mechanisms and instruments. These additional sources could be based on licensing and concessions, establishment of trust funds, benefits transfer through the creation and deployment of a Green Development Mechanism, payments for ecosystem services and creating international markets for biodiversity and ecosystem services through offsetting schemes or trading (see further Chapter 5, and also 7). Transnational and international PES for global public goods (e.g. carbon sequestration through the proposed REDD scheme under UNFCCC) are amongst the most prominent recently proposed financing schemes: others include environmental taxes and public-private partnerships that link businesses, NGOs, public bodies and communities.

Table 8.2 lists the main existing funding mechanisms for protected areas, both traditional and innovative, with an assessment of their strengths and weaknesses. Most of the funds available today come from traditional methods of income generation such as entry and use fees, tourism charges or funds from NGOs, foundations, private and business sources, ODA or trust funds. Between 1991 and 2006, donor countries invested more than US$ 1.6 billion via the GEF in 1,600 protected areas around the world, spanning 360 million hectares (an area equivalent to Mongolia and Greenland together). This investment leveraged an additional US$ 4.2 billion in co-financing. As a result, very few countries lack protected area systems at the national level. However, some of the traditional mechanisms (e.g. debt-for-nature swaps) have proved cumbersome and require specific operational conditions. In the last 15 years, the total generated by commercial debt-for-nature swaps was only US$ 112 million according to figures compiled by the WWF's Center for Conservation Finance.

Despite increased resources, such mechanisms have failed to provide the funds required to establish the comprehensive and ecologically representative protected area system needed to fulfil the CBD objectives (see 8.5 below). On the occasion of the ninth meeting of the CBD Conference of the Parties in May 2008, the world community reiterated concerns that insufficient resources continued to be one of the main obstacles to the planning, design, establishment and effective management of protected areas, particularly by developing countries and countries with economies in transition. It recognised the urgency of mobilising adequate financial resources for protected areas at a time when the conservation agenda in general, and the Millennium Development Goal target of reducing significantly the rate of biodiversity loss, were being integrated in sustainable development programmes.

CBD COP Decision IX/18 also notes that innovative mechanisms, including market-based approaches, can complement but not replace public funding and development assistance (see also UNEP/CBD/COP/8/INF/21 on public private partnerships). Table 8.2 lists several innovative mechanisms (bio-prospecting fees and contracts, green lotteries) which are still being tested and will need capacity building for their design and use. Mechanisms such as PES and REDD have begun to gather significant support due to their flexibility in design, attracting political attention for their further development. Other ideas are still contentious, like the reform of the financing system and international environmental taxation. Some consider that this kind of taxation could help to improve accountability in the use of natural resources and stimulate transnational companies/corporations subject to such taxes to internalise the costs of business-related impacts on biodiversity (Verweij and de Man 2005).

8.4.3. A FRAMEWORK FOR SUCCESSFUL FINANCING

Traditionally, financial planning for protected areas has focused on the priorities of international donors and lacked an enabling regulatory framework or incentives for behavioural change. Plans have rarely been supported by accurate assessments of financial needs and gaps, cost reduction strategies, assessment and diversification of income sources, business plans or a framework to prioritise revenue allocation. As a result, only a few countries have completed financial plans that incorporate the above indicated elements at system level: these include Ecuador, Costa Rica, Peru, Brazil, Colombia, Grenada and the EU (European Commission 2004).

This section outlines four steps to secure more successful financing for protected areas.

CREATE MARKETS AND PROMOTE MARKET-BASED TOOLS

Economic incentives that bridge the gap between private and public values of biodiversity can provide some solutions to the problem of the global commons and improve the rationale for engaging in biodiversity protection actions. Building on the discussion in Chapter 5, creating markets for goods or services derived

Table 8.2: Existing funding mechanisms for protected areas, including lessons learned concerning their effectiveness

		Geographic area			Available Instruments	Weaknesses/needs for improved performance
Source of funds	**Available Instruments**	**L/R**	**Nat**	**Int**		
Privat	Protected areas entrance and use fees	●			Core component of protected area funding	Better calculation of prices, introduce ecological sustainability when extractive/harvesting uses
Privat	Tourism-related incomes	●	●	●	Can recover resource costs, can capture WTP from the visitors, diversification of tourism markets, rural/ local development, can be used to manage demand	Investments to improve facilities, expertise to provide and market these services, calculation of prices and charges
Privat	Markets for sustainable rural/local products	●	●		Can promote and communicate the value of the resource; assist in branding of a protected area; work in combination with local/rural development; moneys are distributed to local communities; certification is a top-up	Investment needed for certification, developing markets/ marketing
Privat	Innovative goodwill fundraising instruments (Internet based, etc)	●	●	●	Very innovative source of funds that seek to reach global 'small' contributors; additionality is key	Need for making it policy specific and targeting, mainstream the instruments in policy, need for new creative ideas and marketing
Privat	Green lotteries	●	●	●	New tool to mobilise funds; to appeal to consumers and wider public; works better when associated with biodiversity of high value	Need for publicity and marketing
Privat	Public Private Partnerships (PPP) & business-public-NGO partnerships	●	●	●	Can evolve in the context of business CSR, measure included in the menu of many international financing efforts (Climate Change, poverty, etc), experiences exist, flexibility and adaptability can be applied	Tendency to 'move on', local/regional implementation can be more stable
Privat	Business voluntary standards		●	●	Can be developed for protected area and sustainable practices; although not really bringing actual money into the protected area system they can contribute to sustainable management of protected area and local development	Not all business can follow, as standards are costly even for those who introduce/are leaders
Privat	Businesses' goodwill investments (like Corporate Social Responsibility - CSR)	●	●	●	Potential for increasing corporate support/sponsoring to PAs	Need to sustain and increase interest in PAs, increase interaction with private sector, develop new approaches and marketing of PAs
Privat	Venture capital and portfolio (green) investments		●	●	Potential for mobilising corporate funds in a sustainable way; sponsoring protected areas and species; can support environmental business from SMEs near the protected area	High administrative costs; may generate low returns and loose support from capital/investors; Providing for corporate tax relief associated with these mechanisms may further support their uptake
Privat / Public	Non-profit organisation (NGOs, foundations, trusts and charities) funding	●	●	●	Important source of funds overall, provided at protected area level or species level, can help in mobilising actors to donate	Need to sustain and increase donor and public interest in protected areas, increase interaction with donors/public, develop new approaches and marketing of protected areas
Privat / Public	(International) Markets for all type of ecosystem services (PES) and green markets		●	●	Use has increased recently, opportunity to generate revenues for services and not only extractive use, can provide compensation to landowners to adhere to protected area management	Need for developing design guidelines, supportive policy and legislative frameworks, improved methodologies for establishing the biophysical links, set prices, monitor delivery of services

Privat / Public	Bio-prospecting		●	●	Immediate link with protected area, can develop significant potential and mobilise additional funds	R&D and administrative costs; need for highly specialised knowledge, need to work together with access and benefit sharing (ABS)
Public / Privat	Biodiversity cap-and-trade schemes and market-based instruments (MBI) (e.g. off-sets, habitat banking)			●	Instrument that can help in but mostly around protected area; can mobilise significant funds; can create markets for biodiversity and their services	Costs for administration; implementation at global level and registration/monitoring; further work on equivalency methods and their application may be needed
Public / Privat	Carbon emission permits (use part of the auctions)		●	●	Can provide complementary funds for protected areas; some synergies can strengthen between climate change adaptation and ecosystem financing needs	Competition for the distribution of the resources coming from actions/permits between different environmental purposes
Public	Government budgetary allocations	●	●	●	Core component of protected area funding, but are not enough on their own	Some evidence of protected area funding decline; resources often driven to/compete with other priorities, strengthening policy integration and mainstreaming protected area is needed
Public	Earmarking public revenues		●	●	Can potentially provide sufficient resources that will go to protected area and biodiversity conservation	Quite difficult to achieve: if resources earmarked for environ-mental purposes there is competition between different environmental goals/policies
Public	Environment-related taxes (national or international)		●	●	Taxing (or increase taxation) to international trade; some products are related to nature (timber, etc); others (aviation, shipping) are of environmental nature but already can be accepted.	Competition about the distribution of revenues between different environmental causes
Public	Environmental tax reform		●	●	Reforming taxation of international currency transactions can bring important resources for environmental purpo-ses (climate and biodiversity)	Political will is needed for environmental tax reform; internationally this require more efforts
Public	Reforming subsidies (rural production, fisheries, etc)		●	●	Can help provide subsidies for land owners and users of protected area that will allow sustainable use of the resource, or even will allow to implement protected area management	Better calculation of prices/subsidies, design of subsidies to be more green (agri-environmental measures), but quite difficult to achieve consensus and harmonised approach at global level
Public	Benefit-sharing and revenue-sharing	●	●		Integral component of protected area funding; potential to offset local opportunity costs; increase availability of local funds; tapping into development sources; impro-ving benefit sharing	Need for design and communication with local/national authorities; monitoring of its implementation to demonstrate benefits
Public	Reforms in the international monetary system			●	Reforming taxation of international currency transac-tions can bring important resources for environmental purposes (climate and biodiversity)	Political will is needed for agreeing the introduction of such taxes internationally
Public	Bilateral and/or multilateral aid (and GEF)			●	Core component of protected area funding; source of direct budgetary support to protected area	Some evidence of funding decline; Major reorientation to poverty reduction and sustainable development may drive resources to other priorities; strengthening integration and mainstreaming of protected area is needed

Public	Debt-for-nature swaps		●	●	Can provide large and secure amounts for protected area or specific sites; funding protected area through SD and poverty reduction	Instrument in decline, due to difficulties in persuading donors/government to release large amounts of funds; difficulties in persuading protected area agencies to invest large amounts for the future
Public	Development banks and agencies		●	●	Big number of agencies, lots of funds, but no increase there	Biodiversity priorities mixed with other environmental objecti-ves/MDG; bureaucracy; increased spending on start-up but not so much on reoccurring costs
Public	Long-term ODA commitments through a Green Development Mechanism	●	●	●	Help transfers from developed/developing countries to less developed countries, GDM can Implement MDG and assist local needs too	Need for developing guidelines, legislative frameworks at global level, improved methodologies for establishing the biophysical links, set prices, monitor delivery of services, evaluate the efficiency of transfers

Abbreviations: Private (Pri), Public (Pub), Local (L), Regional (R), National; (Nat), International (Int), Small and medium sized businesses (SME).

Source: Compilation of information within Emerton et al. (2005); UNEP/CBD/WP-PA/1/3 (2005); Bräuer et al.(2006)

from protected areas calls for removal of trade-related barriers and enhanced public knowledge of their importance and special characteristics. An important precondition is the establishment and assignment of well-defined and stable property and/or use rights and the creation of information instruments for the products and services that protected areas provide.

Market creation is based on the premise that holders of rights derived from a resource (landowners, people with use permits, etc.) will maximise the value of their resources over long time horizons, thus optimising biodiversity use, conservation and restoration (OECD 2008). Translated into simple terms, this means that there needs to be;

- an understanding that a protected area produces ecosystem services and benefits valuable to the public (whether local communities or a global constituency);
- a clear understanding of the property rights involved;
- a commitment to efficient management to reduce pressure on the protected area so that it will continue to provide the services;
- identification of global and local beneficiaries and communication of the value of the services they gain; and
- last but not least, an efficient mechanism to collect the fees/support from global and local beneficiaries and allocate them to efficient management of the resource.

ADDRESS FUNDING INSTABILITY AND CREATE A DIVERSE INCOME PORTFOLIO

Even if funding is obtained and appropriate mechanisms make the transfers from the beneficiary to the resource, there is not always a guarantee of long-term success. Often projects kick off well and raise expectations but are then discontinued for various reasons. A common scenario is where donors only finance initial phases of the protected area management plan and then move on to other areas, or else enabling conditions change significantly and finance stagnates. In other cases, the upward trend in the financial flow collapses; when this is totally unexpected, there can be big consequences for the stability of any conservation project.

Box 8.8: Options for financing a new network of protected areas in Sierra Leone

The Sierra Leone Government applied for GEF funding to create a national network of protected areas. The issue of sustainable financing sources for this network is of paramount importance. A study prepared by RSPB, the National Commission for the Environment of Sierra Leone and the Conservation Society of Sierra Leona demonstrated that although there are several potential mechanisms to generate income for the protected areas (debt swaps, a hypothecated airport departure tax, sale of carbon credits, donations from the mining industry, GEF, support from NGOs), the creation of a trust fund would be the optimum solution for establishing sustainable financial security. This trust fund would help to bring together various possible income streams to ensure they are sufficiently co-ordinated. The reason behind this proposal was the serious constraints on generating dependable on-going revenue in Sierra Leone and the vulnerability associated with dependence on a series of one-off injections of funds.

Source: RSPB et al. 2006

In other cases, government backing or any public authority support may not be strong enough to provide funds needed over time. **This reinforces the need to develop a diverse portfolio of sources of income for protected areas to the extent possible.** This requires committed management efforts and good relations with the range of possible donors and sectors that may wish to operate in the area. Keeping up with all potential funding sources can at times involve a high risk of conflicts between actors with different interests in the protected area.

Bringing different finance sources together under a common umbrella is not always easy, but can be a solution when there is increased risk that independent efforts and mechanisms will fail to deliver, mainly due to institutional conditions in the country concerned. For these reasons, the possibility of establishing trust funds to manage the income generated directly by the protected area and other support flows from international donors may be a better solution in many cases (see Box 8.8).

It is likely that any individual funding source and mechanism may experience changes over time (e.g. limitations to available resources and changes in funding priorities). A diverse portfolio of funding sources, including public and private mechanisms, can therefore increase the long-term sustainability of protected area financing and management.

ADDRESS POSSIBLE SOCIAL IMPACTS OF PROTECTED AREA FINANCING

Ecotourism is widely promoted as a conservation tool and actively practised in protected areas worldwide. Theoretically, support for conservation from the various types of stakeholder inside and outside protected areas is maximised if they benefit in proportion to the opportunity costs they bear. Conversely, unbalanced distribution of benefits between stakeholders can erode their support for or lead to the failure of ecotourism and conservation (see Box 8.9).

Box 8.9: Inequalities in benefit distribution in China's Wolong Nature Reserve

Research on the distribution of benefits derived from ecotourism in the Wolong Nature Reserve for Giant Pandas revealed two types of uneven distribution of economic benefits among four major groups of stakeholder. These created conflicts and subsequently failure in reaching the Reserve's conservation objectives.

Significant inequalities exist between local rural residents and other stakeholders. The former, with farmers, bear most of the cost of conservation but most economic benefits (investment, employment and goods/services) in three key ecotourism sectors (infrastructure construction, hotels/restaurants and souvenir sales) go to other stakeholders outside the Reserve. The distribution of benefits is also unequal even among Reserve residents. Most rural households that benefit from ecotourism are located near the main road and have less negative impacts on panda habitat than households located and exercising activities far from the road and closer to panda habitats. This distribution gap is likely to discourage conservation support from the second group of households, yet their activities are the main forces degrading panda habitats. This unequal distribution of benefits can be lessened by enhancing local participation, increasing the use of local goods and encouraging the relocation of rural households closer to ecotourism facilities.

Source: He et al. 2008

MAKING AVAILABLE FUNDS WORK BETTER

Securing adequate financial resources does not of itself guarantee effective management of protected areas. Enforcement of laws is critical - pressure on valuable and scarce resources will always be present and must be addressed through enforcement of existing restrictions on protected area use (see Chapter 7).

To strengthen appropriate management of protected areas, good monitoring mechanisms are needed to report on site-specific pressures, measure progress towards set objectives, assess efficiency of finance used and identify what else needs to be done (see Chapter 3). Many researchers and practitioners have long identified the lack of monitoring as a key reason for conservation failures in protected areas; along with inadequate community/public participation in decision-making (see Box 8.10). Building capacities within the park and in local or regional administrations can help make implementation more efficient and put meaningful protection in place.

Box 8.10: The importance of monitoring in forest protected areas, Panama

Protected areas are cornerstones in forest conservation and may play a significant role in reducing deforestation rates. Research in nine protected areas in Panama illustrates that coupling monitoring measures with greater funding and strong governance is paramount to reducing deforestation. On their own, however, these factors are insufficient for forest protection. Conservation approaches that complement effective monitoring with community participation and equitable benefit sharing can best address wider issues of leakage and permanence under potential REDD implementation.

Source: Oestreicher et al. 2009

8.5 STRENGTHENING POLICY AND INSTITUTIONAL SUPPORT

Successful establishment and effective management of protected areas, and the delivery of associated benefits, requires multi-level policy support and effective institutional frameworks. This section broadens the analysis in sections 8.1 to 8.4 to discuss the broader policy, institutional and stakeholder context needed to ensure that protected areas achieve their goals and provide societal benefits.

8.5.1. MAJOR POLICY INITIATIVES ON PROTECTED AREAS

Many international and regional agreements, conventions, treaties and global programmes highlight the establishment, management, funding and/or importance of protected areas. Similarly, organisations like IUCN, with its regular global conferences and World Commission on Protected Areas, help create a global consensus on key protected area issues. In the EU, the Natura 2000 Network forms a policy cornerstone for the conservation of Europe's most valuable species and habitats.

In February 2004, the 188 CBD Parties agreed the most comprehensive and specific protected area commitments ever made by the international community by adopting the CBD Programme of Work on Protected Areas (PoWPA) (see Box 8.11). This builds on resolutions from the Vth World Parks Congress (the Durban Accord) and enshrines the development of comprehensive protected area systems that are sustainably financed and supported by society. The PoWPA, by emphasising equitable sharing of costs and benefits, recognising different governance types and giving prominence to management effectiveness and multiple benefits, is the most comprehensive global plan of action for implementation. **It can be considered as a defining framework or 'blueprint' for protected areas for decades to come** (Stolton et al. 2008c; Chape et al. 2008).

8.5.2. INSTITUTIONAL REQUIREMENTS FOR PROTECTED AREAS

Successful institutional structures for protected areas typically include a commitment to the following aspects:

- a common set of goals across a portfolio of diverse protected areas;
- a culture of learning, capacity building and adaptive management;
- collaboration between and among key protected area actors and stakeholders;
- full recognition of the ecological, economic, social, cultural values and benefits of protected areas; and
- the ability to adequately monitor and adapt to ecological and social conditions (Slocombe 2008).

Such institutions also need the authority, ability and willingness to promote sustainable use of resources, facilitate equitable distribution of costs and benefits and support different governance types (Barrett et al. 2001).

Successful establishment and management of protected areas require mechanisms for coordination and collaboration between different institutional levels (e.g. different sectors, stakeholders and government agencies). This contributes to well-informed management planning and significantly improves the efficiency and effectiveness of conservation spending. Communication and exchange of information is an important part of this process (e.g. stakeholder forum, inter-agency groups etc.).

Improved monitoring is a key component of institutional transparency (see 8.4.3). Monitoring needs to be based on clear objectives and measurable targets, agreed with stakeholders that address pressures to protected areas and aim to improve the state of biodiversity and ecosystem services. Efficient monitoring also helps to demonstrate that protected

Box 8.11: The CBD Programme of Work on Protected Areas (PoWPA)

The Programme of Work on Protected Areas, adopted by 188 Parties in 2004, is one of the most ambitious environmental strategies in history. Its aim was to establish a comprehensive, effectively managed and ecologically representative national and regional systems of protected areas by 2010 (terrestrial) and 2012 (marine), The Programme is generally judged to have been a success, even though these goals will not be completed by the target dates (see phased timetable below). It is likely that the CBD Tenth Conference of Parties in late 2010 will propose a new timetable and minor modifications to the actions. A process to develop these proposals is underway.

PHASES OF THE PROGRAMME OF WORK

PHASES	POTENTIAL MAIN OUTCOMES OF EACH PHASE
PHASE I (2004 – 2006)	• **"Master plan" for protected areas.** Completing, in effect, a "master plan" for the system of protected areas (key elements include, for example: plans for filling ecological gaps; securing financial resources; building capacity; promoting governance arrangements; and addressing policy, legislative and institutional barriers). • **Studies and assessments,** for input into "master plans", covering, for example, socio-economic contributions of protected areas, ecological gaps in protected area systems, and types of governance arrangements. • **New protected areas.** Establishment of new protected areas where urgent action is required.
PHASE II (2007 – 2008)	• **Threats.** Mechanisms in place to address key threats. • **Financial resources.** Sufficient financial resources secured. • **Indigenous and local communities.** Policies and mechanisms to support indigenous and local community participation and equitable sharing of costs and benefits. • **Standards.** Standards adopted for all major aspects of protected areas.
PHASE III (2009 – 2015)	• **Effective systems of protected areas.** Comprehensive, ecologically representative, and effectively managed systems of protected areas. • **Integration** of protected areas into wider land and seascapes.

Source: Dudley et al. 2005

areas do indeed provide benefits to biodiversity and people – and therefore are worth the investment.

8.5.3 KEY ELEMENTS FOR SUCCESSFUL MANAGEMENT

Six elements have been identified as critical to focus concerted efforts and combine the strengths of all sectors of society (policy makers, civil society, indigenous and local communities and business). These can be thought of as **'the Six Cs'** and should be embedded in policy and institutional structures for protected areas at local, national, regional and global levels and **translated into practical actions on the ground**.

Box 8.12 shows how these elements can be incorporated for effective implementation of protected areas, using the example of Micronesia. The Annex further illustrates how certain decisions under the CBD, Ramsar Convention on Wetlands, World Heritage Convention and UN Convention to Combat Desertification (UNCCD) touch on these key elements.

Box 8.12: Micronesia Challenge commitment to protected area implementation

"In the Federated States of Micronesia, more than half of our citizens' and residents' livelihoods depend on a subsistence lifestyle; hence managing our natural resources is a matter we take very seriously. In Micronesia, we do not see conservation and development as opposing forces, but rather as complimentary to each other."

The Honorable Joseph Urusemal
President of the Federated States of Micronesia (2006)

The Micronesia Challenge is a commitment by the Chief Executives of the Federated States of Micronesia, the Republic of the Marshall Islands, the Republic of Palau, the U.S. Territory of Guam and the U.S. Commonwealth of the Northern Mariana Islands to effectively conserve at least 30% of the near shore marine resources and 20% of the terrestrial resources across Micronesia by 2020.

Capacity: A regional technical support team includes a wide range of partners, supported by a technical measures working group which helps to ensure that there is adequate capacity among all member countries.

Capital: The Nature Conservancy and Conservation International have jointly pledged US$ 6 million to leverage an additional US$ 12 million for the first phase of the Challenge. The leaders and their partners are working to secure matching funds for this pledge and additional funding to support the long-term expansion and effective management of protected area networks for each of the Micronesia Challenge jurisdictions. GEF has pledged a US$ 6 million match as part of a new Pacific Alliance for Sustainability initiative. These developments have coincided with the establishment of a Micronesia Conservation Trust Fund.

Coordination: The Micronesia Challenge steering committee and partners have developed a comprehensive strategic plan that helped ensure coordination by clearly defining roles and responsibilities of each of the partners.

Cooperation: There is a high level of cooperation among all partners, including participating governments, NGOs, and local communities.

Commitment: There is a strong and publicly-declared commitment of each of the governments as well as clear commitment among stakeholders at sub-national levels, including local communities and locally managed marine areas.

Communication: The communications working group has developed a regional communications strategy, local communication plans and a regional inventory of outreach materials to gain publicity at a global level.

The Micronesia Challenge serves as a model for conservation initiated by a coalition of regional governments, endorsed at an international level and implemented on the ground with local communities.

Source: http://micronesiachallenge.org/index.php

8.5.4. PROMOTING COHERENCE AND SYNERGIES: THE EXAMPLE OF CLIMATE CHANGE

Policy makers need to align protected areas with other policies to ensure broad policy coherence and build on opportunities for synergies. One example of this is making explicit linkages between protected areas and climate change adaptation. **Better managed, better connected, better governed and better financed protected areas are recognised as key to both mitigation and adaptation responses to climate change.**

Protected areas are critical to preventing further carbon emissions from degradation and development and can make an important contribution to an overall strategy for climate change mitigation. A total of 312 Gt of terrestrial carbon is currently stored in the existing protected area network: if lost to the atmosphere, this would be equivalent to approximately 23 times the total global anthropogenic carbon emissions for 2004 (Kapos et al. 2008). Their contribution will certainly increase as governments continue to designate new protected areas in the Arctic, tropical rainforests and boreal forests.

However, protected areas are generally not considered in current REDD discussions and strategies, given the impression that carbon in protected areas is safe and that such areas would not offer additional carbon sequestration. Yet protected areas remain vulnerable to degradation: a significant number of the world's protected areas are poorly or inadequately managed (Leverington et al. 2008). A comprehensive network of effectively designed and managed protected areas would ensure that carbon is protected into the foreseeable future and should therefore be considered as a primary REDD strategy. Links to REDD would needs to respect the need for additionality – ie ensure real, measurable and long-term emission reductions.

The UNFCCC recognises the value of ecosystem resilience in Article 2 of its Convention, and introduced the term 'ecosystem-based adaptation' at COP14. However, it **does not yet explicitly recognise the contribution of protected areas to ecosystem resilience and ecosystem-based adaptation**. Climate adaptation on the ground cannot and should not be addressed exclusively by human-made infrastructure (e.g. CBD AHTEG 2009; Campbell et al. 2009): climate-resilient development needs to include ecosystem-based adaptation where appropriate. Well-designed coherent networks of appropriately managed and ecologically connected protected areas are one of the most cogent responses to climate change and should be an explicit component of an ecosystem-based adaptation strategy (e.g. Kettunen et al. 2007).

Source Getty Images – PhotoDisc®

8.6 CREATING A WORKABLE FUTURE FOR PROTECTED AREAS

Increased support for protected areas is in society's best interest, with their global benefits (i.e. total benefits provided by ecosystems within protected areas) generally far outweighing costs. The scale of the difference between benefits and costs globally appears to be so significant, even allowing for inevitable imprecision in global analyses, that these basic conclusions would be unchanged even if analyses were incorrect by more than an order of magnitude, Even at the local level, benefits can be greater than the costs even without any national or international payments for broader ecosystem service benefits – although the ratio is very site specific. Payments for the provision of services from these sites can increase the economic attractiveness of protected areas and help them be an engine of local development.

Support can take the form of new designations where this would benefit ecosystems of particular value in terms of species and habitats – there is still a large untapped potential for new marine protected areas which currently cover only 5.9% of territorial seas and 0.5% of the high seas (see 8.1 above). Support can also include increased investment in or payment for management of existing protected areas to address the funding gap and help them fulfil their potential to protect biodiversity and deliver important ecosystem services locally, nationally and internationally.

Policy actions for more equitable distribution of benefits and costs are fundamental. Benefits from protection are often broadly disbursed, long term and non-market, whereas the costs of protection are more immediate and the earning potential from not choosing protection are often short-term and concentrated. At the local and sometimes national levels, the question of whether protected areas represent net benefits or net costs therefore depends on recognising local rights, ensuring meaningful local participation, managing to maximise benefits and minimise costs, and creating mechanisms to enable beneficiaries at all scales to pay for protection or invest in maintaining the delivery of ecosystem services. Such policies increase the perceived fairness of protected areas and help ensure their contribution to human well-being at all scales.

Policy makers can strengthen the effectiveness of protected areas through an enabling framework for the national system (e.g. clear legislative basis, policy consistency, cooperation between stakeholders) and by ensuring that funding models provide the right incentives and sufficient financial stability for effective management. They play a key role in raising the profile of protected areas in both national and international fora and in encouraging positive stakeholder engagement.

Valuation of benefits and costs provided by ecosystems within protected areas can deliver multiple benefits for biodiversity and people. It can support decision-making and fundraising (e.g. by showing that biodiversity conservation can often be a socio-economically attractive choice) but its results need to be appropriately interpreted and embedded in sound management processes. Monetary values can help to translate ecological concerns into economic arguments, but these arguments must always be considered within the bigger picture of protected area governance. It should also be noted that sustainable use and broader use of compensation programmes will not make protection attractive for everyone. Enforcement of regulations to ensure respect for jointly agreed protected area rules is therefore vital.

Current expenditure on protected areas does not match funding needs. There is a clear need for an integrated multilevel policy response and a long-term vision for financing protected areas in order to bridge the current funding gap. Steps towards this goal include better communication of benefits and costs to increase public understanding of the positive returns available from funding protected areas and to support the design and implementation of new innovative mechanisms and instruments.

Although practitioners are still refining the figures on financing needs of protected areas, the CBD and the conservation community should consider setting a fundraising target for global biodiversity conservation and mobilise all relevant actors. The CBD's Ninth Conference of the Parties (Bonn, 2008) called for establishing national financial targets to support implementation of the CBD Programme of Work on Protected Wreas (Decision IX/18). This decision should pave the way for consolidated action.

To achieve future funding targets, the financing problem needs to be addressed in a strategic way. Efforts to increase protected area funding have already shown considerable success: the global network continues to expand and dedicated programmes for protected areas now exist in nearly all countries. In 2008, CBD Parties adopted a general strategy to mobilise resources to implement the Convention's objectives, including improving financing for protected areas (Decision IX/11). This strategy addresses key obstacles to achieving adequate biodiversity funding but requires concerted efforts to translate it into practical actions for individual stakeholders.

Stronger cooperation, both North-South and South-South, is essential to increase the funding base for protected areas. The establishment of a dedicated global fund or financial mechanism could help mobilise and focus resources in an effective manner. Reducing existing demands on public financing through the reform of harmful subsidies could help to generate additional resources for protected areas (see Chapter 6). Identified financial needs of protected areas could be further integrated into existing and emerging financial instruments for the environment e.g. the REDD discussions highlight potential synergies between climate change and biodiversity objectives (see Chapter 5). Market-based instruments can significantly contribute to generating additional funds for protected areas, e.g. from consumers and the business sector (see Chapter 7).

There is clear international policy commitment and institutional support for protected areas – this should now be translated into concrete actions on the ground in a coherent and mutually supporting manner. The current global financial crisis may provide an opportunity to devise a new economic system connected to earth's natural systems in the place of a system that is disconnected and runs down natural capital. A suite of long-term economic measures is needed that fully accounts for the true benefits and costs of ecosystem protection. Investment in the network of global protected areas is one such measure.

Chapter 8 has **shown the range of social and economic benefits** that ecosystems within **protected areas** can provide and presented evidence of the generally favourable benefit-cost ratio for their creation and management at global and often national and local levels. Robust policy action to **improve management** of existing areas, **expand the global protected area network** – particularly for marine protected areas – and secure more **equitable distribution of their costs and benefits** is critically important to achieve the full potential of such areas and improve human well-being over the long term.

Chapter 9 focuses on another area of **investment in natural capital** – that of **ecological infrastructure and restoration**. Whilst acknowledging that it is generally economically preferable to avoid the need for restoration, the Chapter explores the economic benefits of restoration where damage has occurred. It demonstrates that while restoration costs can be high, there are many documented cases of very significant social returns on investment, creating important private and particularly public goods.

Endnotes

[1] As listed by the World Database on Protected Areas (WDPA)

[2] Throughout this section, we annualize findings given in Net Present Value assuming a time horizon of 30 years and a discount rate of 10%.

[3] An important exception is visitation to well known culturally important sites such as Machu Picchu in Peru or Angkor Wat in Cambodia.

[4] Management costs can usefully be divided into recurrent costs (e.g. staff salaries, fuel, maintenance of equipment, community engagement/participation, monitoring and evaluation, site level administration), upfront establishment costs (e.g., stakeholder consultations, scientific study, boundary demarcation, land/equipment purchase, construction) and subsequent investment (to upgrade management and also upgrade the protected area itself (e.g., via infrastructure, restoration, or other improvements). It is appropriate to note that key establishment activities have not been carried out in many existing protected areas.

[5] The valuations of ecosystem goods and services underlying these estimates have been criticized, e.g. see Toman (1998) and Daily et al. (2000). On the other hand, the study makes an important methodological advance in calculating marginal rather than total benefit of protection, by comparing the goods and services provided by intact versus converted forms of each biome.

[6] Countries included were Zimbabwe, Kenya, Zanzibar, Uganda, India, Mongolia, and China.

[7] While an average is given for illustrative purposes, in reality there values will vary significantly site to site, depending on the state of ecosystem, the services it provides, the spatial relation with the beneficiaries and the socio-economic status of these beneficiaries (See Chapters 1 and 4 for further discussion).

[8] Not all ecosystem services are covered given limits to what valuation studies have covered. In addition, the average has excluded some high outliers to avoid undue influence on the illustrative average. These values are arguably conservative.

[9] The difference in the ratio of benefits to costs here compared to Balmford et al. (2002) might reasonably be expected given that protected areas have on balance been created on less agriculturally valuable lands and farther from transportation infrastructure, implying significantly lower opportunity costs than those found in areas of active deforestation (Gorenflo and Brandon 2005; Dudley 2008).

[10] This perspective (net benefits from competing scenarios) is not directly comparable to the two previous assessments (benefit/cost of conservation) and would be expected to yield a much lower ratio. In addition, the studies reviewed in this section include a smaller set of ecosystem goods and services than do the benefit/cost assessments, suggesting that benefits of conservation are estimated conservatively.

[11] Existence and carbon sequestration are assumed to be purely global values.

[12] See IUCN management categories. Categories I-IV (strictly protected areas and National Parks) require between US$ 60-240/ha/year in land and over US$ 1,000/ha/year in small marine parks.

[13] Based on their own estimates and those in Molinar et al. (2004), James et al. (2001) and Pearce (2005 and 2007)

[14] Full text of the paragraphs can be accessed at http://www.cbd.int/decision/cop/?id=11661.

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ANNEX: KEY ELEMENTS FOR SUCCESSFUL IMPLEMENTATION AND RELEVANT POLICY PROVISIONS

Key elements for successful implementation of protected areas	Relevant paragraphs of CBD COP Decision IX/18 on Protected Areas[14], some Ramsar resolutions, World Heritage Convention and UN Convention to Combat Desertification decisions
Capacity	• Establish or strengthen regional/sub-regional forum (para.A.6f) • Establishing regional technical support networks (para.A.12) • Strengthen capacity of national protected area professionals (para.A13) • Convene regional capacity building workshops (para.A.15) • Further develop and make available a range of implementation tools (para.A.16) • Develop a user friendly and comprehensive central website (para.A.17) • IUCN to further contribute to capacity building for implementation • Provide developing countries with assistance, including capacity building, in order to help reverse the factors leading to consideration of deletion or restriction of a Ramsar site: Ramsar Resolution IX.6, 12 • Promote the training of personnel in the fields of wetland research, management and wardening: Ramsar Article 4, 5 • Identify the training needs of institutions and individuals concerned with wetland conservation and wise use, and implement appropriate responses: Ramsar Strategic Plan 2003-2008, Operational Objective 20.1 • Include risk preparedness as an element in World Heritage Site Management plans and training strategies: WHC Decision 28 COM 10B, 4 • Promote gender-sensitive capacity-building to enable stakeholders to carry out specific participatory and synergistic programmes as part of their National Action Programmes to combat land degradation and mitigate the effects of drought, protect biodiversity, facilitate the regeneration of degraded forests, while promoting sustainable livelihoods at local level: UNCCD Decision 1/COP.6, 17
Capital	• Recognised the urgency for mobilising adequate financial resources (preamble para.B.4) • Urged the developed countries and others to provide adequate, predictable and timely financial support (para.B.1) • Parties to develop and implement sustainable financing plans based upon needs assessment and diversified portfolio (para.B3 a, b and d) • Urged donor countries to enhance financial resources and technical support for implementation of the programme of work and ensure better alignment of PA funding with aid delivery mechanisms in the Paris Declaration on Aid Effectiveness (para.B4.d) • Invited GEF to continue to provide adequate funding including supporting protected areas under Climate change (para.B.9 a and b) • Explore funding opportunities for protected areas in the context of climate change (para.B3h) • Provide developing countries with assistance in order to help reverse the factors leading to consideration of deletion or restriction of a Ramsar site: Ramsar Resolution IX.6, 12 • Increase support to States Parties for the identification of cultural, natural and mixed properties of potential outstanding universal value, as well as in the preparation of nomination dossiers: WHC Decision 28 COM 13.1, 11 (a) • Strengthen support for reforestation and forest conservation to combat desertification caused by drought, deforestation due to population increase, overgrazing, logging or fires; building on self-help efforts by developing countries: UNCCD Decision 21/COP.4, 2 and Decision 21/COP.4, Annex
Coordination	• Establishment of multisectoral advisory committees (para.A.5b) • Designate a national focal point for PoWPA for coordinated development and implementation (para.A.21) • Parties, relevant inter-governmental organisations, ILCs, NGOs, donors research institutions to establish regional support networks and enhancing partnership (para.A.12) • Mainstream and integrate protected areas with development agendas (para.B.3e) • Promote international coordination of measures to further public awareness of wetland values in reserves: Ramsar Recommendation 5.8 • Collaborate with IUCN and provide support to the strategic implementation of the Global Framework Programme for Capacity Building on Natural Heritage: WHC Decision 29 COM 10, 6

Key elements for successful implementation of protected areas	Relevant paragraphs of CBD COP Decision IX/18 on Protected Areas[14], some Ramsar resolutions, World Heritage Convention and UN Convention to Combat Desertification decisions
Commitment	• Parties to finalise the ecological gap analysis not later than 2009 and give special attention to the implementation of programme element 2 and improving management effectiveness including monitoring (para. A3, 4b and c) • Parties to improve, diversify and strengthen protected area governance types and recognize co-managed areas and community conserved areas through acknowledgement in national legislation. • Develop national and regional mechanisms to ensure consultation with local and indigenous people in management planning for Ramsar sites Ramsar Recommendation 6.3, 15 • Involve local communities and indigenous peoples in restoring and maintaining wetlands Ramsar Resolution VIII.16, 19 • Continue implementing the Regional Programme and the Action Plans adopted in Abu Dhabi to be developed into operational national work plans, and establish a fund raising strategy to provide the necessary financial and human resources: WHC Decision 30 COM 11C.1
Communication	• Recognised limited availability of information on implementation (para.A.1) • Increase public awareness on protected area benefits in poverty eradication and achieving sustainable development (para.A.22) • Review and report national implementation (para.A.25 a) • Promote valuation of protected area goods and services including socio- economic costs and benefits of protected areas (para.B3d) • Develop facilities for promoting public awareness of wetland values at wetland reserves: Ramsar Recommendation 5.8 • Strengthen appreciation and respect for cultural and natural heritage, particularly by educational and information programmes: WHC Article 27, 1 • Develop initiatives at all levels to promote dialogue that will increase national and regional understanding for the protection of World Heritage: WHC Decision 27 COM 20B.6, 9

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 9: Investing in ecological infrastructure

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Chapter 9

Investing in ecological infrastructure

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Key Messages of Chapter 9

Investing in 'ecological infrastructure' makes economic sense in terms of cost effectiveness and rates of return, once the whole range of benefits provided by maintained, restored or increased ecological services are taken into account. Well-documented examples include investing in mangroves or other wetland ecosystems as well as watersheds, instead of man-made infrastructure like dykes or waste water treatment plants, in order to sustain or enhance the provision of ecosystem services.

It is usually much cheaper to avoid degradation than to pay for ecological restoration. This is particularly true for biodiversity: species that go extinct can not be brought back. Nonetheless, there are many cases where the expected benefits from restoration far exceed the costs. If transformation of ecosystems is severe, true restoration of pre-existing species assemblages, ecological processes and the delivery rates of services may well be impossible. However, some ecosystem services may often be recovered by restoring simplified but well-functioning ecosystems modelled on the pre-existing local system.

Recommendations:

Investments in **ecosystem restoration can benefit multiple policy sectors** and help them to achieve their policy goals. This applies – but is not limited to – urban development, water purification and waste water treatment, regional development, transport and tourism as well as protection from natural hazards and policies for public health.

In the light of expected needs for significant investment in **adaptation to climate change**, investing in restoring degraded ecosystems also has important potential for many policy sectors. Obvious examples include enhancing the productive capacity of agricultural systems under conditions of increased climate fluctuations and unpredictability, and also providing buffering services against extreme weather events.

Investment in natural capital and conservation of ecosystems can **help to avoid crises and catastrophes** or to soften and mitigate their consequences. However, if catastrophes do strike, they should be regarded as opportunities to rethink policy and to incorporate greater investments in natural capital into new programmes and rebuilding efforts – e.g. mangrove or other coastal ecosystem restoration and protection following a tsunami or hurricane, wetland restoration and protection after flooding in coastal areas, forest restoration after a catastrophic mudslide.

Direct government investment is often needed, since many returns lie in the realm of public goods and interests and will be realised only over the long term. This applies especially to degraded sites and ecosystems such as post-mining areas, brownfield sites, converted forests, dredged wetlands and areas prone to erosion or desertification.

Proactive strategies for investment in natural capital need to be further developed and implemented and link natural capital explicitly with natural hazard risks. Systematic assessments of natural capital, creating natural capital accounting systems and maps pave the way for combining environmental risk reduction with economically efficient investment.

9 Investing in ecological infrastructure

"More and more, the complementary factor in short supply (limiting factor) is remaining natural capital, not manmade capital as it used to be. For example, populations of fish, not fishing boats, limit fish catch worldwide. Economic logic says to invest in the limiting factor. That logic has not changed, but the identity of the limiting factor has."

Herman Daly, 2005, former chief economist with World Bank

"If we were running a business with the biosphere as our major asset, we would not allow it to depreciate. We would ensure that all necessary repairs and maintenance were carried out on a regular basis."

Prof. Alan Malcolm, Chief Scientific Advisor, Institute of Biology, IUPAC

This chapter focuses on ways to augment renewable natural capital – upon which our economies ultimately depend –by investing in the maintenance, restoration and rehabilitation of damaged or degraded ecosystems. Such investments can promote many different policy goals including secure delivery of clean drinking water, natural disaster prevention or mitigation, and climate change adaptation.

9.1 shows how investments in renewable natural capital are a worthwhile investment. Building on Chapter 8 (protected areas), it discusses the **costs and benefits of restoration** and focuses on specific situations in which policy makers should consider directly investing public money in natural capital. **9.2** highlights the **benefits of ecosystem restoration beyond the environmental sector**, particularly with regard to water management, natural hazard prevention and mitigation and protection of human health. **9.3** explores the potential of ecosystem investments to deliver concrete **benefits for climate change mitigation and adaptation** policies. **9.4** concludes the chapter by identi-fying opportunities for **developing proactive investment strategies** based on precaution to provide benefits across a range of sectors.

9.1 IS NATURAL CAPITAL A WORTHWHILE INVESTMENT?

Does investing in natural capital make economic sense? To answer this we have to determine:

- if it is ecologically feasible to restore degraded natural capital or to invest in ecological infrastructure;
- whether restoring the natural capital in question is expected to generate significant benefits; and
- if investment is both possible and a high priority, what might it cost?

Only a few studies have addressed these questions comprehensively to date. However, there are encouraging examples that illustrate the potential for a positive economic outcome. The following section highlights and synthesises these results.

9.1.1. THE ECOLOGICAL FEASIBILITY OF NATURAL CAPITAL ENHANCEMENT

There is a lively debate between ecologists, planners and economists about the extent to which building 'designer' or engineered ecosystems – such as artificial wastewater treatment plants, fish farms at sea or roof gardens to help cooling cities– can adequately respond to the huge problems facing humanity today. Increasingly, ecological restoration – and more broadly, the restoration of renewable natural capital – are seen as important targets for public and private spending to complement manmade engineering solutions.

True restoration to prior states is rarely possible, especially at large scales, given the array of global changes affecting biota everywhere and that 'novel' ecosystems with unprecedented assemblages of organisms are increasingly prevalent (see Hobbs et al. 2006; Seastedt et al. 2008). Nevertheless, the growing body of available experience on the restoration and rehabilitation of degraded ecosystems suggests that this is a viable and important direction in which to work, provided that the goals set are pragmatic and realistic (Jackson and Hobbs 2009).

Success stories exist, such as providing nurseries for fish in mangroves, reconstructing natural wetlands for water storage, restoring entire forest ecosystems after centuries of overuse and reintroducing valuable species e.g. sturgeon in the Baltic Sea for replenishing fisheries. As catastrophic destruction of the world's coral reefs accelerates, effective restoration techniques are at last being developed (Normile 2009). Over the last thirty years, considerable progress has been made in our know-how both in fundamental (Falk et al. 2006) and practical realms (Clewell and Aronson 2007). Ways and means to integrate restoration into society's search for global sustainability are moving forward quickly (Aronson et al. 2007; Goldstein et al. 2008; Jackson and Hobbs 2009).

Box 9.1 shows how the concept and focus of restoration has been gradually broadened in recent years to encompass natural capital in order to better integrate ecological, environmental, social and economic goals and priorities.

Depending on an ecosystem's level of degradation, **different strategies can be applied** to improve its state and to enhance or increase its capacity to provide services in the future. Box 9.2 illustrates a conceptual framework for decision-making on restoration within the broader context of integrated ecosystem management at the landscape scale.

Box 9.1: Key definitions and the expanding focus of restoration

Ecological restoration is defined as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" and is "intended to repair ecosystems with respect to their health, integrity, and self-sustainability" (International Primer on Ecological Restoration, published by the Society for Ecological Restoration (SER) International Science and Policy Working Group 2004). In a broader context, the ultimate goal of ecological restoration, according to the SER Primer, is to recover resilient ecosystems that are not only self-sustaining with respect to structure, species composition and functionality but also integrated into larger landscapes and congenial to 'low impact' human activities.

The concept of **restoring natural capital** is broader still.

'Natural capital' refers to the components of nature that can be linked directly or indirectly with human welfare. In addition to traditional natural resources such as timber, water, and energy and mineral reserves, it also includes biodiversity, endangered species and the ecosystems which perform ecological services. According to the Millennium Ecosystem Assessment (MA 2003), natural capital is one of four types of capital that also include manufactured capital (machines, tools, buildings, and infrastructure), human capital (mental and physical health, education, motivation and work skills) and social capital (stocks of social trust, norms and networks that people can draw upon to solve common problems and create social cohesion). For further details, see TEEB D0 forthcoming, Chapter 1 and glossary.

Restoring renewable and cultivated natural capital (Restoring Natural Capital – RNC) includes ***"any activity that integrates investment in and replenishment of natural capital stocks to improve the flows of ecosystem goods and services, while enhancing all aspects of human wellbeing"*** (Aronson et al. 2007). Like ecological restoration, RNC aims to improve the health, integrity and self-sustainability of ecosystems for all living organisms. However, it also focuses on defining and maximising the value and effort of ecological restoration for the benefit of people, thereby helping to mainstream it into daily social and economic activities.

RNC activities may include, but are not limited to:

- restoration and rehabilitation of terrestrial and aquatic ecosystems;
- ecologically sound improvements to arable lands and other lands or wetlands that are managed for useful purposes i.e. cultivated ecosystems;
- improvements in the ecologically sustainable utilisation of biological resources on land and at sea; and
- establishment or enhancement of socio-economic activities and behaviour that incorporate knowledge, awareness, conservation and sustainable management of natural capital into daily activities.

In sum, RNC focuses on achieving both the replenishment of natural capital stocks and the improvement in human welfare, all at the landscape or regional scale.

Source: Aronson et al. 2007

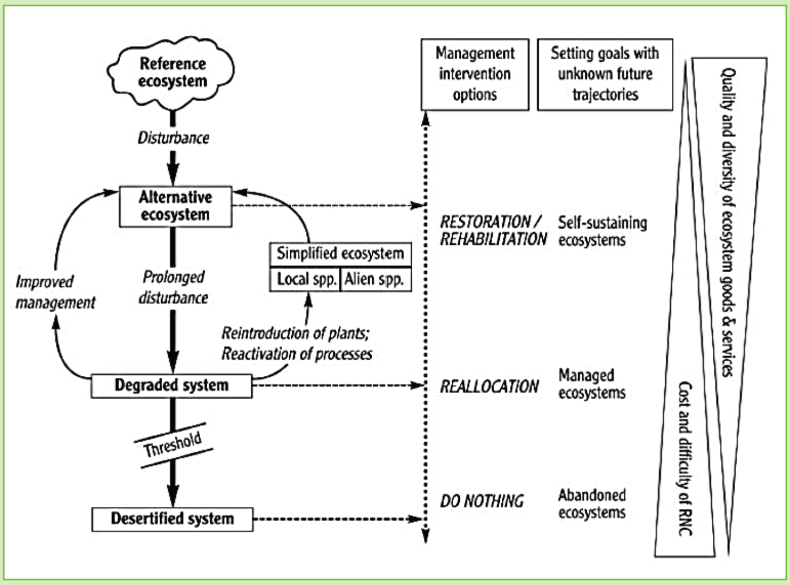
Box 9.2: An ecosystem-based framework for determining restoration strategies

Where the spatial scale of **damage is small** and the surrounding environment is healthy in terms of species composition and function, it may be sufficient to implement **measures for 'passive restoration'** so that the ecosystem can regenerate itself to a condition resembling its pre-degradation state in terms of their "health, integrity, and self-sustainability", as per the SER (2004) definition of restoration. This of course requires a series of decisions and trade-offs and thus is ultimately not a passive process at all. If self-regeneration is not possible in a reasonable time period, **active interventions** may be necessary to 'jump-start' and accelerate the restoration process (e.g. by bringing in seeds, planting trees, removing polluted soil or reintroducing keystone species).

In both the above cases, reduction, modification and/or rationalisation of human uses and pressures can lead to full or at least partial recovery of resilient, species-rich ecosystems that provide a reliable flow of ecosystem services valued by people. In both cases it is important to clarify objectives and priorities ahead of time (Society for Ecological Restoration International Science and Policy Working Group 2004; Clewell and Aronson 2006 and 2007).

If transformation is severe and ecosystems have crossed one or more thresholds of irreversibility (Aronson et al. 1993), **ecological rehabilitation** may be a more realistic and adequate alternative. This aims to repair some ecosystem processes at a site and help recover the flow of certain ecological services, but not to fully reproduce pre-disturbance conditions or species composition. It is typically done on post-mining sites as well as grazing lands (Milton et al. 2003) and in wetlands used by people for production (see example in Box 9.4).

Where **profound and extensive transformations** of ecosystem structure and composition have taken place, it may be advisable to implement measures for **reallocation of the most degraded areas**. This means assigning them a new – usually economic – main function which is generally unrelated to the functioning of the original ecosystem e.g. farmland reallocated to housing and road construction.



Source: Aronson et al. 2007

Conceptual framework for restoration

As part of a holistic planning approach, all three interventions can – and generally should be – undertaken simultaneously within appropriate landscape units. This type of landscape or regional scale programme, if conceived and carried out effectively in close collaboration with all stakeholders, can provide the much-needed bridge between biodiversity conservation objectives and local, regional or national economic development needs (Aronson et al. 2006 and 2007).

The timescale required for ecosystem restoration varies considerably (see Table 9.1). As noted, full restoration is not feasible for many ecosystems destroyed or degraded beyond a certain point. Even the more realistic goal of rehabilitation (recovery to an acceptable state of ecosystem resilience and performance) tends to be a slow process though recovery may be quick in some instances (Jones and Schmitz 2009). This means that the full benefits from restoration or rehabilitation may only become obvious at some time in the future, which reinforces the need to protect functioning ecosystems to maintain current levels of biodiversity and flows of ecosystem goods and services.

However, the flow of some goods and services may increase from the early stages of a restoration programme (Rey-Benayas et al. 2009), even if the optimum is only reached much later. Detailed information remains

Table 9.1: Feasibility and time-scales of restoring: examples from Europe

Ecosystem type	Time-scale	Notes
Temporary pools	1-5 years	Even when rehabilitated, may never support all pre-existing organisms.
Eutrophic ponds	1-5 years	Rehabilitation possible provided adequate water supply. Readily colonised by water beetles and dragonflies but fauna restricted to those with limited specialisations.
Mudflats	1-10 years	Restoration dependent upon position in tidal frame and sediment supply. Ecosystem services: flood regulation, sedimentation.
Eutrophic grasslands	1-20 years	Dependent upon availability of propagules. Ecosystem services: carbon sequestration, erosion regulation and grazing for domestic livestock and other animals.
Reedbeds	10-100 years	Will readily develop under appropriate hydrological conditions. Ecosystem services: stabilisation of sedimentation, hydrological processes.
Saltmarshes	10-100 years	Dependent upon availability of propagules, position in tidal frame and sediment supply. Ecosystem services: coastal protection, flood control.
Oligotrophic grasslands	20-100 years +	Dependent upon availability of propagules and limitation of nutrient input. Ecosystem services: carbon sequestration, erosion regulation.
Chalk grasslands	50-100 years +	Dependent upon availability of propagules and limitation of nutrient input. Ecosystem services: carbon sequestration, erosion regulation.
Yellow dunes	50-100 years +	Dependent upon sediment supply and availability of propagules. More likely to be restored than re-created. Main ecosystem service: coastal protection.
Heathlands	50-100 years +	Dependent upon nutrient loading, soil structure and availability of propagules. No certainty that vertebrate and invertebrate assemblages will arrive without assistance. More likely to be restored than re-created. Main ecosystem services: carbon sequestration, recreation.
Grey dunes and dune slacks	100-500 years	Potentially restorable, but in long time frames and depending on intensity of disturbance Main ecosystem service: coastal protection, water purification.
Ancient woodlands	500 – 2000 years	No certainty of success if ecosystem function is sought – dependent upon soil chemistry and mycology plus availability of propagules. Restoration is possibility for plant assemblages and ecosystem services (water regulation, carbon sequestration, erosion control) but questionable for rarer invertebrates.
Blanket/Raised bogs	1,000 – 5,000 years	Probably impossible to restore quickly but will gradually reform themselves over millennia if given the chance. Main ecosystem service: carbon sequestration.
Limestone pavements	10,000 years	Impossible to restore quickly but will reform over many millennia if a glaciation occurs.

Source: based on Morris and Barham 2007 scarce but recent reviews show clearly that when done well, restoration across a wide range of ecosystem types can achieve enhancement of services even if full recovery is rarely possible (Rey-Beneyas et al. 2009; Palmer and Filoso 2009). The modern approach for ecological restoration and RNC is therefore pragmatic. Jackson and Hobbs (2009) state, for example, that "restoration efforts might aim for mosaics of historic and engineered ecosystems, ensuring that if some ecosystems collapse, other functioning ecosystems will remain to build on. In the meantime, we can continue to develop an understanding of how novel and engineered ecosystems function, what goods and services they provide, how they respond to various perturbations, and the range of environmental circumstances in which they are sustainable".

In summary, many restoration processes take considerable time but can often have rapid effects with respect to at least partial recovery of some key functions. From an ecological perspective, a strategy to avoid damage and maintain ecosystem functions and services should be preferred. However, given the scale of current damage, **ecological restoration is increasingly required** and understood to play an important role in bridging conservation and socio-economic goals, linked to better appreciation of the values of natural capital (see Aronson et al. 2007; Goldstein et al. 2008; Rey-Benayas et al. 2009). Its crucial role is further illustrated by the fact that billions of dollars are currently being spent on restoration around the world (Enserink 1999; Zhang et al. 2000; Doyle and Drew 2007; Stone 2009).

9.1.2. POTENTIAL COSTS OF ECOSYSTEM RESTORATION

Thousands of projects are carried out each year to improve the ecological status of damaged ecosystems. Unfortunately and surprisingly, cost-benefit analyses of those projects are scarce. Even simple records of restoration costs are rare in the peer-reviewed literature, let alone a full discussion of the benefits to society (Aronson et al. in press). Over 20,000 case studies and peer-reviewed papers were reviewed for this chapter (and for Chapter 7 in TEEB D0 forthcoming) yet only 96 studies were found to provide meaningful cost data on restoration.

The breadth and quality of information available, however, varies from study to study: Some only provide aggregate costs, others only capital or only labour costs. Some restoration activities are conducted on a small scale for research An analysis of the studies gives an overview of restoration project costs and outcomes. They cover a wide range of different efforts in different ecosystem types as well as very different costs, ranging between several hundreds to thousands of dollars per hectare (grasslands, rangelands and forests) to several tens of thousands (inland waters) to millions of dollars per hectare (coral reefs) (see Figure 9.2). Costs also vary as a function of the degree of degradation, the goals and specific circumstances in which restoration is carried out and the methods used.

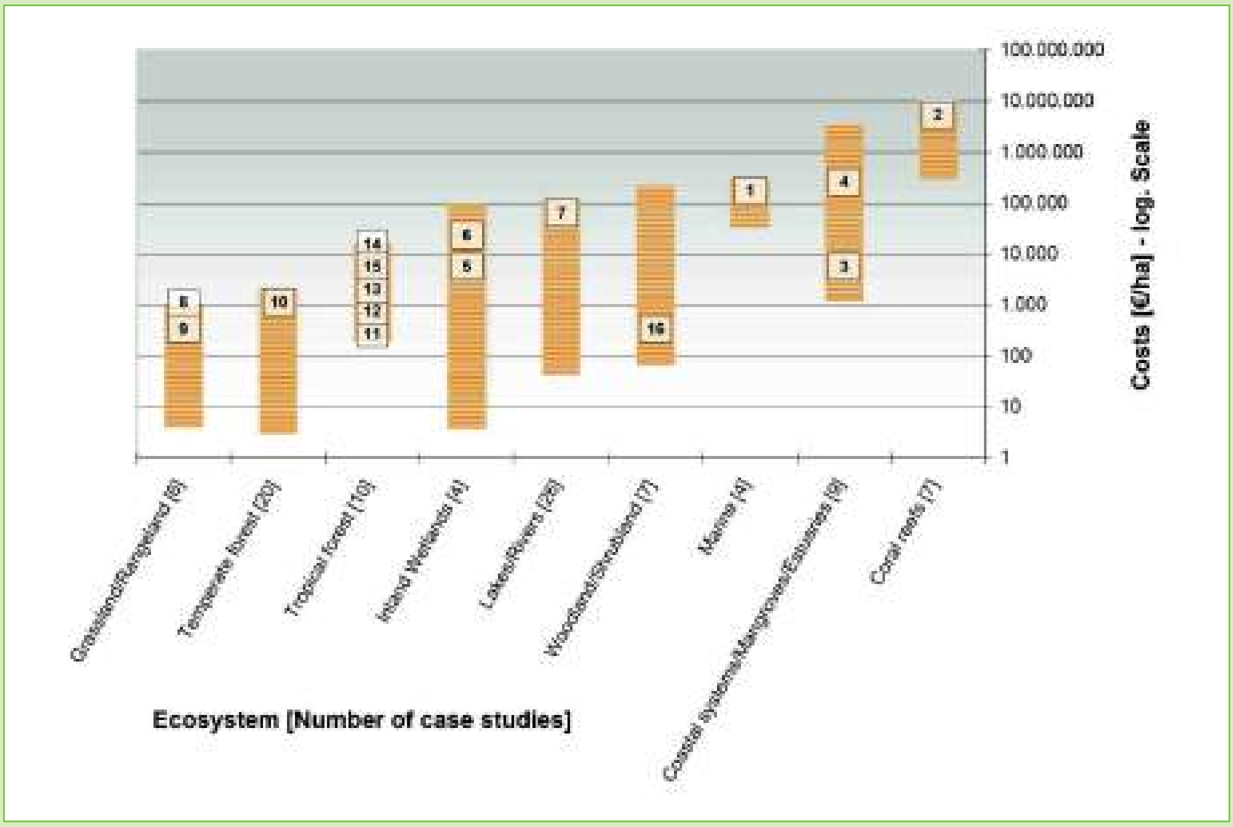
One way to decide whether investments are worthwhile from an economic perspective is to **compare the costs of services provided by ecosystems with those of technically-supplied services**. The most famous example of this type of cost-effectiveness estimation is New York City's decision to protect and restore the Catskill-Delaware Watershed (see Box 9.3).

Cost effectiveness analysis often focuses only on one particular ecosystem service e.g. in the example discussed in Box 9.3, watershed protection and restoration costs were more than compensated by the single service of water purification. However, investing in natural capital enhancement becomes even more economically attractive if the **multitude of services** that healthy ecosystems provide is also taken into account (e.g. climate regulation, food and fibre provision, hazard regulation). This calls for **identification and valuation of the broad range of benefits of natural capital investment in order to adequately compare costs and benefits of ecosystem restoration approaches**.

9.1.3. COMPARING COSTS AND BENEFITS OF ECOSYSTEM RESTORATION

As noted above, few studies analysing the costs of restoration were found and even fewer provided values or detailed analysis of the achieved or projected benefits. This section uses the findings of two studies on benefits

Figure 9.2: Summary of cost ranges of restoration efforts



Bars represent the range of observed costs in a set of 96 studies. The specific studies identified and listed in the annex serve as illustrative examples of the studies in which cost data has been reported in sufficient detail to allow analysis and reflection.

Sources for examples given (for detailed list, see Annex to this Chapter):

[1] Eelgrass restoration in harbour, Leschen 2007
[2] Restoration of coral reefs in South East Asia, Fox et al. 2005
[3] Restoration of mangroves, Port Everglades, USA, Lewis Environmental Services, 2007
[4] Restoration of the Bolsa Chica Estuary, California, USA, Francher 2008
[5] Restoration of freshwater wetlands in Denmark, Hoffmann 2007
[6] Control for phosphorus loads in storm water treatment wetlands, Juston and DeBusk, 2006
[7] Restoration of the Skjern River, Denmark, Anon 2007a
[8] Re-establishment of eucalyptus plantation, Australia, Dorrough and Moxham 2005
[9] Restoring land for bumblebees, UK, Pywell et al. 2006
[10] Restoration in Coastal British Columbia Riparian Forest, Canada, Anon 2007b
[11] Masoala Corridors Restoration, Masoala National Park, Madagascar, Holloway et al. 2009
[12] Restoration of Rainforest Corridors, Madagascar, Holloway and Tingle 2009
[13] Polylepis forest restoration, tropical Andes, Peru, Jameson and Ramsey 2007
[14] Restoration of old-fields, NSW, Australia, Neilan et al. 2006
[15] Restoration of Atlantic Forest, Brazil, Instituto Terra 2007
[16] Working for Water, South Africa, Turpie et al. 2008

and costs of mangrove restoration as an illustrative example followed by a synthesis of findings across a range of studies.

Following the 2004 tsunami disaster, there is now considerable interest in rehabilitating and **restoring 'post-shrimp farming' mangroves** in Southern Thailand as natural barriers to future coastal storm events (see also 9.4.1). Yields from commercial shrimp farming sharply decline after five years, after which shrimp farmers usually give up their ponds to find a new location. One study found that the abandoned mangrove ecosystems can be rehabilitated at a cost of US$ 8,240 per hectare in the first year (replanting mangroves) followed by annual costs of US$ 118 per hectare for maintenance and protecting of seedlings (Sathirathai and Barbier 2001: 119). Benefits from the restoration project comprise the estimated net income from collected forest products of US$ 101 per hectare/year, estimated benefits from habitat-fishery linkages (mainly the functioning of mangroves as fish nursery) worth US$ 171 per hectare/year and estimated benefits from storm protection worth US$ 1,879 per hectare/year (Barbier 2007: 211).

In order to compare costs and benefits of restoration, it has to be recognised that rehabilitating mangroves and the associated ecosystem services will take time and may never reach pre-degradation levels. Therefore the benefits are accounted for on a gradual basis, starting at 10% in the second year and then increasing them every year until they were eventually capped in the sixth year at 80% of pre-degradation levels. Applying these assumptions and a 10% discount rate, the rehabilitation project would pay off after thirteen years. If lower discount rates – as argued for in TEEB D0, Chapter 6 – are applied, the cost-benefit ratio of the restoration project improves. At a discount rate of 1%, the project would pay off after nine years. If one extends the calculation to 40 years, the project generates a **benefit/cost ratio of 4.3 and a social rate of return[1] of 16%**. It should be noted that these calculations still do not account for the wide range of other ecosystem services that may be attached to the presence of mangroves, ranging from microclimate effects and water purification to recreational values.

Box 9.3: Cost effectiveness of protection over engineered solutions: example of a US watershed

"It represents a commitment among all of the parties – the city, state and federal government – to focus on the challenges of protecting the source water supply rather than pursue a costly and gargantuan construction project."

Eric A. Goldstein, senior lawyer for the Natural Resources Defense Council

Even in industrialised countries, such as the USA, restoration of watersheds is an increasingly attractive alternative. The decision summarised below sustainably increased the supply of drinking water and saved several billion dollars that would have otherwise have been spent on engineering solutions (Elliman and Berry 2007). A similar project is underway on the Sacramento River basin in northern California (Langridge et al. 2007).

About 90% of the more than one billion gallons used daily in New York City comes from huge reservoirs in the adjacent Catskill and Delaware watersheds, located approximately 120 miles north of the city. The remaining 10% are drawn from the nearer Croton reservoirs in Westchester County (these are surrounded by development and thus have to be filtered). A US$ 2.8 billion filtration plant for the Croton water supply is under construction in the Bronx and is scheduled to be operational by 2012.

In April 2007, after a detailed review lasting several years, the US federal Environment Protection Agency concluded that New York's Catskill and Delaware water supplies were still so clean that they did not need to be filtered for another decade or longer and extended the City's current exemption from filtration requirements. This means that at least until 2017, the City will not have to spend approximately US$ 10 billion to build an additional filtration plant that would cost hundreds of millions of dollars a year to operate.

In return for this extended exemption, the City agreed to set aside US$ 300 million per year until 2017 to acquire upstate land to restrain development causing runoff and pollution. It will purchase land outright or work with non-profit land trusts to acquire easements that would keep land in private hands but prohibit their development (see Chapter 5.4). The City also committed itself to reduce the amount of turbidity (cloudiness) in certain Catskill reservoirs by erecting screens, building baffles and using other technology to allow sediment to settle before water enters the final parts of the drinking water system.

Sources: New York Times 2007 April 13th; Elliman and Berry 2007; Langridge et al. 2007

The example mentioned above is one of the few cases where decisions can be taken on a solid data base. For cases in other biomes where only cost data was available, the TEEB team **estimated potential benefits based on a 'benefits transfer' approach**, i.e. taking results from valuation studies in similar ecosystems as a basis for estimating potential benefits for the biomes concerned. The estimation of benefit values was based on the results of 104 studies with 507 values covering up to 22 different ecosystem services for 9 major biomes. These documented values were the basis to estimate the benefit of a restored or rehabilitated ecosystem. Recognizing that projects take time to restore flows of benefits, an appropriate accreting profile was modelled for annual benefits, growing initially and then stabilising at 80% of undisturbed ecosystem benefits (see TEEB D0, Chapter 7 forthcoming). This approach makes it possible to carry out an illustrative comparison. Clearly, careful site specific analysis of costs and benefits is required before any investment decision: therefore the example listed below should be seen as indicating the scope for potential benefits.

When calculating the potential benefits for the biome in question, we found **high potential internal rates of return for all biomes**. These calculations are rough first estimates for two reasons: they do not include opportunity costs of alternative land use (which can be expected to be rather low in many degraded systems) and the value base on which the benefit transfer is based is small for some of the services considered. A detailed analysis is therefore recommended before investing in restoration. Nevertheless, these values indicate that in many situations high returns can be expected from restoration of ecosystems and their services.

For example, a study by Dorrough and Moxham (2005) found that cost for **restoring eucalyptus woodlands and dry forests** on land used for intensive cattle farming in southeast Australia would range from € 285 per hectare for passive restoration to € 970 per hectare for active restoration. Restoration of tree cover yields numerous benefits including i) reversing the loss of biodiversity, ii) halting land degradation due to dryland salinisation and thereby iii) increasing land productivity. Using a benefit transfer approach and a discount rate of 1% over 40 years these services may constitute a NPV of more than € 13,000 per ha (D0 Chapter 7 forthcoming).

Along the Mata Atlantica in Brazil a non-profit organization named Instituto Terra undertakes active **restoration of degraded stands of Atlantic Forest** by establishing tree nurseries to replant denuded areas (Instituto Terra 2007). The costs for this approach are estimated at € 2,600 per hectare as one off investment. Benefits include biodiversity enhancement, water regulation, carbon storage and sequestration as well as preventing soil erosion. Using the benefit transfer approach a 40 years NPV of tropical forests may reach € 80,000 per hectare (1% discount rate).

In South Africa the government-funded Working for Water (WfW) (see also Box 9.6) programme clears mountain catchments and riparian zones of invasive alien plants in order to restore natural fire regimes, the productive potential of land, biodiversity, and hydrological functioning. WfW introduces a special kind Payment for Ecosystem Services (PES) scheme (for PES see Chapter 5): previously unemployed individuals tender for contracts to restore public or private lands. By using this approach costs to **rehabilitate catchments** range from € 200 to € 700 per hectare (Turpie et al. 2008) while benefits may reach a 40 year NPV of € 47,000 per hectare (using the benefit transfer approach described above and a 1% discount rate).

As the above-mentioned case studies and benefits transfer analysis show, **restoration can pay**. However, the costs are also quite high and many ecosystems cannot be effectively restored within reasonable timescales (see Table 9.1). For these reasons, it is much better to conserve these ecosystems rather than letting them degrade and then trying to undertake restoration. Moreover, systematic estimation of the potential costs and economic benefits of preservation and restoration needs to be better incorporated into the projects themselves. **Valuation of ecosystem services** can help, by enabling policy makers to decide which investments are worthwhile from an economic point of view and to make informed choices (TEEB D0 forthcoming), especially as many ecosystems currently have unrecognised economic and social benefits (Milton et al. 2003; FAO 2004; Bullock et al. 2007; de Groot et al. 2007; Blignaut et al. 2008; Blignaut and Aronson 2008).

9.1.4. AN INDISPENSABLE ROLE FOR GOVERNMENTS

In spite of the potentially high internal rates of return, investment in natural capital seems to be a story of unrealised potential. One important reason is that the benefits of such investments often lie far in the future or accrue over long periods of time. This means that, with some exceptions, **private investment is unlikely to occur unless this is supported or required by governments**. Governments can provide incentives for this purpose by paying for or subsidising private activities such as reforestation (see Chapters 5 and 6) and/or prescribe mandatory offsets to mitigate ecosystem disturbance caused by human interventions (see Chapter 7).

There are several key reasons why governments should consider also **directly investing public funds in natural capital** and its restoration. The first relates to large-scale and complex interrelated ecosystems, where the costs of restoration can be very high due to the size of the restoration site, the level of degradation and/or uncertainties about the technical efforts needed e.g. potentially contaminated brownfields, mining areas or other heavily degraded areas. An interesting example in this regard is the Aral Sea (Box 9.4) which has suffered from catastrophic environmental damage.

Typically, large scale and complex restoration projects involve **costs that exceed the benefits identified by private parties - even though the public benefits of restoration are likely to be higher**. It may therefore be worthwhile only for governments to invest in such efforts, although opportunities to develop public-private restoration partnerships need to be considered. To ensure the success and replicability of such projects, investments in restoration should include a multidisciplinary research component.

The second justification for direct government investment relates to situations where **early action is likely to be the most cost-effective approach**. Here policy makers need to understand the close relationship between prevention and response. Upfront precautionary measures to avoid damage are the best way to minimise long-term socio-economic and environmental costs (see example of invasive species in Box 9.5).

Government investment may also be called for in situations where potential beneficiaries are unable to afford restoration costs. Box 9.6 illustrates how livelihoods can be improved alongside with degraded ecosystems.

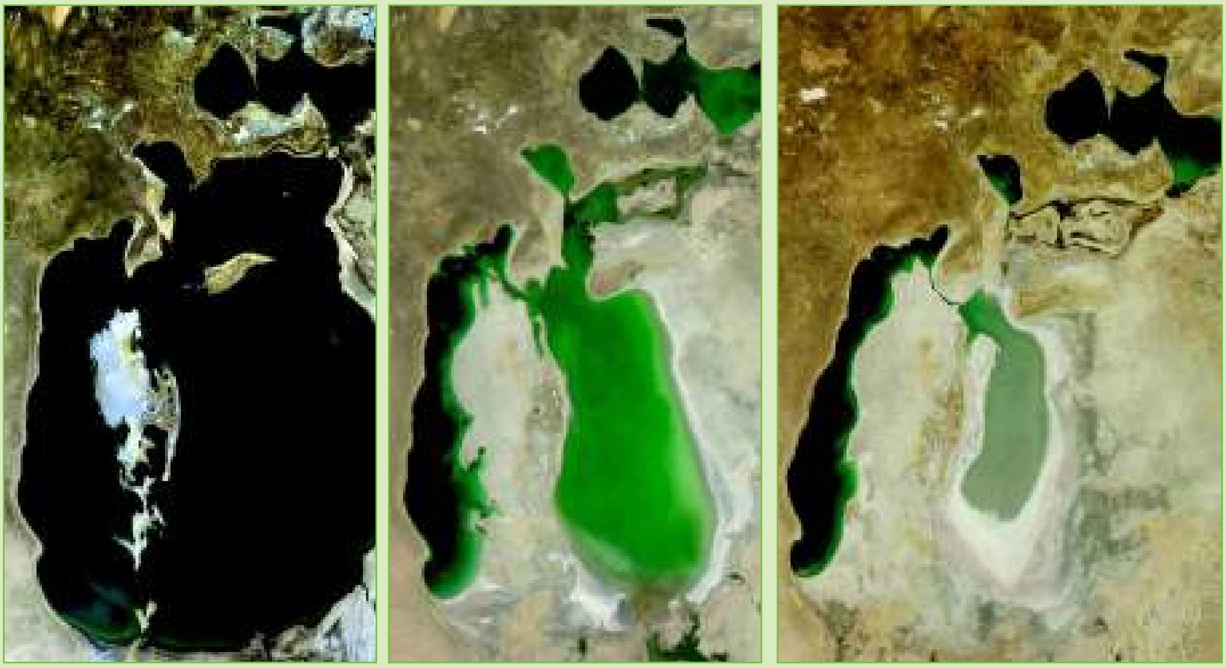
Innovative and integrated regional or landscape scale programmes to restore or rehabilitate degraded natural systems can make use of instruments such as payments for ecosystems services (PES) (Blignaut et al. 2008; see further Chapter 5 on the Clean Development Mechanism (CDM) and the proposed REDD mechanism for Reducing Emissions from Deforestation and Forest Degradation). In Ecuador, two PES-funded restoration programmes include the six-year old Pimampiro municipal watershed protection scheme and the 13-year old PROFAFOR carbon-sequestration programme (Wunder and Albán 2008). 'Pimampiro' is mostly about forest conservation, but it has also achieved some abandonment of marginal lands that have grown back into old fallows, enrolled in the scheme. PROFAFOR is a voluntary programme on afforestation and reforestation mainly on degraded lands that sought and got carbon credit certification. Many more are under way elsewhere in Latin America, Asia and, with some lag time, Africa and Madagascar. Countries making significant strides in this area include Costa Rica (Janzen 2002; Morse 2009), Indonesia (Pattanayak 2004; Pattanayak and Wendland 2007) and South Africa (Holmes et al. 2007; Mills et al. 2007; Blignaut and Loxton 2007; Turpie et al. 2008; Koenig 2009).

In summary, there is growing evidence of a positive correlation between investment and benefits from ecological restoration, both in terms of biodiversity and ecosystem services (Rey-Benayas et al. 2009). However, the funds available are far less than what is needed. It is critical to plan and budget investments at the landscape and regional scales so as to maximise returns on investments in ecological, social and economic terms.

Box 9.4: A natural capital 'mega-project': example of the Aral Sea restoration

Fifty years ago, the Aral Sea was the world's fourth largest freshwater lake and supported a large and vibrant economy based on fisheries, agriculture and trade in goods and services. In the 1960s, however, the two main rivers flowing into the Aral Sea were massively diverted for cotton cultivation and the Sea began to shrink and to split into smaller pieces – the 'Northern Aral' and 'Southern Aral' seas. Although large amounts of cotton were grown and exported in subsequent decades, thousands of jobs were lost in other sectors, the surrounding environment was severely degraded and the health of local people deteriorated. By 1996, the Aral Sea's surface area was half its original size and its volume had been reduced by 75%. The southern part had further split into eastern and western lobes, reducing much of the former sea to a salt pan.

Images of the Aral Sea: 1989 (left) and 2003 (middle) and 2009 (right)
Source: NASA Earth Observatory. URL: http://earthobservatory.nasa.gov/IOTD/view.php?id=9036



Against this background, neighbouring countries made several approaches to restore the Aral Sea. In 2005, Kazakhstan built the Kok-Aral Dam between the lake's northern and southern portions to preserve water levels in the north. The Northern Aral actually exceeded expectations with the speed of its recovery, but the dam ended prospects for a recovery of the Southern Aral. According to Badescu and Schuiling (2009), there are now three main restoration options: (1) halting cotton production and letting the waters of the two feed rivers (Amu Darya and Syr Darya) flow naturally into the Aral Sea; (2) diverting waters from the Ob and other major Siberian rivers to the Aral Sea; and (3) building a new inter-basin water supply canal, including a long tunnel from Lake Zaisan to the Balkhash Lake. All three options involve very high costs and there are considerable uncertainties about the ultimate restoration benefits.

To further illustrate the scale and complexity of the problem and its possible solutions, the implications for climate regulation also need to be considered. The discharge of major Siberian rivers into the Arctic Ocean appears to be increasing which could affect the global oceanic 'conveyor belt', with potentially severe consequences for the climate in Western and Northern Europe. By diverting part of this river water towards the Aral Sea, a restoration project may have potential beneficial effects on climate, human health, fishery and ecology in general (Badescu and Schuiling 2009).

Sources: Micklin and Aladin 2008; Badescu and Schuiling 2009; World Bank 2009a

Box 9.5: The economic case for government-led rapid response to invasive species

Invasive species are widely recognised to be one of the major threats to biodiversity and ecosystem functioning (Vitousek et al. 1997; Mack et al. 2000; van der Wal et al. 2008). Several economic studies estimate the scale of damage and management costs they impose on society (e.g. van Wilgen 2001; Turpie 2004; Turpie et al. 2008). A well-known assessment of environmental and economic costs in the US, UK, Australia, South Africa, India and Brazil carried out in 2001 and updated in 2005 (Pimentel et al. 2001, Pimentel et al. 2005) estimated costs of invasive species across these six countries at over US$ 314 billion/year (equivalent to US$ 240 per capita). Assuming similar costs worldwide, Pimentel estimated that invasive species damage would cost more than US$ 1.4 trillion per year, representing nearly 5% of world GDP. A recent review by Kettunen et al. (2009) suggests that damage and control costs of invasive alien species in Europe are at least € 12 billion per year. The following table 9.2 shows some examples of the costs of single invasive species in European countries (Vilà et al. 2009).

Table 9.2: Alien species in Europe generating high costs

Species	Biome/taxa	Country	Extent	Cost item	Period	Cost (million €year^{-1})	Reference
Carpobrotus spp	Terrestrial plant	Spain	Localities	Control/eradication	2002–2007	0.58	Andreu et al. (in press)
Anoplophora chinensis	Terrestrial invertebrate	Italy	Country	Control	2004–2008	0.53	Van der Gaag (2007)
Cervus nippon	Terrestrial vertebrate	Scotland	Localities	Control		0.82	White and Harris (2002)
Myocastor coypus	Terrestrial vertebrate	Italy	Localities	Control/damages	1995–2000	2.85	Panzacchi et al. 2007
Sciurus carolinensis	Terrestrial vertebrate	UK	Country	Control	1994–1995	0.46	White and Harris (2002)
Azolla filiculoides	Freshwater plant	Spain	Protected area	Control/eradication	2003	1.00	Andreu et al. (in press)
Eichhornia crassipes	Freshwater plant	Spain	River basin	Control/eradication	2005–2007	3.35	Andreu et al. (in press)
Oxyura jamaicensis	Freshwater vertebrate	UK	Country	Eradication	2007–2010	0.75	Scalera and Zaghi (2004)
Chrysochromulina polylepis	Marine algae	Norway	Country	Toxic bloom		8.18	Hopkins 2002
Rhopilema nomadica	Marine invertebrate	Israel	Coast	Infrastructure damage	2001	0.04	Galil and Zenetos (2002)

Source: Vila et al. 2009

A biological invasion is a dynamic, non-linear process and, once initiated, is largely self-perpetuating (Richardson et al. 2000; Kühn et al. 2004; Norton 2009). In the majority of cases, invasions are only reversible at high cost (Andersen et al. 2004). Introduced species may appear harmless for a long time, and only be identified as harmful after it has become difficult or impossible – and costly – to eradicate, control or contain them and to restore or rehabilitate formerly infested sites (Ricciardi and Simberloff 2008). For these reasons, prevention should always be the preferred management option where feasible, consistent with CBD provisions and guiding principles (CBD 1993; Bertram 1999; CBD 2002; Finnoff et al. 2006).

Delayed intervention increases the cost of intervention and thus the period required before the benefits potentially outweigh the costs. For example, Japanese knotweed (Fallopia japonica) is invasive in several EU Member States. It is estimated that in Wales, a three-year eradication programme would have cost about € 59 million (£ 53.3 million) if started in 2001 but around € 84 million (£ 76 million) if started in 2007 (Defra 2007).

Box 9.6: Valuation of livelihood benefits arising from ecosystem rehabilitation in South Africa

The Manalana wetland (near Bushbuckridge, Mpumalanga) was severely degraded by erosion that threatened to consume the entire system if left unchecked. The wetland supports about 100 small-scale farmers, 98 of whom are women. About 70% of local people make use of the wetland in some way, with about 25% depending on it as their sole source of food and income. The wetland was thus considered to offer an important safety net, particularly for the poor, contributing about 40% of locally grown food. As a result, the 'Working for Wetlands' public works programme intervened in 2006 to stabilise the erosion and improve the wetland's ability to continue providing its beneficial services.

An economic valuation study completed in 2008 revealed that:

- the value of livelihood benefits derived from the degraded wetland was just 34% of what could be achieved after investment in ecosystem rehabilitation;
- the rehabilitated wetland now contributes provisioning services conservatively estimated at € 315 per year to some 70% of local households, in an area where 50% of households survive on an income of less than € 520 per year;
- the total economic value of the livelihood benefits (€ 182,000) provided by the rehabilitated wetland is more than twice what it cost to undertake the rehabilitation works (€ 86,000), indicating a worthwhile return on investment by 'Working for Wetlands';
- the Manalana wetland acted as a safety-net that buffered households from slipping further into poverty during times of shock or stress.

Sources: Pollard et al. 2008

9.2 PROVIDING BENEFITS BEYOND THE ENVIRONMENTAL SECTOR

Investing in natural capital does not only concern the environmental sector. Other policy sectors can also reap benefits from public investment to ensure or enhance the delivery of services provided by natural capital. Considering all benefits provided by ecosystems can make investments worthwhile whereas approaches focused on single sectors and services may not.

A wide range of sectors – especially those dealing with natural hazard prevention, natural resource management, planning, water provision, alternative energy sources, waste management, agriculture, transport, tourism or social affairs – can gain from explicitly considering and valuing the services provided by natural capital. Investing in natural capital can thus create additional values, especially where natural capital has itself become the limiting factor to economic development (Herman Daly, quoted in Aronson et al. 2006).

9.2.1. BENEFITS FOR NATURAL RESOURCE MANAGEMENT

The limits of natural capital are most obvious in **natural resource management**. Fisheries, agriculture, forestry and water management directly depend on its maintenance in a healthy state. Ecological degradation (e.g. soil erosion, desertification, reduced water supply, loss of waste water filtering) impacts on productivity, livelihoods and economic opportunities (see Box 9.7).

Box 9.7: Socio-economic benefits from grassland restoration projects, South Africa

In the Drakensberg mountains, local communities depend heavily on various ecosystem services for their livelihoods. By restoring degraded grasslands and riparian zones and changing the regimes for fire management and grazing, early results suggest that it may be possible to increase base water flows during low-flow periods (i.e. winter months when communities are the most vulnerable to not having access to any other source of water) by an additional 3.9 million m^3. Restoration and improved land use management should also reduce sediment load by 4.9 million m^3/year.

While the sale value of the water is approximately € 250,000 per year, the economic value added of the additional water is equal to € 2.5 million per year. The sediment reduction saves € 1.5 million per year in costs, while the value of the additional carbon sequestration is € 2 million per year. These benefits are a result of an investment in restoration that is estimated to cost € 3.6 million over seven years and which will have annual management costs of € 800,000 per year. The necessary ongoing catchment management will create 310 permanent jobs, while about 2.5 million person-days of work will be created during the restoration phase.

Source: MTDP 2008

Increased investments in natural infrastructure to harness and optimise fresh water resources can complement or replace technical infrastructure systems (Londong et al. 2003). Optimising microbial activity in rivers through re-naturalisation of river beds has been shown to improve water quality at lower costs than by clean-up through water treatment plants. Big cities like Rio de Janeiro, Johannesburg, Tokyo, Melbourne, New York and Jakarta all rely on protected areas to provide residents with drinking water, which offer a local alternative to piping water from further afield and cost less than building filtration plants (see also Box 9.3). Further examples include:

- in Venezuela, just 18 national parks cater to the fresh water needs of 19 million people (83% of the country's population that inhabit large cities). About 20% of the country's irrigated lands depend on protected areas for their irrigation water;
- Venezuela has a potential for generating hydroelectricity equivalent to the production of 2.5 million barrels of oil per day (it currently produces 3.2 million barrels of oil per day); of course careful planning is required in order to minimise negative ecological impacts;
- in Peru, around 2.7 million people use water that originates from 16 protected areas with an estimated value of US$ 81 million/year (Pabon 2009).

Like sponges, forests soak up water and release it slowly, limiting floods when it rains and storing water for dry periods. Watershed and catchment protection near cities is therefore smart – economically, ecologically and socially (Benedict and McMahon 2008) – and as noted above, may justify payments for environmental services (see Chapter 5).

These benefits are attributable not only to protected areas but also to wider ecosystems. Sound management is needed to maintain and ensure the continuous provision of these ecosystem services. Restoration can help to keep ecosystems functioning at levels that can in principle be calculated and managed. Boxes 9.6 (above) and 9.8, and 9.9 (below) present some examples of costed approaches from Africa.

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Box 9.8: Multiple benefits from wetland restoration in the Everglades, Florida

Much of the unique Everglades ecosystem, of enormous natural beauty and the region's primary source of water, was drained in the early 1900s to make way for the cities of Miami and Fort Lauderdale. The remaining wetlands (outside the 600,000 km^2 Everglades National Park) have suffered heavily from pollution and further drainage in the last two decades (Salt et al. 2008).

To improve the quality and secure the supply of drinking water for south Florida and protect dwindling habitat for about 69 species of endangered plants and animals (including the emblematic Florida panther of which only 120 individuals survive in the wild) the US Congress enacted the **Comprehensive Everglades Restoration Plan** (CERP) in 2000. The total cost of the 226 projects to restore the ecosystem's natural hydrological functions is estimated at close to US$ 20 billion (Polasky 2008).

The return on this investment, generally lower than the costs, relates to different areas including agricultural and urban water supply, flood control, recreation, commercial and recreational fishing and habitat protection (Milon and Hodges 2000). However, many benefits – especially as regards the cultural value of the intact ecosystem – can only be measured indirectly as there are no markets for these non-use values. For the Everglades, a study covering non-use values shows that the overall benefits are in a similar range to the costs of restoration, depending on the discount rate used (Milon and Scroggins 2002).

Box 9.9: Reducing poverty by investing in floodplain restoration in Cameroon

The Waza floodplain (8,000 km^2) is a high productivity area and critical for biodiversity. Whilst extremely important for the population, it is also very fragile with fluctuating levels of rainfall, widespread poverty and precarious living conditions. 125,000 people depend for subsistence livelihoods on services provided by this floodplain ecosystem, which in turn depends to a large extent on the annual inundation of the Logone River. In 1979, construction of a large irrigated rice scheme reduced flooding by almost 1,000 km^2 which had devastating effects on the region's ecology, biodiversity and human populations (UNDP-UNEP 2008).

Engineering works to reinstate the flooding regime have the potential to restore up to 90% of the floodplain area at a capital cost of approximately US$ 11 million (Loth 2004). The same study found the socio-economic effects of flood loss to be significant, incurring livelihood costs of almost US$ 50 million over the 20 years since the scheme was constructed. Local households suffer direct economic losses of more than US$ 2 million/year through reduced dry season grazing, fishing, natural resource harvesting and surface water supplies (see Table below). The affected population, mainly pastoralists, fishers and dryland farmers, represent some of the poorest and most vulnerable groups in the region.

By bringing around US$ 2.3 million dollars additional income per year to the region, the economic value of floodplain restoration, and return on investment, would be significant in development and poverty alleviation terms. The benefits of restoring the pre-disturbance flood regime will cover initial investment costs in less than 5 years. Investment in flood restoration measures was predicted to have an economic net present value of US$ 7.8 million and a benefit: cost ratio of 6.5: 1 (over a period of 25 years and using a discount rate of 10%). Ecological and hydrological restoration will thus have significant benefits for local poverty alleviation, food security and economic well-being (Loth 2004).

Effects of land conversion in the Waza floodplain and costs and benefits of its restoration (in US$)

Losses of floods to local households		**Measures of economic profitability**	
Pasture	US$ 1.31 mio/year	Net present value	US$ 7.76 mio
Fisheries	US$ 0.47 mio/year	Benefit: cost ratio	6.5 : 1
Agriculture	US$ 0.32 mio/year	Payback period	5 years
Grass	US$ 0.29 mio/year		
Surface water supply	US$ 0.02 mio/year	**Costs and benefits of flood restoration**	
Total	US$ 2.40 mio/year	Capital costs	US$ 11.26 mio
Physical effects of flood restoration		Net livelihood benefits	US$ 2.32 mio/year
Additional flow	215 m^3/sec		
Flood recovery	90 percent		

Sources: UNDP-UNEP 2008; Loth 2004

9.2.2 BENEFITS FOR NATURAL HAZARD PREVENTION

The damage potential of storms for coastal areas, floods from rivers and landslides can be considerably reduced by a combination of careful land use planning and maintenance or restoration of ecosystems to enhance buffering capacity. In Vietnam, for example, mangrove re-planting by volunteers cost US$ 1.1 million but saved US$ 7.3 million annual expenditure on dyke maintenance and benefited the livelihoods of an estimated 7,500 families in terms of planting and protection (IFRC 2002). The reduction of the impact of cyclones was also one of the main reasons for Bangladesh to invest in their coastal green belt. Since 1994 a continuous effort is done to implement forestry along the belt. The program with the overall scope of US$ 23.4 million also helps local farmers to use the newly accreted areas in a sustainable way (Iftkehar and Islam 2004; ADB 2005).

The success of this type of project is closely linked to integrated planning and implementation. A huge amount of money was wasted in the Philippines when two decades of replanting of mangroves, including very intensive post-tsunami replanting, were not based on sound science (see Box 9.10).

Box 9.10: Restoration failures: an example from coastal protection in the Philippines

Over the past century, the islands that make up the Philippines have lost nearly three-quarters of their mangrove forests. These provide key habitats for fish and shellfish but were routinely cleared for development and fish farming ponds. To reverse the trend, conservation groups started replanting projects across the archipelago two decades ago, planting 44,000 hectares with hundreds of millions of mangrove seedlings.

In practice, one of the world's most intensive programmes to restore coastal mangrove forests has produced poor results, largely because trees were planted in the wrong places. A survey of 70 restoration sites in the archipelago (Samson and Rollon 2008) found mostly dead, dying or "dismally stunted" trees because seedlings were planted in mudflats, sandflats or sea-grass meadows that could not support the trees. Some of these areas have inadequate nutrients; in other places, strong winds and currents batter the seedlings. Ironically, the failed restoration effort may sometimes have disturbed and damaged otherwise healthy coastal ecosystems, thus entailing a double ecological and economic cost.

To get mangrove restoration back on track, Samson and Rollon (2008) suggest that planters need better guidance on where to place the seedlings and that the government needs to make it easier to convert abandoned or unproductive fish ponds back to mangrove swamps. However, the study recognises that this is a thorny legal and political issue as landowners are reluctant to consider the 'voluntary surrender' of potentially valuable shorefront back to nature.

Sources: Malakoff 2008; Samson and Rollon 2008

Letting ecosystems degrade can exacerbate the devastating impact of natural disasters. Many cases have shown that deforestation, destruction of mangroves and coral reefs or wetland drainage have significantly increased the vulnerability of regions to natural hazards and the level of damage caused (Harakunarak and Aksornkoae 2005; Barbier 2007).

Haiti is a tragic example of this. Following steady forest degradation for firewood over many decades, Hurricane Jeanne in 2004 caused 1800 deaths in Haiti, mainly by mudslides from deforested slopes. On the other side of the island, in the Dominican Republic, which was equally hard hit by Hurricane Jeanne, very few deaths were reported (IUCN 2006; see also Chapter 3, Box 3.5).

9.2.3. BENEFITS FOR HUMAN HEALTH

Healthy ecosystems are recognised as essential for maintaining human health and well-being (see the summary report of the Millennium Ecosystem Assessment: WHO 2006). Yet around the world, collapsing ecosystems pose increasing risks for human health (Rapport et al. 1998).

The spread of many infectious diseases can be accelerated by converting natural systems into intensively used ones (e.g. following deforestation or agricultural development: see Box 9.11) and the concurrent spread of invasive harmful species (Molyneux et al. 2008). The management of watersheds and water borne diseases are interlinked as shown for example in watershed-level analyses in South East Asia (Pattanayak and Wendland 2007). Deforestation creates new edges and interfaces between human populations and facilitates population growth in animal reservoir hosts of major insect vector groups, creating opportunities for several serious diseases like leishmaniosis and yellow fever to spread (Molyneux et al. 2008). The destruction of forest habitat can also result in common vector species being replaced by more effective disease vectors e.g. where one Anopheles species replaces a more benign native mosquito. This has occurred following deforestation in some parts of Southeast Asia and Amazonia (Walsh et al. 1993).

Negative impacts of ecosystem change and degradation on human health can also occur much more directly. For example, the degradation of agricultural areas can lead to decreased harvests and thus contribute to malnutrition in many areas of the world (Hillel and Rosenzweig 2008; IAASTD 2008). In addition, livestock and game form a key link in a chain of disease transmission from animal reservoirs to humans - as recently seen in the bird flu pandemic outbreak.

For these reasons, the degradation of ecosystems also directly compromises efforts to achieve several Millennium Development Goals (WHO 2006; UNDP-UNEP Poverty-Environment-Initiative 2008). There is consequently an urgent need to further explore the relationships between healthy ecosystems and human health in order to better incorporate these considerations into ecosystem and landscape management and restoration planning (WHO 2006; Crowl et al. 2008).

Box 9.11: Dams, irrigation and the spread of schistosomiasis in Senegal

In the 1980s, the Diama Dam on the Senegal River was constructed to prevent intrusion of salt water into the river during the dry season. While it succeeded in reducing salinity, it also dramatically altered the region's ecology. One organism that made its appearance and prospered after the dam was built was the snail *Biomphalaria pfeifferi,* an important intermediate host for *Schistosoma mansoni*, which is the parasite that causes intestinal *schistosomiasis*. *Bulinus globosus*, the main snail species that B. *pfeifferi* replaced in many areas around the river, is not a S. *mansoni* host.

Previously unknown to the region, *S. mansoni* quickly spread in the human population. By the end of 1989, almost 2000 people were tested positive for *S. mansoni*. By August 1990, 60 % of the 50,000 inhabitants of the nearby town of Richard-Toll were infected.

Since 1990, schistosomiasis has continued to spread in the Senegal River basin upstream from the Diama Dam. This provides a cautionary tale about the potential effects of dam construction and human-caused changes of ecosystems on the spread of vector-borne diseases and illustrates the complexity of human-ecosystem interactions.

Source: adapted from Molyneux et al. 2008

9.3 INVESTING IN ECOSYSTEMS FOR CLIMATE CHANGE ADAPTATION

"We cannot solve biodiversity loss without addressing climate change and vice versa. We therefore need to look for the 'triple win' of biodiversity that can actively contribute to climate mitigation and adaptation."

Message from Athens on the Future of Biodiversity Policies
European Commission Conference on Biodiversity
(Athens, April 2009)

Protecting biodiversity and ecosystems - and using them sustainably in the case of culturally modified systems - is the best way to preserve and enhance their resilience and one of the most cost-effective defences against the adverse impacts of climate change. An ecosystem-based approach to adaptation is crucial to ensure ecosystem services under conditions of climate change.

Climate adaptation is a challenge to many different sectors. Benefits from investment in natural capital may provide cost-effective solutions across multiple policy areas by focusing on the maintenance and enhancement of the joint provision of ecosystem services. All ecosystems provide a set of services and this creates opportunities to streamline policy making. Flood protection, water provision and water quality regulation (including reduction of infectious diseases) may be provided by one and the same wetland area and thus buffer the effects of changing climate regimes (see Box 9.12). By making sure that climate adaptation and water provision policies are coordinated, it will be possible to minimise implementation costs whilst maximising the appropriated flow of services or dividends from relevant natural capital (World Bank 2009b). as shown for example in watershed-level analyses in South East Asia (Pattanayak and Wendland 2007).

There is clearly a need to **address biodiversity loss and climate change in an integrated manner** and

Box 9.12: The restoration of wetlands and lakes in the Yangtze River basin

The extensive lakes and floodplains along the Yangtze River in China form large water retention areas which attenuate floods during periods of heavy precipitation and provide a continued flow of water during dry periods. Due to the conversion of the floodplains to polder the wetland area has been reduced by 80% and the flood retention capacity reduced by 75%. Consequently, the risk of floods increases, whereas during dry periods the reduction in water flow increases pollutants concentration in the remaining water bodies, thereby causing the decline in fish stocks. It is anticipated that under continued climate change the frequency of extreme events with heavy precipitation and droughts will increase, having negative consequences for the livelihoods of the 400 million people that are living in the basin of the Yangtze River.

In 2002 WWF initiated a programme in the Hubei Province to reconnect lakes and restore wetlands – so far 448 km3 of wetlands have been rehabilitated which can store up to 285 million m3 of floodwaters. On the one hand this is expected to significantly contribute to the prevention of floods. On the other the increased water flow and better management of aquacultures and improved agricultural practices enhanced the water quality to drinking water levels. This contributed to an increase in the diversity and population of wild fish species in recent years and in turn catches increased by more than 15 %. The restoration of the wetlands thus not only reduces the vulnerability of local communities to extreme events but also improves their living condition.

Source: WWF 2008

to develop strategies that achieve mutually supportive outcomes for both policy challenges. One way to achieve this is by promoting sustainable adaptation and mitigation based on ecosystem approaches (e.g. World Bank 2009b). **Ecosystem-based approaches seek to maintain ecological functions at the landscape scale in combination with multi-functional land uses.** They represent potential triple-win measures: they help to preserve and restore natural ecosystems; mitigate climate change by conserving or enhancing carbon stocks or by reducing emissions caused by ecosystem degradation and loss; and provide cost-effective protection against some of the threats resulting from climate change (for discussion, see Paterson et al. 2008).

The CBD AHTEG (2009) on biodiversity and climate change supports this way forward. This expert group concluded that "maintaining natural ecosystems (including their genetic and species diversity) is essential to meet the ultimate objective of the UNFCCC because of their role in the global carbon cycle and because of the wide range of ecosystem services they provide that are essential for human well-being" and stressed that ecosystem-based adaptation is key to successful strategies. This can ensure the long-term success of relevant strategies while the wider ecosystem challenges can be addressed appropriately in climate change negotiations under UNFCCC e.g. by **establishing a REDD-Plus mechanism** and by including ecosystem-based approaches in the Framework for Climate Change Adaptation Action (see also Chapter 5.2 and TEEB 2009).

Given the uncertainties surrounding future rates and mpacts of climate change, as well as the gaps in knowledge and uncertainty of responses to policy initiatives, a **precautionary approach** is necessary. Strong emissions-cutting policies need to be complemented with plans to adapt to major environmental, social and economic changes during the period when we are likely to overshoot safe levels of global warming, as suggested in recent IPCC reports (IPCC 2007). This will require much more **investment in adaptation** than is currently planned (Parry et al. 2009; TEEB 2009). Furthermore, mitigation activities need to be designed to **create synergies with adaptation**, biodiversity conservation and sustainable

Box 9.13: Climate Change adaptation in Bolivia

In Bolivia the frequency of natural disasters such as floods and forest fires has increased over the past years and is expected to rise further as climate change continues. This has negative impacts in particular for the rural communities that are heavily dependent on agricultural production. In the Altiplano farmers always had to cope with the risks from natural climate variability but over the past decades the depletion of vegetation, soil erosion, desertification and the contamination of water bodies decreased their resilience. Climate change puts additional stress on the agricultural sector and exacerbates the living conditions for rural communities. Although farmers try to adapt their management of crops to the changing climate conditions this is often not sufficient and the migration of farmers to cities is becoming a bigger problem. As the agricultural sector is contributing 20% to the national GDP and employs 65% of the work force, climate change poses a real threat to the national economy. Therefore, the government of Bolivia has identified key adaptation strategies which are of importance for national development: (i) Sustainable forest management; (ii) Enhancing the efficiency of industrialization processes; (iii) Reducing habitat fragmentation; (iv) Improving soil and water resource management, agriculture research and technology transfer; (v) Identifying pastures resistant to climate change and improving livestock management; (vi) Coordinating water use and water conservation. Five out of the six adaptation strategies are directly related to ecosystem management which highlights the significance of ecosystem services for human well-being and development under climate change. The World Bank has initiated a study on the Economics of Adaptation to Climate Change (EACC) and is assessing the costs of adaptation within a broader national and international context. Similar efforts of identifying adaptation strategies and their costs are undertaken in Bangladesh, Ethiopia, Ghana, Mozambique, Samoa and Vietnam.

Source: World Bank 2009c

development (Paterson et al. 2008; Galatowitsch 2009). Where such activities have negative impacts on biodiversity, such as biofuel production, they need to be carefully planned and controlled and their impacts continuously assessed. This type of 'mal-adaptation' should be avoided and remedial measures implemented. Conversely, mitigation measures with positive outcomes represent opportunities that should be sought and promoted.

Ecosystem-based approaches can be applied to virtually all types of ecosystems, at all scales from local to continental, and have the potential to reconcile short and long-term priorities. Green structural approaches – e.g. ecosystem-based adaptation - contribute to ecosystem resilience. They not only help to halt biodiversity loss and ecosystem degradation and restore water cycles but also enable ecosystem functions and services to deliver a more cost-effective and sometimes more feasible adaptation solution than can be achieved solely through conventional engineered infrastructure. Such approaches also reduce the vulnerability of people and their livelihoods in the face of climate change. Many pilot projects in this area are under way (Box 9.13, for a summary of important initiatives, see World Bank 2009b). The experience gained needs to be mainstreamed across countries and regions.

Analysis of measures targeting emission reductions illustrate that there are 'low cost co-benefit' measures which can add significantly to biodiversity conservation and sustainable use (GTZ & SCBD 2009, CBD AHTEG 2009). These include restoring degraded forestland and wetlands, increasing organic matter in soils, reducing the conversion of pastureland and use of 'slash and burn' practices and improving grassland management. These ecosystem-based approaches and land management practices also help to maintain services important for human wellbeing and vital to reinforce nature's adaptive capacity in the face of climate change. The costs of such actions may be much lower than those of major technological actions. They require policy incentives, rather than actions such as carbon pricing or research and development, and are therefore easier to develop.

Agricultural productivity is affected by rising temperatures and increased drought. Agricultural resilience is therefore a key part of adaptation, especially in countries with large populations dependent upon subsistence farming. A recent study has illustrated its potential (see Box 9.14).

Box 9.14: Ecosystem gains from sustainable agricultural practices

Agricultural sustainability centres around the world respond to the need to develop best practices and deliver technologies that do not adversely affect the supply of environmental goods and services, but still improve yields and livelihoods. A study of 286 recent 'best practice' initiatives in 57 developing countries covering 37 million hectares (3% of cultivated area in developing countries) across 12.6 million farms showed how productivity increased along with improvement to the supply of ecosystem services (e.g. carbon sequestration and water quality). The average yield increase was 79%, depending on crop type, and all crops showed gains in efficiency of water use. Examples of these initiatives included:

- pest management: using ecosystem resilience and diversity to control pests, diseases and weeds;
- nutrient management: controlling erosion to help reduce nutrient losses;
- soil and other resources management: using conservation tillage, agro-forestry practices, aquaculture, nd water harvesting techniques, to improve soil and water availability for farmers.

Source: Pretty et al. 2006

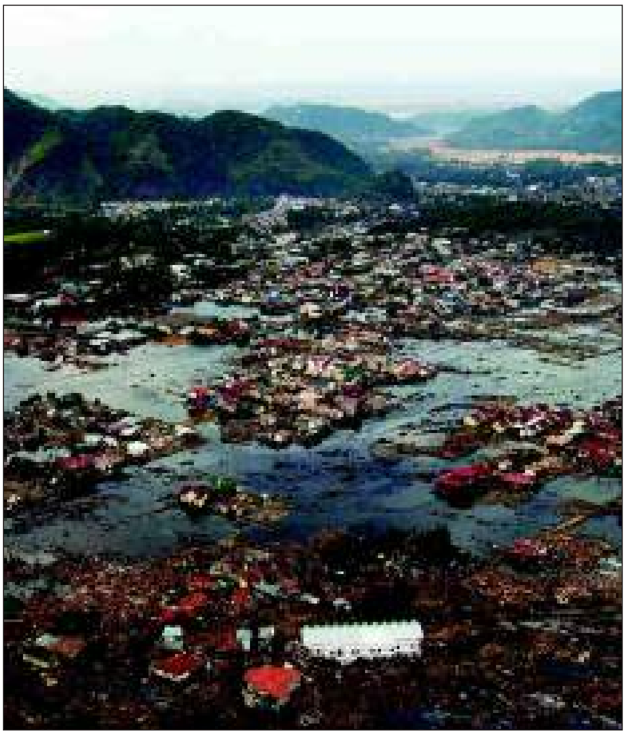
9.4 PROACTIVE STRATEGIES FOR MAKING INVESTMENT HAPPEN

TEEB findings show that a proactive strategy to maintain natural capital and ecosystem services, especially regulating services, should be a high priority for decision-makers. Reactive restoration efforts are generally the fall-back option for severe cases where ecosystem degradation has already taken place. However, both natural and man-made catastrophes and crises provide important opportunities to rethink political practice and procedures and to undertake major public-private or all-public investments. Investing in natural capital can be a very beneficial strategy in the follow-up after catastrophes.

9.4.1 TURNING CATASTROPHES AND CRISES INTO OPPORTUNITIES

When natural crises strike, the necessary rebuilding can be designed to allow future economic development and protection from disasters to go hand in hand (SER-IUCN 2004). After Hurricane Katrina devastated New Orleans, a billion dollars were allocated by the federal government to the city's reconstruction. The goal was to restore and revitalise the region to make it less vulnerable to future hurricanes and other natural disasters. The US Army Corps of Engineers initiated a massive Hurricane and Storm Damage Risk Reduction System that has focussed on repairing and rebuilding the artificial levees along the Gulf of Mexico seafront. However, environmental engineers and restoration ecologists pointed out that over the past century, large wetland areas surrounding the city and providing barriers against storms have been lost to urban sprawl. Now, in the wake of Katrina the opportunity existed to restore them in conjunction with reconstructing the city's built environment by using high-performance green buildings (Costanza et al. 2006a). It was argued that New Orleans could become a model of how to move towards a sustainable and desirable future after a series of severe shocks (Costanza et al. 2006b). Unfortunately, so far wetland restoration has not actually been undertaken, and rebuilding of seafront levies has been favoured instead.

Other opportunities include coastal area restoration activities implemented after the catastrophic 2004 tsunami in the Indian Ocean, and Cyclone Nargis in 2008. The goal is to improve the buffering function of coral reefs and mangroves for future events (UNEP-WCMC 2006; IUCN 2006). In 2005, the Indonesian Minister for Forestry announced plans to reforest 600,000 hectares of depleted mangrove forest throughout the nation over the next five years. The governments of Sri Lanka and Thailand, amongst others, have launched large programmes to recover the natural barriers provided by mangrove areas, largely through reforestation (Harakunarak and Aksornkoae 2005; Barbier 2007).



Source: U.S. Navy photo by Philip A. McDaniel. URL: http://www.news.navy.mil/view_single.asp?id=19968

Box 9.15: Launch of the Sloping Land Conversion Programme after flooding in China

In 1998, the Yangtze River overflowed causing severe floods. The protection capacities of nearby dams were hindered because of the river's heavy sedimentation, leading to worse damage occurring along the river. After the flood, the river's high sediment yield was linked to the erosion from intensively farmed sloping land (Tallis et al. 2008).

As a consequence, the Chinese government implemented the Sloping Land Conversion Programme which aims to reduce soil erosion in key areas of 24 provinces by converting farmland back into forest land (Sun and Liqiao 2006). Farmers are offered cash incentives, or quantities of grain, to abandon farming and restore forests on their land on steep slopes along key rivers. By the end of the programme in 2010, the aim is to have reconverted 14.6 million hectares into forest (Tallis et al. 2008).

The cost of the overall investment in this project, undertaken mainly by the Chinese government, is Yuan 337 billion (about US$ 49 billion, see Bennett 2009). The government aims to combine soil protection activities with activities for socio-economic improvement of underdeveloped regions along the Yangtze River to improve local living standards by helping families to create new means for earning their livelihoods.

Sources: Sun and Liqiao 2006; Tallis et. al. 2008; Bennett 2009

Another example is provided by China's land conservation programme launched after severe flooding of the Yangtze River (see Box 9.15).

Current interest in – and increased funding opportunities for – climate change adaptation and mitigation provide new possibilities for integrating a natural capital perspective into projects and programmes. The result should be to reduce the future vulnerability of societies to new catastrophes, not only by reducing the impact of future events but also by increasing the ability of local people to cope with the effects of climate change and ensure their livelihoods in a changing world (IUCN 2006).

Lastly, financial crises, like all major upheavals, should be regarded as an opportunity for major investments in natural capital. The financial crisis of 2008/2009 led to multi-billion dollar investment in 'stimulus packages' in many countries. If this money were used for investing in natural capital, it would present a unique opportunity for the environment and for redirecting economic growth towards sustainability. Some governments realise that investments in green infrastructure can lead to multiple benefits such as new jobs in clean technology and clean energy businesses (see Box 9.16). Investment in natural capital in the broader sense could secure the sustainable flow of ecosystem services and provide additional jobs in sustainable agriculture and conservation-based enterprises.

9.4.2 PUTTING PRECAUTION INTO PRACTICE THROUGH GREEN INVESTMENT

Do we have to wait for crises to occur or natural disasters to strike or should we invest in securing our common future before severe damages occur? The World Bank (2004) supports taking **a precautionary approach** and estimates that **every dollar invested in disaster reduction measures saves seven dollars in losses from natural disasters**. In other words, investment in natural capital pays - not only to improve environmental conditions and livelihoods but also in economic terms.

When tackling the many challenges we face (widespread environmental degradation, climate change and major threats by catastrophes), an integrated economic perspective can and should be developed by national governments to improve capacity to identify and address the benefits of maintaining and restoring our limited and increasingly threatened stocks of renewable natural capital (see examples of South Korea and Great Britain in Box 9.16 above).

Box 9.16: Investing in the environment during the financial crisis

South Korea: The government is linking its strategy to revitalise its national economy under the current crisis with green growth (Hyun-kyung 2009). In early 2009, President Lee Myung-bak announced that US$ 10 billion would be invested in restoration of four major degraded rivers to build dams and protect water reservoirs. The aim is to prevent neighbouring areas from flooding and to create 200,000 new jobs. "Our policies of green development will benefit the environment and contribute to the fight against climate change, but it is not only an environmental plan: it's primarily a plan for economic development" (Statement of Korea's Permanent Representative to the OECD, Kim Choong-Soo).

United Kingdom: In June 2009, the government decided to enhance research in the environmental sector and invest £ 100 million (US$ 160 million) to prepare for climate challenges and related environmental changes (LWEC 2009) through new and innovative solutions for environmental problems. The programme supports the design of more energy-efficient buildings, better public transport systems and better water solutions for cities, as well as tackling the spread of diseases and addressing the economic impact of our changing environment. Programme expectations are that the outcomes will bring benefits for the public in different sectors.

Sources: Hyun-kyung 2009; LWEC 2009

A crucial step towards more proactive strategies is to develop overviews of ongoing losses of and threats to natural capital. All countries require more detailed information at regional and national scales on ecosystem services and the factors that threaten their provision, as well as better accounting systems that reflect the importance of natural capital (see Chapter 3). This information will enable policy makers to develop investment strategies that include schemes to maintain or restore ecosystems that provide key services, e.g. via targeted payment schemes (see Chapter 5) or other means, including the designation of protected areas (see Chapter 8).

Achieving this transition will require much closer links between different actors in development and restoration projects, especially in developing countries. Too often, academic institutions, government forestry and agricultural research partners, communities and commercial operators are not adequately connected and therefore do not adequately use the potentials of working together closely. Environmental agencies and institutions have a critical role to play in promoting strong cross-sectoral policy and project coordination, facilitating the development of efficient and cost-effective actions and ensuring that the benefits of such actions are fairly shared across different stakeholder groups.

To pave the way for **combining environmental risk reduction with economically efficient investment**, TEEB recommends that each country carries out a **systematic assessment of their national stocks of natural capital by creating natural capital accounting systems and maps**. These tools will enable restoration needs to be identified in different ecosystem types, especially with regard to endangered biodiversity and the services that ecosystems provide to people, and should be developed at local up to national scales. High priorities should include:

- water provision and purification for cities;
- climate change adaptation and associated natural hazard management, risk management and natural capital;
- carbon storage and sequestration; and
- protecting biodiversity hotspots and other ecosystems considered valuable from a conservation and landscape management perspective.

A structured scientifically-based framework for natural capital accounting will open up new possibilities for decision-makers to systematically and proactively invest in ecological infrastructure. This will not only protect communities and societies against natural hazards – including those most exposed to environmental risk – but also makes economic sense by providing a positive return on investment in the mid-term (see e.g. World Bank 2004). Such investments in a resource-efficient economy are fundamental to help humanity move towards a sustainable future in the long-term, including fairer sharing of nature's social and ecological benefits.

Chapter 9 has, complementing the chapters 5 to 8, outlined the role **of direct investment in ecological infrastructure**, stressing the economic argument for proactive strategies and the precautionary principle, but also outlining the needs and the costs and benefits for restoration efforts on different scales.

Chapter 10 will sum up the findings from the study and give an overview for the future **steps needed to respond to the value of nature**.

Endnotes

[1] Instead of ‚internal rate of return' we use ‚social rate of return' to highlight that besides private benefits some of the public benefits have been considered.

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Direct costs and potential benefits of restoration: selected examples by ecosystem

Restoration effort & context	Type of restoration and cost items	Source or link	Ecosystem	Last Year of data collection	Cost: €/ha	Benefits of restoration
[1] Eelgrass restoration in harbour (seabed) following the installation of an oil pipeline	Growing of shoots and the transplantation thereof using volunteer workers	Leschen 2007	Seagrass meadows	2007	170,000	Habitat improvement to support the proliferation of juvenile marine resources and other forage species.
[2] Restoration of coral reefs following blast fishing in South East Asia	Construction of new reef using special cement: All inclusive	Fox et al. 2005	Coral reef	2002	11,000,000	Dynamite fishing destroys corals and habitat, which leads to reduced fishing and income from tourism. In Indonesia, lost income from this cause ranges from €410million and €2.2 billion. Restoration attempts to restore value, both economically and biologically.
	Establishment of EcoReefs, i.e. branching ceramic stoneware modules: Materials only				500,000	
	Placement of stones (from terrestrial sources)				50,000	
	Comparison with Florida Keys restoration				5,000,000 - 80,000,000	
	Comparison with restoration in Maldives				300,000 - 1,200,000	
[3] Restoration of mangroves in West Lake estuary (Port Everglades, USA)	The restoration of 500 ha of mangrove forest through hydrologic improvements to blocked mangroves, and the removal of 80 ha of historical dredged material fill and various Pine species	Lewis Environmental services 2007	Mangroves & estuaries	1995	7,148	Habitat creation to restore fish populations and to develop nature-based tourism through construction of a nature centre and outdoor classroom, multi-use boardwalks, fishing facilities, small boat launching site, public observation areas, and hiking trails.
[4] Restoration of the Bolsa Chica estuary, California	Restoration to form part of the offset program to mitigate large industrial scale development	Francher 2008	Mangroves & estuaries	2006	325,000	Creation of habitat to i) food for fish, crustaceans, shellfish, birds and mammals, ii) absorb pollutants, iii) reduce erosion of the marine shore, iv) provide an opportunity to observe nature.

[5] Restoration of fresh-water wetlands in Denmark	Wetland restoration through hydrological manipulation	Hoffmann 2007	Inland wetland	2005	8,375	The reduction of nitrogen loads to down-stream recipients and to enhance the resource value.
[6] Control for phosphorous loads in stormwater treatment wetlands	Wetland construction and hydrological manipulation	Juston and DeBusk 2006	Inland wetland	2005	25,000	The removal of phosphorous loads from open water bodies.
Restoration of the little Tennessee River, North Carolina	Riparian buffer costs, without fencing cost	Holmes et al. 2004	Rivers & riparian zones	2000	2,302 (€/km)	Restoration benefits are i) abundance of game fish, ii) water clarity, iii) wildlife habitat, iv) allowable water uses, and v) ecosystem naturalness. The benefit/cost ratio for riparian restoration ranged from 4.03 (for 2 miles of restoration) to 15.65 (for 6 miles of restoration).
	Riparian buffer costs, with fencing cost				7,341 (€/km)	
	Average cost of revetments where on-site trees were available				36,348 (€/km)	
	Average cost of revetments where on-site trees were not available				47,670 (€/km)	
	Average cost of establishing a riparian buffer in a "Representative" restoration				4,825 (€/km)	
	Average cost of establishing a representative mix of restoration activities				17,870 (€/km)	
[7] Restoration of the Skjern River, Denmark	Construction and restoration of water courses	Anon 2007a	Rivers & riparian zones	2002	130,000	Benefits are to i) reinstate flow conditions of the Skjern River and remove unnatural barriers, ii) improve the aquatic environment of Ringkøbing Fjord and allow the river, fjord and sea to function as a single biological entity, iii) enhance conditions for migratory fish, iv) recreate a natural wetlands habitat of international importance, v) develop the leisure and tourist potential of the Skjern River Valley.
Restoration of the Cheonggyecheon River, Seoul	Flood mitigation and channelling of the river	City of Seoul 2007	Rivers & riparian zones	2005	120,000	Benefits are to i) improve environmental conditions in the downtown area, ii) create a focal point of both historical significance and aesthetic appeal, iii) trigger long-term economic growth by attracting tourists and investors, iv) aid in making Seoul a financial and commercial hub in the East Asian region.

[8] Re-establishment of native eucalyptus trees in former grassy woodland, southeast Australia	Re-vegetation after intensive grazing and farming: Active restoration	Dorrough and Moxham 2005	Grasslands & rangelands	2003	970	Benefits are to i) stop and reverse the loss of biodiversity, ii) land degradation, iii) land [productivity loss and, iv) dryland salinisation.
	Re-vegetation after intensive grazing and farming: Passive restoration				285	
[9] Restoring land to increase forage for bumblebees in intensively farmed landscapes in UK	Reseeding of study area with a mixture of grass seeds	Pywell et al. 2006	Grasslands & rangelands	2003	101	Pollination services for semi-natural ecosystems and a wide range of agricultural and horticultural crops, and many garden plants.
[10] Restoration in Coastal British Columbia Riparian Forests	Thinning treatments, Conifer Planting. Structures were made using surplus conifer and alder trees removed at streamside to release existing site conifers.	Anon 2007b	Temperate forests	2002	2,200	Management aims to improve streamflow integrity (bank stability, water quality, shade) and provision of downed trees (large woody debris) for stream channels. Large woody debris is crucial for healthy salmon and trout habitat, by creating pools and cover, retains nutrients and stabilizes the stream.
[11] Masoala Corridors Restoration, Masoala National Park, Madagascar	Tree and plant nurseries	Holloway et al 2009	Tropical forests	2008	11-223	Communities depend on the ecosystem services delivered by the forests and the establishment of corridors between existing clumps of forests are essential to ensure the survival of these and the ongoing delivery of ecosystem services to communities.
	Plantation				19-372	
	Forest maintenance				15-670	
[12] Restoration of rainforest corridors, Andasibe area, Toamasina Region, Madagascar [Tetik'asa Mampody Savoka TAMS]	Sourcing and planting of trees	Holloway and Tingle 2009	Tropical forests	2008	570 – 1,250	Enhancement of native biodiversity, human and ecosystem wellbeing through restoring degraded wasteland to a mosaic of integrated/ing, diverse natural forest and productive ecosystems.

[13] Polylepis forest restoration, Peru	Restoration and re-vegetation of landscape	Jameson and Ramsey 2007	Tropical forests	2005	760	Regulation of water supplies in a seasonally dry climate - the importance of this is likely to increase as tropical glaciers retreat and dry season meltwater declines in volume. The forest floor, with a high coverage of shaded mosses, also regulates the flow of water into the rivers and the reduction of soil erosion during heavy rain on the shallow soils of the steep Andean slopes.
[14] Restoration of old-fields, New South Wales, Australia	Restoration and enhancement of natural succession of old-growth tropical plantations	Neilan et al. 2006	Tropical forests	2004	16,000	Soil productivity, biodiversity, reduced vulnerability and exposure to the invasion by alien species, and the reduction of soil erosion.
[15] Restoration of the Atlantic Forest (Mata Atlântica), Brazil	Aroeira trees *(Lithraea molleoides)* were thinned as needed, tree seedlings of other native species were planted on degraded sites and natural regeneration in these areas is being monitored	Instituto Terra 2007	Tropical forests	1999	2,600	Besides biodiversity, water from the Bulcão stream and other springs is beginning to return. A dam that had previously been silted up, along with two other springs, have been recovered. During the dry season, these recovered springs have outflows of around 20 liters/minute.
[16] Working for water, South Africa	Clearing of invasive alien plants	Turpie et al. 2008	Woodland and shrub-land	2008	200-700	Improved water supply, carbon sequestration and fire protection,
[17] Mangrove restoration from former shrimp farms	Replanting mangrove trees and other rehabilitation measures	Barbier 2007	Mangroves	2007	8,800-9,300	Improved coastal protection, Fisheries and forest products from mangroves

Source: Aaronson et al. in press

[i] Instead of ‚internal rate of return' we use ‚social rate of return' to highlight that besides private benefits some of the public benefits have been considered.

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY

TEEB for National and International Policy Makers

Chapter 10: Responding to the value of nature

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Chapter 10

Responding to the value of nature

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10 Responding to the value of nature

"I believe that the great part of miseries of mankind are brought upon them by false estimates they have made of the value of things."

Benjamin Franklin, 1706-1790

"There is a renaissance underway, in which people are waking up to the tremendous values of natural capital and devising ingenious ways of incorporating these values into major resource decisions."

Gretchen Daily, Stanford University

Biodiversity provides a range of ecosystem services that support people's livelihoods and contribute to and underpin the economy. Too often, however, their value is unrecognised or under-recognised by market prices and signals and ignored in decision making by policy makers, local administrators, businesses and/or citizens. As a result, nature is almost invisible in the choices we make at every level. We have been steadily drawing down our natural capital without understanding its value – or what it would really cost to replace the services nature provides for free.

Chapter 10 pulls together the insights and analysis from across the TEEB report. It links the current biodiversity crisis with its economic and human implications to concrete actions for measuring biodiversity and its value, integrating it into decision making and responding through a flexible range of instruments, from market solutions to regulation to investments in natural capital.

10.1 explains **why valuing ecosystem services makes economic sense** and contributes to better decision making. It shows how values are becoming more visible but that market limitations underline the need for robust public policies. **10.2** focuses on the need for and **benefits of measuring to manage our natural capital**. Better measurement of biodiversity and ecosystem services can improve links to national accounts and macro-economic indicators, leading to better informed management of natural capital. **10.3** presents the main arguments for **investing in natural capital**, providing examples of potential gains related to climate mitigation and adaptation, healthy ecological infrastructure, an expanded network of protected areas and restoration of degraded ecosystems, and showing how such investment can support jobs and alleviate poverty. **10.4** highlights the need to **improve the distribution of costs and benefits** for reasons of equity, efficiency and effectiveness. Getting the right people to pay (polluters, resource users) and the right people to share in the benefits (those helping to supply ecosystem services) is critical and requires appropriate incentives, regulations and clearly-defined rights and responsibilities. Specific consideration is given to practical aspects of managing economic transition and overcoming resistance to change.

Lastly, the scope for natural capital to deliver prosperity is discussed in **10.5**. This looks at **policies that can make a major difference** using existing funds (e.g. subsidy reform) and identifies policy windows of opportunity (e.g. international collaboration on REDD-Plus). The chapter concludes with a vision of the road ahead – leading not only to a low carbon economy but also to a resource efficient economy that values nature and respects its limits.

10.1 WHY VALUING ECOSYSTEM SERVICES MAKES ECONOMIC SENSE

Losses in the natural world have direct economic repercussions that we systematically underestimate. Making the value of our natural capital visible to economies and society creates an evidence base to pave the way for more targeted and cost-effective solutions.

We are facing a biodiversity crisis even though we are major beneficiaries of nature's multiple and complex values. Forests store carbon, provide timber and other valuable products and shelter species and people. Wetlands purify water and offer protection against floods. Mangroves protect coasts and their populations by reducing the damage caused by storms and tsunamis. Coral reefs provide breeding grounds for fish, leisure and learning for tourists and scientists … The list of benefits provided by nature is vast. Yet species are still being lost and nearly two thirds of ecosystem services have been degraded in just fifty years (Millennium Ecosystem Assessment (MA) 2005). We have become only too familiar with the gradual loss of nature – this 'death by a thousand cuts' of the natural world. Our natural capital is being run down without us even knowing its real worth.

The **cost of these losses is felt on the ground but can go unnoticed at national and international level** because the true value of natural capital is missing from decisions, indicators, accounting systems and prices in the market. 'Ecosystem services' – the benefits we derive from nature – are a useful concept to make these benefits more explicit. They form a key building block of the new approach we urgently need to manage natural resources.

The sheer range of benefits derived from ecosystems is often poorly understood. As reflected in the typology used by the MA – which distinguishes provisioning, regulating, cultural and support services – benefits can be direct or indirect and tangible or intangible (beautiful landscapes foster cultural identity and human wellbeing). They can be provided locally and at global scale (forests influence local rainfall but also sequester carbon and help regulate climate change). They can be scattered and in some cases are even more important to future generations – all of which makes measurement particularly hard.

10.1.1 VALUES ARE BECOMING MORE VISIBLE

We have made significant progress in economic valuation over the last twenty years, and the economic invisibility of ecosystems and biodiversity has no doubt reduced over these years, although a lot more needs to be done. This includes identifying and quantifying impacts that occur when ecosystems are damaged or services lost and then estimating their monetary equivalent. Both the ecological understanding of these services and monetary valuation methods are continuously being improved, especially for regulating and cultural services, which are harder to measure than provisioning services.

Estimating the value of ecosystem services in monetary terms comes at the end of the evaluation sequence (see Figure 1). It needs to build on the scientific information collected earlier to understand and assess the impacts of biodiversity loss or changes in ecosystem condition on the provision of services. Economic valuation is best applied not to an entire ecosystem but to an incremental change and within a specified policy context.

A large, if heterogeneous, body of empirical studies is now available on the values attached to a wide range of ecosystem services, in different world regions and in different socio-economic conditions. However, coverage is uneven. There are still significant gaps in the scientific and valuation literature, for example on marine

Figure 10.1: Evaluation sequence building on scientific information

Source: Stephen White, own representation

ecosystems. Provisioning services (food, fibre and water) and a few cultural services (such as recreation and tourism) are better covered than regulating services (water and climate regulation), although research on regulating services is developing rapidly.

Valuation can help reveal the relative importance of different ecosystem services, especially those not traded in conventional markets (see Box 10.1). 'Direct use values' – associated with services like the production of raw materials – are most relevant to people who live in or near the ecosystem yet even these values are rarely considered fully, particularly if they have no market price. It is even rarer for indirect use values associated with regulating services to be taken into account. However, many studies indicate significant and in some cases substantial ecosystem service values, as compared to local incomes or to the economic benefits from competing land uses. In particular, there is increasing evidence that regulating services often add up to the biggest share of total economic value.

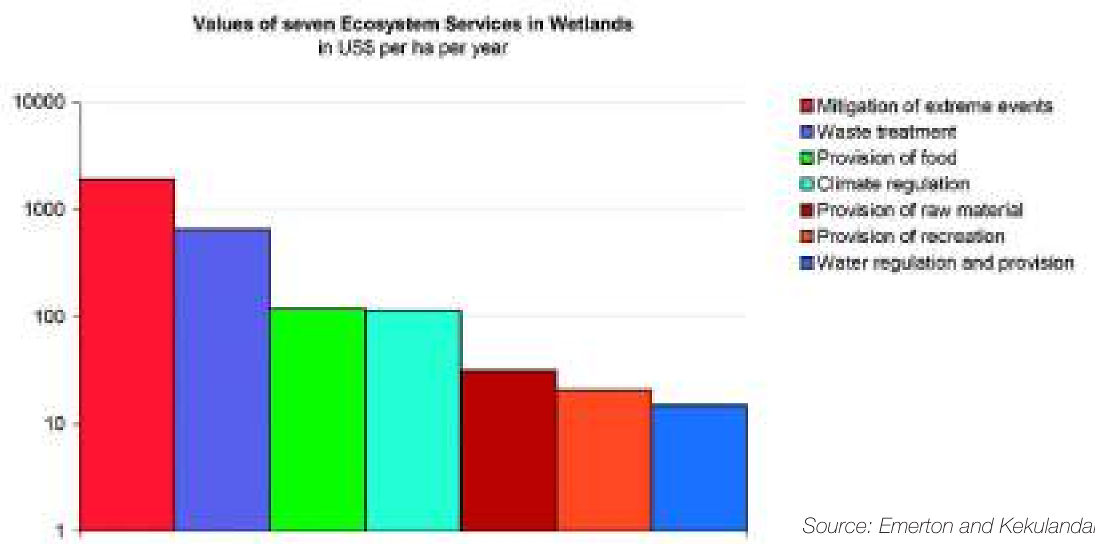
Many ecosystem service values, especially those relating to local benefits, are context specific. This reflects the natural environment's sheer diversity and the fact that economic values are not a natural property of ecosystems but are integrally linked to the number of beneficiaries and the socio-economic context. The role of a coastal buffer zone to protect against extreme weather events can be vital or marginal, depending where you live. Water regulation is a lifeline in certain conditions, a useful back-up in others. Tourism is a major source of income in some areas, irrelevant in others, etc. This dependence on local conditions explains the variability of the values and implies that in general, the value of a service measured in one location can only be extrapolated to similar sites and contexts if suitable adjustments are made.

However, for practical reasons, making use of existing value estimates through benefit (or value) transfer can be a useful approach. Undertaking new valuation studies can be expensive and time-consuming, making it impractical in some policy settings. Through benefit transfer the lack of specific information can be overcome in a relatively inexpensive and quick way. It requires assessing the quality of the primary valuation studies and carefully analysing the similarities and differences in the conditions of the original estimate and those where the valuation is applied. The use of benefit transfer is growing and can benefit from the abundant research carried out in recent years to refine the methods, although large-scale generalisations remain challenging (cf. D1 Chapter 4 and TEEB D0, Chapter 5).

Loss of biodiversity or degradation of an ecosystem often does not translate directly or immediately into loss of services. Ecosystems can be resilient up to a point, and then start a rapid decline. Detecting how close an ecosystem is to thresholds can be highly material to economic analysis (see Box 10.3 and TEEB Climate Issues Update 2009). The value of biodiversity and ecosystems also relates to their capacity to maintain services over time in the face of changing environmental conditions and disturbances. This is what we mean by 'insurance value' (see TEEB D0, Chapter 5), closely related to ecosystem resilience. There is increasing scientific evidence that biodiversity plays an important role in underpinning the resilience of ecosystems, and that securing resilience involves maintaining minimum ecological assets (see TEEB D0, Chapter 2). In daily practice, insurance values are difficult to measure, justifying a precautionary approach to ecosystem and biodiversity conservation.

Box 10.1: Estimated values for a range of services in wetlands and forests

Muthurajawela Marsh is a coastal wetland in a densely populated area in North Sri Lanka. A broad assessment of its benefits was provided using different valuation methods (Emerton and Kekulandala 2003) to estimate the economic significance of conserving the wetland which is under growing pressure from industrial and urban development. Several provisioning services (agriculture, fishing and firewood) directly contribute to local incomes (total value: US$ 150 per hectare and per year) but the most substantial benefits, which accrue to a wider group of the population and to economic actors, are related to flood attenuation (US$ 1,907) and industrial and domestic wastewater treatment (US$ 654). It should be noted that the value of carbon sequestration, in this case like in most existing valuation studies, was estimated using conservative assumptions (a damage cost of US$ 10 per tonne of carbon). Rapid progress in research on climate change over recent years now leads to substantially higher estimates of the value of this service.



Source: Emerton and Kekulandala 2003

Among the multiple services provided by tropical forests, the pollination service supplied to agriculture has a particular status as it is generated even by small patches of natural forest in human-dominated agricultural landscapes and it can be locally important. Based on ecological experiments in Costa Rica, Ricketts et al. (2004) found that the presence of forest-based wild pollinators increased coffee yields by 20% and improved its quality for farms located close to the forest (less than one km). The economic value of this service was estimated at around US$ 395 per hectare of forest per year, or 7% of farm income. This value is of the same order of magnitude as those of cattle and sugar cane production, the major competing land uses in the area – without taking into account the other important services provided by forests such as carbon sequestration.

Decisions are often based on the value and utility of only one or a few ecosystem services (e.g. wood provision for a forest) and on what can be done with the land later on (e.g. after deforestation). There is rarely any assessment of the value of wider ecosystem services – not only carbon sequestration and storage that now has such a high profile but also soil erosion control, water purification, maintenance of genetic diversity (for crops, medicines) and air pollution control, to name but a few. The reality is that such services can have high value. Ignoring this dimension can mean taking decisions with only part of the story told.

Box 10.2: Collecting and synthesising evidence on the values of ecosystem services

The TEEB D0 report (2009) is analysing a large number of economic values that have been estimated for the main types of ecosystem services around the world, making use of existing databases and the valuation literature. It aims to provide a synthetic picture of values for different services in different regions and socio-economic conditions (population density, income level) to provide an information pool for future assessments. This data collection and analysis places the values in their context, this facilitates their interpretation and use, notably through benefit transfer.

Over 1,100 values have been collected so far, covering 10 biomes and 22 ecosystem services. These are being organised based on geographical and socio-economic criteria. Work is still ongoing and will be completed in 2010.

Source: TEEB D0, Chapter 7

Finally, it should be stressed that economic valuation has its limits and can ever only be one input into the decision process. Estimated values of non-market goods and services remain approximations and despite the substantial progress made, no method is perfect. Besides, economic value is not an adequate measure of how important a service may be to human survival. Nevertheless, monetary values are highly attractive because they allow for comparisons with financial costs on the basis of a single currency or on a like-for-like basis. This reduces the potential for bias and the risk of overlooking real environmental costs in decisions affecting, for example, land use. Even incomplete valuation not covering the full range of ecosystem services can provide useful information for decision makers when compared with the benefits from conversion.

10.1.2 MARKETS LIMITATIONS AND THE ROLE OF PUBLIC POLICIES

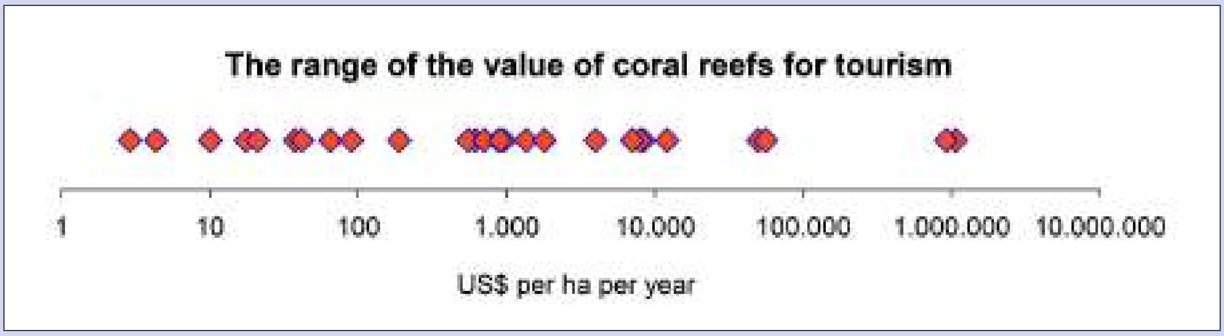
Markets fail to capture most ecosystem service values. Existing price signals only reflect – at best – the share of total value that relates to provisioning services like food, fuel or water and their prices may be distorted. Even these services often bypass markets where carried out as part of community management of shared resources. The values of other ecosystem services are generally not reflected in markets apart from a few exceptions (such as tourism).

This is mainly explained by the fact that many ecosystem services are **'public goods'** or 'common goods': they are often open access in character and non-rival in their consumption. In addition, their benefits are felt differently by people in different places and over different timescales. Private and public decisions affecting biodiversity rarely consider benefits beyond the immediate geographical area (e.g. from watershed protection). They can also overlook local public benefits (e.g. provision of food and fuel) in favour of private benefits (e.g. from commercial timber extraction), even when local livelihoods are at stake, or focus on short-term gains to the detriment of the sustained supply of benefits over time (e.g. in the case of fisheries). Benefits that are felt with a long-term horizon (e.g. from climate regulation) are frequently ignored. This **systematic under-valuation of ecosystem services** and failure to capture the values is one of the main causes underlying today's biodiversity crisis. Values that are not overtly part of a financial equation are too often ignored.

Public policies therefore have an essential role to play in ensuring that the main types of benefits are identified and taken into account in decisions – to avoid grossly underestimating the overall value of conserving or sustainably using biodiversity and ecosystem services, and to recognise their particular importance to the poor who most depend upon them. Public policies need to make markets work better, by integrating ecosystem service values where possible into price signals, and to put adequate institutions, regulations and financing in place.

Box 10.3: The plight of coral reefs – and the cost of exceeding nature's tipping point

Coral reefs are now understood to have a critical range of ecosystem service values – for natural hazard management (up to 189,000 US$/hectare/year), tourism (up to 1 million US$/hectare/year), genetic materials and bio-prospecting (up to 57,000 US$/ha/year), fisheries (up to 3,818 US$/ha/year). These benefits are site-specific – so a global loss of coral reefs will impact communities differently. Lost benefits will be lowest in places with few people, poor ecosystem quality or limited accessibility – but dramatic for island and coastal communities where fish protein can make up half the protein intake as well as for jobs and local economic development in areas dependent on tourism. There is a large variability in the values, particularly for tourism, which can be a major source of income in some areas and irrelevant in others. The lowest values generally correspond to sites with limited accessibility or facilities for tourism, while the very high values relate to international tourism hotspots.



Over 20% of coral reefs are already seriously degraded or under imminent risk of collapse (MA 2005). Human activities are the cause, including coastal development, destructive fishing practices, over-fishing and pollution. In the decades ahead, recent research suggests that global warming and ocean acidification may exacerbate these effects and cause widespread losses (50% to 100%). The long-term survival of coral reefs would depend on major reductions in CO_2 emissions together with a reduction in local pressures (see TEEB Climate Issues Update 2009).

Source: All economic values are preliminary estimates from TEEB D0, Chapter 7

10.1.3 RECOGNISING ECOSYSTEM SERVICE VALUES CONTRIBUTES TO BETTER DECISIONS

Decision-makers with access to information on ecosystem service values are better placed to make more efficient, cost-effective and fair choices and to justify their reasons for taking action or for choosing between options. This is a positive step towards greater transparency in handling policy trade-offs.

Identification and measurement of such values has begun to feed into the policy process and, to a lesser extent, into price signals (see Boxes 10.4 to 10.6). This can reveal opportunities for cost savings through timely or targeted action. For example, valuation can help determine where ecosystem services could be provided at lower cost than man-made alternatives e.g. for water purification/ provision, carbon storage or flood control (see Box 10.5 and Chapter 9).

Valuing ecosystem services and comparing the benefits associated with conservation of natural areas with the benefits from conversion can provide useful information for setting priorities in a variety of contexts, such as development decisions in urban areas (see Box 6) and conservation planning at the national or local scale.

Making values explicit can help build support for new instruments to change the decision equation facing landowners, investors and other users of natural resources. Appropriate tools can take many forms including payments for ecosystem services, subsidy reform, pollution taxes, resource charges and entry fees for national parks (see Chapters 5-8 for detailed examples).

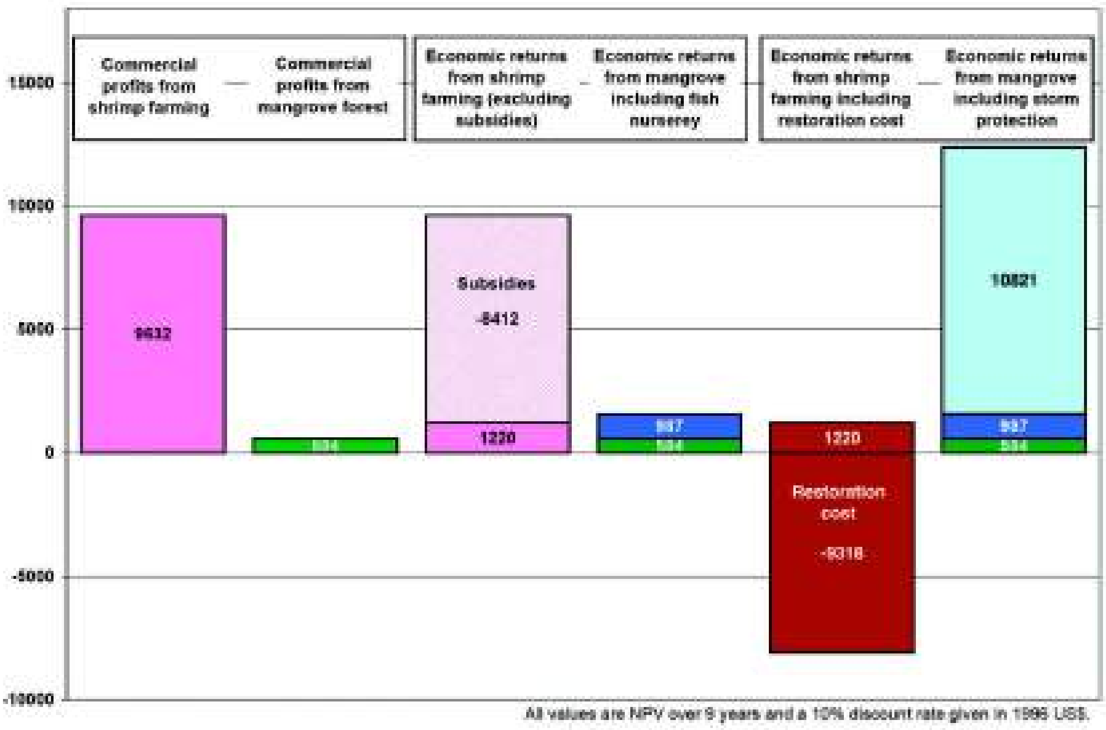
Valuation is also increasingly used to inform impact assessments of proposed legislation and policies. Examples include the EU Water Framework Directive and the UK's up-coming marine legislation which provides for Marine Conservation Zones because of the ecosystem benefits they supply (see Chapter 4). Valuation tools are also useful for assessing damage to natural resources to set compensation e.g. by the courts under formal liability regimes in the US, India and the EU (see Box 10.7 and Chapter 7).

Despite some successful examples, the **potential for using valuation to inform policy making is still largely unrealised**. For most countries, the first step is to put appropriate assessment procedures in place for identification and understanding of the impacts of losses.

Box 10.4: The conversion choice: economics, private interest and public interest

Looking at the full range of costs and benefits can show whether land conversion makes economic sense. A study in Southern Thailand (Barbier 2007) on conversion of mangroves into commercial shrimp farms showed net private economic returns estimated at US$ 1,220 per ha per year (10% discount rate), taking account of available subsidies. This return does not integrate rehabilitation costs (US$ 9,318 /ha) when the pond is abandoned after 5 years of exploitation. The conversion decision is clearly an easy one for those making the private gain but the conclusion changes if the main costs and benefits to society are included. Estimated benefits provided by mangroves, mostly to local communities, were around US$ 584/ha for collected wood and non-wood forest products, US$ 987/ha for providing nursery for off-shore fisheries and US$ 10,821/ha for coastal protection against storms, totalling US$ 12,392/ha (even without considering other services like carbon sequestration) – an order of magnitude larger than the benefits of converting the mangroves to shrimp farming (see figure below). Only through appropriate policy responses (e.g. clear property rights, permit systems, removal of any perverse subsidies that encourage conversion, compensation mechanisms) can such unbalanced trade-offs be avoided.

Comparison of land use values per ha, Southern Thailand



Source: Hanley and Barbier 2009

Box 10.5: Valuing the benefits of water provision in New Zealand

The Te Papanui Conservation Park in New Zealand's Lammermoor Range provides the Otago region with water for free that would cost NZ$ 136 million to bring in from elsewhere. The 22,000 hectares tussock grass area acts as a natural water catchment, supplying water flows valued at NZ$ 31 million for hydroelectricity, NZ$ 93 million for urban water supply and NZ$ 12 million for irrigating 60,000 hectares of Taieri farmland. The total benefit is equivalent to the cost that would have to be paid to get the water currently provided free of charge from somewhere else.

Source: New Zealand Department of Conservation 2006

Box 10.6: Assessing the benefits of not converting a floodplain in Delhi

Around 3,250 ha of floodplain between the Yamuna River and the landmass in Delhi offer benefits such as provision of water, fodder and other materials, fisheries, and recreation. Faced with pressures to convert the floodplain into areas suitable for habitation and industry, the decision makers, even though acknowledging the ecological role of the floodplain, were not able to establish sufficient justification for conserving it without economic valuation of the ecosystem services to enable a cost-benefit analysis of conversion. Value estimates for a range of services totalled US$ 843/ha/year (2007 prices) (Kumar 2001). The embankment of the Yamuna would virtually dry the floodplain, causing disappearance of these services. These ecosystem benefits exceeded the opportunity costs of conservation (estimated from the land price, assumed to reflect the discounted value of 'development' benefits) for a range of discount rates from 2 percent to 12 percent, justifying the maintenance of the floodplain. The Delhi Government halted the embankment plan of Yamuna until further order.

Source: Kumar et al. 2001

Box 10.7: Using valuation to assess levels of compensation and steer policy

Valuation has a long history in influencing policy. As long ago as 1989, the Exxon Valdez oil spill:

- accelerated the development and use of new methodologies to estimate the value of biodiversity and ecosystem services;
- spurred the introduction of policy responses consistent with the polluter pays principle, including compensation payments based on the value of the ecosystem services compromised;
- based on economic analysis, led to mandatory rules for double-hull shipbuilding – 79% of all oil tankers now criss-crossing the globe are of double-hull design.

In 2006, the Indian Supreme Court drew up a scale of compensatory payments for converting different types of forested land to other use. The Court based the rates on a valuation study by the Green Indian States Trust (GIST 2006) which estimated values (e.g. timber, fuel wood, non-timber forest products and ecotourism, bio-prospecting, forest ecological services, non-use values for conserving charismatic species e.g. Royal Bengal tiger and Asian lion) for 6 classes of forests. Compensatory payments are paid by those who obtain permits to convert forest to other uses into a publicly managed Afforestation Fund to improve the country's forest cover. In 2009, the Supreme Court's decisions directed Rs.10 billion (~143 million EUR) to be released every year for afforestation, wildlife conservation and the creation of rural jobs.

Source: GIST 2006

10.2 MEASURING TO MANAGE OUR NATURAL CAPITAL

Developing our capacity to measure and monitor biodiversity, ecosystems and the provision of services is an essential step towards better management of our natural capital. Providing relevant information in ways accessible to decision-makers will require not only a wider use of valuation but also progress on indicators of biodiversity and ecosystem services and on the integration of natural capital into macro-economic indicators and accounts.

We do not measure the state of natural capital nearly as well as we measure the state of man-made capital and flows of economic services nor do we monitor and report on it as frequently. Yet biological resources are a stock of capital in their own right – and one that generates important inputs to the economy, brings benefits to people and contributes to social well-being. Proper measurement is integrally linked to good management.

10.2.1 BETTER MEASUREMENT OF BIODIVERSITY AND ECOSYSTEM SERVICES

Indicators are particularly useful for policy makers as they can indicate the state of resources and trends in the pressures affecting these resources, thus enabling policy makers to identify the policies needed to better manage them. The first area for improvement concerns tools to better assess biodiversity trends and changes in the capacity of ecosystems to deliver services. This report examines a number of available indicators and presents ways in which measurement can be improved and information can be used (see Chapter 3 of this report and also TEEB D0, Chapter 3).

There are still large gaps in available information, even though the importance of measuring and monitoring biodiversity has long been recognised and strenuous efforts made to collect data. In many parts of the world and for most taxa groups, biodiversity monitoring is still not sufficient or data are too heterogeneous to reliably develop baselines from which to set indicators and targets. We need to elaborate headline indicators to present a synthetic picture and measure progress towards objectives. The first priority is to address the status of species and population trends, the extent and condition of ecosystems and the provision of ecosystem services, with further development and expansion on an ongoing basis. This will also require a major effort in terms of monitoring.

From the economic perspective, the most important gaps to be filled relate to the measurement of ecosystem services and of the ecological condition of the ecosystems that provide them. These gaps are serious weaknesses because degradation can go unnoticed until it triggers substantial disruption of ecosystem functioning, which has knock-on effects for the provision of human benefits. It is true that ecosystem service indicators have received far more attention since the Millennium Ecosystem Assessment (MA 2005) but very few widely-accepted indicators are available yet to measure regulating, cultural and supporting services.

As the establishment of a standardised system to measure ecosystem condition would be time-consuming, one possible solution would be to establish a global framework identifying a set of key attributes, and then monitor these building on national indicators.

In the short term, all available indicators should be used – despite the recognised need to strengthen the knowledge base and boost research efforts – to support better assessment of trade-offs between ecosystem services and the sustainability of use.

10.2.2 BETTER LINKS TO MACRO-ECONOMIC AND SOCIETAL INDICATORS AND NATIONAL ACCOUNTS

Most services provided by the natural environment to human society are not captured by GDP or other conventional macro-economic indicators because, as noted above, they are not directly traded in markets. However, in no way does this lessen the need to treat them as economic assets, given their vital contribution to long-term economic performance.

Taking tropical forests as an example, the marketplace currently ignores a whole series of ecosystem services they provide (e.g. regulation of local and regional climate and freshwater flows, carbon storage, preservation of soil cover, provision of habitat for plants and animals, downstream flood protection). Without prices, these services go unmeasured in conventional accounting procedures such as the universal System of Standard National Accounts (SNA).

SNA has major limitations when it comes to measuring natural capital. It recognises depreciation for man-made capital assets but not the 'wear and tear' of ecological assets which is just as real. This gap is one of the main reasons why natural capital losses remain largely hidden from policy makers and from the corrective power of public scrutiny.

This problem has not gone unnoticed. **A System of Economic Environmental Accounting** (SEEA) has been developed, covering land, water, environmental expenditures and social issues in monetary and physical terms, and adopted by some countries. However, an upgrade of the UN SEEA manual (2003) is urgently needed to catalyse progress on measurement and incorporate ecosystem services into national accounts. This should prioritise physical accounts for forest carbon stocks to reflect the emerging 'green carbon' regime (REDD or REDD-Plus, see 10.3 below) but also support the gradual and full inclusion of other forms of natural capital and ecosystem services.

A possible way forward would be to develop simplified natural capital accounts, annually updated to assess losses and gains in the ecological potential of ecosystems in terms of physical units and estimate the economic costs of maintaining or restoring this capital (e.g. natural capital consumption or formation). These accounts could then be integrated with conventional national accounts, using natural capital consumption as a possible adjustment factor for macro-economic aggregates such as national income. More detailed ecosystem accounts, relying on economic valuation of ecosystem service flows, would obviously be useful for specific evaluation and policy purposes. However, their development presents substantial challenges and full integration with national economic accounts may therefore be a longer term prospect.

The need to move beyond GDP indicators to measure sustainability and human well-being is now increasingly recognised. Ways to achieve this range from complementing traditional macro-economic aggregates with adapted indicators to promoting more fundamental reform of economic and societal progress reports to embed sustainability principles. Integrating the contribution of ecosystems to human well-being through national accounts could form a core element of this effort.

Concrete progress could be made by developing a set of indicators based on the concept of inclusive ('extended') wealth, involving regular measurement of per-capita physical, natural, human and social capital. This idea is not new, and has been developed notably in the World Bank's adjusted net savings index (Hamilton and Clemens 1999) and in the genuine investment indicator (Dasgupta 2001). Recent work such as the report of the Stiglitz-Sen-Fitoussi Commission to President Sarkozy and ongoing activities under the EU's 'Beyond GDP' initiative (CEC 2009) points in the same direction.

These new approaches to measurement give rise to new terms and concepts. A well-known example is the 'ecological footprint'. This is sometimes criticised as reflecting an inherently anti-trade bias as it focuses on ecological deficits or surpluses at a national level. However, in a context of increasing global scarcity of natural assets, it can nevertheless be considered a useful tool to inform policy-making as well as for education and public awareness.

10.2.3 THE NEED FOR BETTER INFORMED MANAGEMENT OF NATURAL CAPITAL

Not having or not using information on biodiversity, ecosystem services, and their value can compromise effective and efficient management of natural capital. Economic growth could be increasingly compromised by the continued reduction of natural capital (see TEEB D0, Chapter 6). There is also growing evidence of the risks of reaching 'tipping points' in ecosystem functioning, leading to large and rapid changes that may trigger negative regional or global impacts on the provision of food, water and regulating services. Tools to identify and locate our most valuable natural assets and evaluate the risks of losing them are essential for efficient targeting of protection and investment efforts.

Alerting for problems and taking early action depends on indicators and monitoring that establish the existence of a problem and issue an alert. Normally it is much easier and cheaper to address environmental problems early on rather than intervening once damage is widespread. Rapid response to invasive alien species is a prime example (see Box 10.8): prevention often costs a fraction of subsequent damage and control costs to protect natural assets (crops, forests) or terrestrial and water-based infrastructure.

Box 10.8: Cost savings linked to early action: the example of invasive alien species

In the Mediterranean, failure to respond rapidly to detection of Caulerpa taxifolia in 1984 (coverage $1m^2$) enabled the marine algae to proliferate (31 hectares by 1991, 12,140 hectares by 2001 across Spain, France, Italy, Croatia and Tunisia) with negative impacts on native phytobenthos species and tourism, commercial and sport fishing and recreational activities like diving. Eradication is no longer feasible. A Mediterranean network has been set up to coordinate efforts to restrict expansion of range.

In California (USA), an infestation of the same species was detected in 2000. Based on prior contingency planning that took the Mediterranean impacts into account, eradication started 17 days later. A coordination group was created (Southern California Caulerpa Action Team), comprised of representatives of the national Marine Fisheries service, regional water quality control board, electrical supply company and the Departments of Fish and Game and of Agriculture. Full eradication was successful and cost 2.5 million EUR (Anderson 2005).

Source: Shine et al. 2009

Strengthening biodiversity assessment capacity to better feed science into policy-making can help us identify, evaluate and manage future risks. The establishment of an Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) would be an important step forward. Building on the IPCC's success in developing strong consensus by validating the scientific evidence on climate change and catalysing the global response, the IPBES initiative could start to fill up the knowledge gaps, provide scientific support and improve the credibility, robustness and durability of future response strategies.

Governments should be encouraged to carry out national assessments to estimate the value of their own natural capital (see e.g. UK NEA (2009)). This report includes a review of valuation methodologies, measurement approaches and indicators (see also TEEB D0) and shows how integrated assessments need to analyse interconnections between natural capital, its benefits and the economic sectors concerned. Capacity building for this purpose is critical, particularly for biodiversity-rich countries, and will require international support.

Lastly, we should never forget that the value of natural capital calculated today – i.e. what current techniques enable us to understand and measure – is only a fraction of its possible worth.

10.3 REASONS TO INVEST IN NATURAL CAPITAL

Investing in natural capital supports a wide range of economic sectors and maintains and expands our options for economic growth and sustainable development. Such investments can be a cost-effective response to the climate change crisis, offer value for money, support local economies, create jobs and maintain ecosystem benefits for the long term.

Many more economic sectors than we realise depend on natural capital. We can all appreciate the importance of healthy biodiversity and ecosystems for primary production like agriculture, forestry and fisheries. Yet natural capital also contributes significantly to manufacturing and the service economy. Biodiversity also protects against natural hazards and addresses risks to food security and health. Table 10.1 gives examples for market sectors dependent on genetic resources. We have not yet identified – let alone utilised – the full range of ecosystems services potentially available.

It is possible to better manage our natural capital. Today we observe a lot of inefficiencies that result from barriers such as: decision-making that takes place around the narrow concept of GDP; poor awareness of the value of ecosystem services; weak legal framework; private benefits that rarely match up with public needs; and poor governance. Tackling these barriers should automatically lead to better returns, as the evidence from case studies throughout the report shows. Better management leads to better financial returns that can be relied on over time.

10.3.1 INVESTMENT FOR CLIMATE CHANGE MITIGATION AND ADAPTATION

'Green carbon' policies (see Box 10.9) **to halt deforestation can be a more cost-effective way to mitigate climate change impacts than alternative options, such as carbon capture and storage.** Forests contain a stock of 547 Gt of carbon (Trumper et al. 2009) and may sequester up to 4.8 Gt of carbon per year in addition (Lewis and White 2009). Emissions from deforestation are substantial and studies suggest that they can be avoided at relatively low cost (Eliasch 2008), potentially reducing carbon prices by up to 40% (OECD 2009).

Table 10.1: Market sectors dependent on genetic resources

Sector	Size of Market	Comment
Pharmaceutical	US$ 640 bn. (2006)	25-50% derived from genetic resources
Biotechnology	US$ 70 bn. (2006) from public companies alone	Many products derived from genetic resources (enzymes, microorganisms)
Agricultural Seeds	US$ 30 bn. (2006)	All derived from genetic resources
Personal Care, Botanical and Food & Beverage Industries	US$ 22 bn. (2006) for herbal supplements US$ 12 bn. (2006) for personal care US$ 31 bn. (2006) for food products	Some products derived from genetic resources. Represents 'natural' component of the market.

Source: SCBD 2008

Box 10.9: The 'colours of carbon'

- **'Brown carbon'**: industrial emissions of greenhouse gases that affect the climate.
- **'Green carbon'**: carbon stored in terrestrial ecosystems e.g. plant biomass, soils, wetlands and pasture and increasingly recognised as a key item for negotiation in the UNFCCC (in relation to forest carbon and mechanisms such as REDD, REDD-Plus, or LULUCF).
- **'Blue carbon'**: carbon bound in the world's oceans. An estimated 55% of all carbon in living organisms is stored in mangroves, marshes, sea grasses, coral reefs and macro-algae.
- **'Black carbon'**: formed through incomplete combustion of fuels and may be significantly reduced if clean burning technologies are employed.

Past mitigation efforts concentrated on **brown carbon**, sometimes leading to land conversion for biofuel production which inadvertently increased emissions from **green carbon**. By halting the loss of **green** and **blue carbon**, the world could mitigate as much as 25% of total greenhouse gas (GHG) emissions with co-benefits for biodiversity, food security and livelihoods (IPCC 2007, Nellemann et al. 2009). This will only be possible if mitigation efforts accommodate all four carbon colours.

Source: TEEB Climate Issues Update 2009:14; Nellemann et al. 2009

Reaching an international agreement on an instrument to Reduce Emissions from Deforestation and forest Degradation (REDD) – with emphasis on a REDD-Plus variant that can further incorporate conservation, sustainable management of forests and enhancement of carbon stocks – would properly reward the global carbon sequestration and storage services, as well as help to maintain other valuable services provided by forests. Given the considerable amounts of emission reduction needed, not acting to halt deforestation is not an option; forests are part of the solution for the climate change crisis. Expanding REDD to REDD-Plus can increase the mitigation potential (Zarin et al. 2009), not least because of the restoration potential of degraded forests: REDD would only halt further degradation – not incentivise restoration. Forest protection and restoration also generate a whole range of co-benefits which – if valued explicitly – improve the cost-effectiveness ratio of forest carbon investments (Paterson et al. 2008; Galatowitsch 2009).

A REDD-Plus instrument could create a revenue stream attractive to national and regional governments, cost-effective for industrial polluters seeking options to meet their emission reduction targets and potentially beneficial to local communities and the rural poor (see Chapter 5). The approach could be further extended to cover similar services provided by soils, peatlands and other ecosystems to fully address greenhouse gasses emissions from land use changes.

We also need to prepare for the climate change that will happen despite mitigation policies. This will require much more **investment in adaptation** than is currently planned (Parry et al. 2009; TEEB-CIU 2009). A cost-effective part of an adaptation strategy will be based on broader investments in ecological infrastructure (see below): protecting against natural hazards helps to decrease society's vulnerability and cushion the impacts of global warming. Policy-makers need to develop strategies that recognise these risks

Box 10.10: REDD (Reducing Emissions from Deforestation and Forest Degradation)

The proposed REDD instrument is based on payment for carbon storage ecosystem services and could lead to an estimated halving of deforestation rates by 2030, cutting emissions by 1.5-2.7 Gt CO_2 per year. The estimated costs range from US$ 17.2 billion to US$ 33 billion/year whilst the estimated long-term net benefit of this action in terms of reduced climate change is estimated at US$ 3.7 trillion in present value terms (Eliasch 2008). Delaying action on REDD would reduce its benefits dramatically: waiting 10 more years could reduce the net benefit of halving deforestation by US$ 500 billion (see Chapter 5).

Sources: Eliasch 2008; McKinsey 2008

Box 10.11: Value for money: natural solutions for water filtration and treatment

Cities like Rio de Janeiro, Johannesburg, Tokyo, Melbourne, New York and Jakarta all rely on protected areas to provide residents with drinking water. They are not alone – a third of the world's hundred largest cities draw a substantial proportion of their drinking water from forest protected areas (Dudley and Stolton 2003). Forests, wetlands and protected areas with dedicated management actions often provide clean water at a much lower cost than man-made substitutes like water treatment plants:

- in **New York**, payments to maintain water purification services in the Catskills watershed (US$ 1-1.5 billion) were assessed at significantly less than the estimated cost of a filtration plant (US$ 6-8 billion plus US$ 300-500 million/year operating costs). Taxpayers' water bills went up by 9% instead of doubling (Perrot-Maitre and Davis 2001).
- **Venezuela**: the national protected area system prevents sedimentation that if left unattended could reduce farm earnings by around US$ 3.5 million/year (Pabon-Zamora et al. 2008).

See further Chapters 8 and 9

as well as the value for money and additional co-benefits generated by these alternative investment approaches.

10.3.2 INVESTMENT IN ECOLOGICAL INFRASTRUCTURE

Ecological infrastructure refers to nature's capacity to provide freshwater, climate regulation, soil formation, erosion control and natural risk management, amongst other services. **Maintaining nature's capacity to fulfil these functions** is often cheaper than having to replace lost functions by investing in alternative heavy infrastructure and technological solutions (see examples in Box 10.11). The benefits of ecological infrastructure are particularly obvious with regard to provision of **water purification and waste water treatment**. However, despite some impressive exceptions, these kinds of values are often understood only after natural services have been degraded or lost – when public utilities face the bill for providing substitutes.

Risks of natural hazards are predicted to increase with climate change and have significant impacts in some parts of the world. Coastal realignment, storms, flooding, fires, drought and biological invasions could all significantly disrupt economic activity and society's well-being. Natural hazard control can be provided by forests and wetlands (e.g. flood control) and on the coast by mangroves or coral reefs (e.g. reducing impacts from storms and tsunamis) (see Box 10.12).

Ecological infrastructure investments can be justified on the basis of one valuable service but they become even more attractive when the full bundle of services provided by a healthy ecosystem is taken into account (see section 10.1). This strengthens the case for integrated approaches to valuation and assessment: considering possible investments from a single-sector perspective may overlook supplementary key benefits.

Box 10.12: Restoring and protecting mangroves in Vietnam

Potential damage from storms, coastal and inland flooding and landslides can be considerably reduced by a combination of careful land use planning and maintaining/restoring ecosystems to enhance buffering capacity. Planting and protecting nearly 12,000 hectares of mangroves cost US$ 1.1 million but saved annual expenditures on dyke maintenance of US$ 7.3 million.

Source: Tallis et al. 2008: see further Chapter 9

The spatial dimension of ecological infrastructure – beyond site boundaries to the web of connected ecosystems – needs consideration for similar reasons. When deciding on management actions and investment in a river system, for example, it is essential for coherent management of the river as a whole to look both upstream to the source and downstream to the wetland or delta created. The decision maker needs to take on board that actions benefiting people downstream have to be implemented upstream. This calls for consistent land use planning and collaboration between countries, communities and people throughout the river basin.

10.3.3 INVESTMENT IN PROTECTED AREAS

Protected areas are a cornerstone of conservation policies and provide multiple benefits. There are over 120,000 designated protected areas covering around 13.9% of the Earth's land surface. Marine protected areas cover 5.9% of territorial seas but only 0.5% of the high seas (Coad et al. 2009).

People often focus on the global benefits that a global network of protected areas brings but there are also significant local benefits, ranging from provisioning to cultural services and existence values. There is a **strong socio-economic case for managing these protected areas properly**. Over one billion people – a sixth of the world's population – depend on protected areas for a significant percentage of their livelihoods, whether it be food, fuel or support to economic activity (UN Millennium Project 2005). Partly because of this, investing in the proper functioning of protected areas and ensuring that a range of ecosystem services is maintained can offer significant returns (see Box 10.13).

Protected areas provide benefits of various natures at all levels: locally, nationally and globally (see Table 10.2). Whereas their global benefits far outweigh global costs, the position may be different closer to the ground because costs of protected areas are primarily met at local and national levels and can exceed local benefits (see Chapter 8). Where there is no compensation for the opportunity costs and/or funding mechanism for the management costs of protected areas, associated costs mainly occur at site level.

Once the full range of provided ecosystem services is taken into account, protected area benefits often exceed costs. These potential returns are demonstrated by case studies. Findings from quite diverse approaches and sources agree that benefits from conservation far outweigh benefits from converting wild or extensively used habitats into intensively used agricultural or silvicultural landscapes (see Figure 2 below).

Box 10.13: How protected areas can generate benefits: selected examples

In the **Brazilian Amazon**, ecosystem services from protected areas provide national and local benefits worth over 50% more than the returns to smallholder farming (Portela 2001). They draw three times more money into the state economy than would extensive cattle ranching; the most likely alternative use for park lands (Amend et al. 2007).

In **Cambodia's Ream National Park**, effective protection is estimated to generate benefits from sustainable resource use, recreation and research worth 20% more than the benefits from current destructive use. The distribution of costs and benefits additionally favours local villagers, who would earn three times more under a scenario of effective protection than without management (De Lopez 2003).

In **Scotland**, the public benefits of protecting the European network of protected areas, the so-called Natura 2000 network, are estimated to be more than three times greater than costs, including direct management and opportunity costs (Jacobs 2004).

Table 10.2: Examples of protected area benefits and costs at different levels

	Benefits	Costs
Global	- Dispersed ecosystem services (e.g., climate change mitigation and adaptation) - Nature-based tourism - Global cultural, existence and option values	- Protected area management (global transfers to developing countries) - Alternative development programs (global transfers to developing countries)
National or Regional	- Dispersed ecosystem services (e.g., clean water for urban centres, agriculture or hydroelectric power) - Nature-based tourism - National cultural values	- Land purchase - Protected area management (in national protected area systems) - Compensation for foregone activities - Opportunity costs of forgone tax revenue
Local	- Consumptive resource uses - Local ecosystem services (e.g., pollination, disease control, natural hazard mitigation) - Local cultural and spiritual values	- Restricted access to resources - Displacement - Opportunity costs of foregone economic activities and management costs - Human wildlife conflict

Source: Chapter 8, Table 8.1

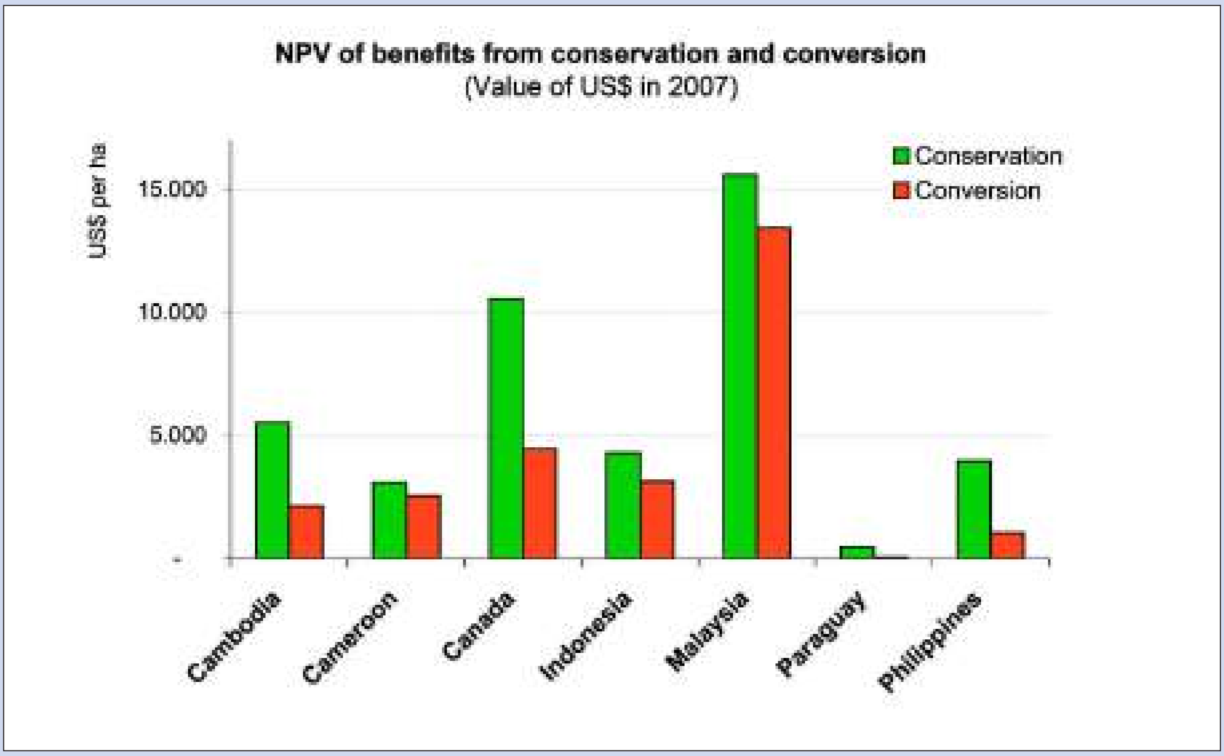
This result comes with a word of caution: in each case study, it reflects the present situation with regard to the relative scarcity of protected areas as compared to the abundance of agricultural, pasture and forest land for production of needed commodities. But if the balance shifts (and shifts are manifested at local level) the relative value of the protected areas shifts too as a consequence of changing opportunity costs. This does not mean of course that past conversion has generally not been economically beneficial; it suggests that there are currently large opportunities to invest in protected areas. It is important to note the large spatial variations in both benefits and costs, which calls for more analysis to help in allocating conservation funding efficiently (Naidoo and Ricketts 2006).

Current expenditure on the global network of protected areas is estimated to be around US$ 6.5 to 10 billion/year (Gutman and Davidson 2007). However, many protected areas do not receive adequate funds to ensure their effective management. The total annual cost of managing the existing network effectively have been estimated to be around US$ 14 billion/year (James et al. 1999 and 2001). In developing countries investment is closer to 30% of needs (see Chapter 8). There are naturally major differences between countries.

The existing network is not yet complete as it still does not include a number of important areas, especially marine areas. The cost of investing in an 'ideal' global protected area network – if expanded to cover 15% of land and 30% of marine areas – could be up to US$ 45 billion per year (Balmford et al. 2002). This includes effective management, direct costs of acquiring new land and compensation for the opportunity costs of curtailing private use. Private opportunity costs probably represent the largest single element of this figure: these costs have been estimated at US$ 5 billion/year for current protected areas in developing countries and further expansion would increase opportunity costs to more than US$ 10 billion/year (James et al. 2001; Shaffer et al. 2002).

All the above estimates necessarily rely on various assumptions and generalisations. However, even if they are rough proxies, they clearly indicate the magnitude of the current funding gap and the bigger gap that would need to be filled in order to put an expanded and functioning network of protected areas in place. Even if figures need to be transferred from case to case with caution, there are well-documented and robust **reasons for governments to consider the economic case for conservation** of both terrestrial and marine protected areas (see Box 10.14).

Figure 10.2: Total benefits of conservation compared to benefits from conversion for seven case studies in different countries



Sources: Bann (1997), Yaron (2001), van Vuuren and Roy (1993), van Beukering et al. (2003), Kumari (1994), Naidoo and Ricketts (2006), and White et al. (2000), as reviewed by Balmford et al. (2002), Papageorgiou (2008) and Trivedi et al. (2008). 'Conservation' includes sustainable production of market goods and services including timber, fish, non-timber forest products, and tourism. 'Conversion' refers to replacement of the natural ecosystem with a system dedicated to agriculture, aquaculture, or timber production.

10.3.4 RESTORATION OF DEGRADED ECOSYSTEMS

Avoiding ecosystem loss in the first place is obviously the better option, but where it is already too late, well-targeted **restoration of natural capital can provide very high returns on investment** in certain contexts. Preliminary estimates presented in the TEEB Climate Issues Update (2009) suggested that the potential social returns of return can reach 40% for mangrove and woodland/shrublands, 50% for tropical forests and 79% for grasslands when the multiple ecosystem services provided are taken into account.

Despite the promising potential for high returns, ecological infrastructure projects require significant up-front investment. The costs vary widely, not only between ecosystem types but also according to the level of degradation, the level of ambition and the specific circumstances in which restoration is carried out. Evidence on costs collected in this report range from hundreds to thousands of Euros per hectare in grasslands, rangelands and forests, to several tens of thousands in inland waters, and even up to millions of dollars per hectare for coral reefs (see Chapter 9).

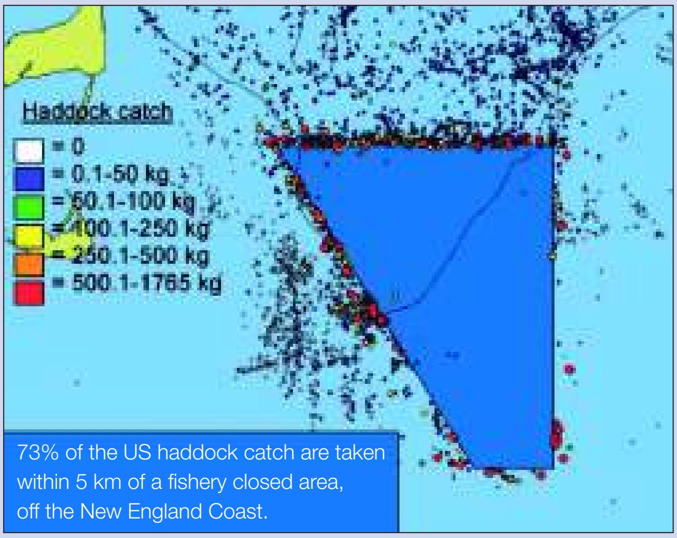
Another constraint is that the expected benefits, even when they are marketable (such as in the case of freshwater provision or waste treatment) can take time to materialise. Together with the high costs, this can put off private investment, meaning that **the role of governments and public budgets is critical**. Government support and coordination of stakeholders is particularly important for mega-sites of degradation with large-scale complex interactions and far-reaching

Box 10.14: The protective and productive potential of Marine Protected Areas

Despite the increasing threats to marine environments, progress in establishing marine protected areas (MPAs) has been slow: MPAs only cover a fraction (0.5%) of the high seas (Coad et al. 2009).

It has been estimated that conserving 20-30% of global oceans through a network of Marine Protected Areas could create a million jobs, sustain a marine fish catch worth US$70-80 billion/year (Balmford et al 2004). A review of 112 studies and 80 MPAs found that fish populations, size and biomass all dramatically increased inside reserves, allowing spillover to nearby fishing grounds (Halpern 2003). The figure presents the catch outside the borders of a no take zone for a protected area (not all MPAs have no take zones).

Naturally, the success of MPAs, both in conserving biodiversity and providing benefits to fishing, depends on their careful design and effective management. However well managed, the awaited recovery of fish populations may also often take time which means that the benefits of MPAs for fishing may only become apparent after a number of years. For example, eight years after the creation of the Mombasa Marine National Park, Kenya, fish catches in the vicinity of this MPA reached three times the level of catches further away (McClanahan and Mangi 2000).



Source: Fogarty and Botsford 2007

These benefits are often coupled with short-term local costs. St Lucia's Sufriere MPA has significantly increased fish stocks since its creation, providing a sustainable local benefit. However, this success required 35% of fishing grounds to be placed off limits which inflicted short-term costs on local fishermen in the form of reduced catch (Icran et al. 2005).

implications. The continuing efforts to restore the Aral Sea are a well-known and inspiring example of what can be achieved with great government commitment and institutional support (see Chapter 9).

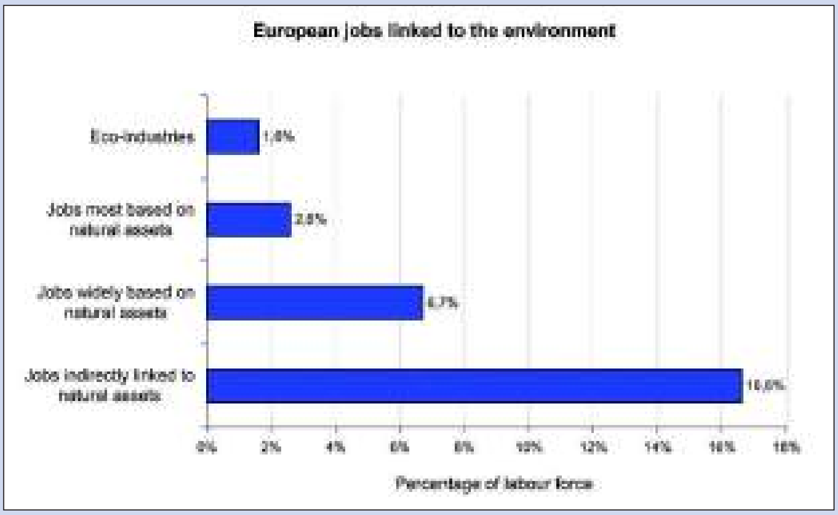
10.3.5 INVESTMENT IN ECOLOGICAL INFRASTRUCTURE SUPPORTS JOBS

Well-designed investments often lead to benefits for employment and social policy objectives: by supporting economic activity, ecosystems support jobs. Indeed, natural capital is often a relatively labour-intensive form of investment. This can be seen in the current statistics on jobs linked to the environment, which go way beyond 'eco-industries' and pollution management to include a variety of jobs depending directly on good quality environment as an input (see Boxes 10.15 and 10.16).

Box 10.15: European jobs linked to the environment

Based on a narrow definition limited to eco-industries and activities such as organic agriculture, sustainable forestry and 'green' forms of tourism, **around one in forty of those working in Europe are directly employed in jobs linked to the environment**. Using wider definitions of job sectoral allocation, such as 'all those working in agriculture', then one in ten European jobs depends to some extent on the environment. These jobs have multiplier effects, sustaining other jobs elsewhere in the economy e.g. through demand for materials and services. When including these effects, **around one European job in every six** is somehow dependent on the environment. In most developing countries, the link between ecosystems and jobs will be even stronger.

Source: GHK et al. 2007



Box 10.16: Job creation derived from biodiversity and ecosystems services

- **Ecotourism** is the fastest-growing area of the tourism industry (Mastny 2001). In 2004, this market grew three times faster than the industry as a whole and the World Tourism Organisation estimates that global spending on ecotourism is increasing by 20% a year, about six times the industry-wide rate of growth.
- **Nature-based recreation** is a very significant market. In the USA in 2006, private spending on wildlife-related recreational activities such as hunting, fishing and observing wildlife amounted to US$ 122 billion – just under 1% of GDP (US Fish and Wildlife Service 2007). As this sector requires maintenance of areas and nature in a high quality state for continued development, reinvestment of part of the ecotourism receipts in ecosystem protection is a good strategy.
- Economic activity in conservation lands within the West Coast Region of **New Zealand's** South Island led to an extra 1,814 jobs in 2004 (15% of total jobs), and extra spending in the region of US$ 221 million a year (10% of total spending), mainly from tourism (Butcher Partners 2004).
- In **Bolivia**, protected area tourism generates over 20,000 jobs, indirectly supporting over 100,000 people (Pabon-Zamora et al. 2009).
- In **South Africa**, the ecosystem restoration programme 'Working for Water' combined control of invasive alien species with rural economic and social development. The project treated 3,387 ha of land and created 91 person years of employment. Contracting costs up to 2001 were R 2.7 million, with an estimated total cost of R 4.9 million (including project management costs and all other transaction costs). The action prevented losses of between 1.1 and 1.6 million m^3 of water annually (Turpie et al. 2008).

See further Chapters 5, 8 and 9

10.4 IMPROVING THE DISTRIBUTION OF COSTS AND BENEFITS

By taking distributional issues into account when using and protecting natural capital, policy makers can simultaneously address social and environmental concerns. This involves making sure the right people pay – both locally and globally. It also means looking at property and use rights and potentially easing any transition pains.

Biodiversity is important for all but essential for the rural poor who often rely directly on local ecosystem services and biodiversity for their food, shelter, income, fuel, health, quality of life and community. Measurement based on the 'GDP of the poor' (see Chapter 3) captures the reliance of rural populations on nature and makes visible the social impacts of running down our natural capital. In Brazil, for example, the contribution of agriculture, forestry and fishing to GDP increased from 6% to 17% once the unrecorded goods and unaccounted services provided by forests were included in national accounts (based on Torras 2000).

The poor are more vulnerable because access to substitute products and services may simply be impossible or extremely expensive and income alternatives are often scarce. The TEEB Interim Report highlighted the **link between persistent poverty and the loss of biodiversity and ecosystem services**, showing how the latter may compromise our ability to meet several Millennium Development Goals e.g. on eradicating poverty and hunger, women's status in society, child mortality, maternal health and economic development. This leads to questions about equity, property rights and the distributional impacts of degrading nature.

10.4.1 MAKING SURE THE RIGHT PEOPLE PAY

The **social impacts of environmental harm can be addressed by applying the 'polluter pays principle' and the associated 'full cost recovery principle'** when designing environmental regulation (see Chapter 7). Regulations and fiscal measures can make the economic cost of damage to biodiversity and ecosystem services visible to, and felt by, those responsible – and thus change the incentives that influence their actions. Designing a robust instrumental and market framework to confront resource users with these costs is a key priority for policy makers.

- **Making the polluter pay** means reflecting the value of natural resources within public and private decision-making and bringing private incentives more in line with society's interests. Many instruments to implement the principle exist: standards, fees, fines for non-compliance, compensation payment requirements, pollution taxes (e.g. air and water pollution taxes), and product taxes (e.g. pesticide and fertiliser taxes).
- The **full cost recovery principle** means that the costs of providing products or services (including environmental costs) are assigned to the user or the beneficiary. Consumers therefore pay the full cost of what they consume e.g. for water supply or timber concessions.

Taken in isolation, this approach could create problems – for example, by increasing the price of access to essential services like water for groups who would struggle to pay. However, there are many ways to support such groups, such as excluding them from paying or granting them concessions. This is more cost effective than providing services to everyone at belowcost price which is a 'lose-lose' approach: it creates incentives for over-use without generating sufficient funding to invest in conservation and restoration.

If properly designed, management of natural capital considers the distribution of costs and benefits across the full range of ecosystem services. Then it can benefit the most vulnerable and lead to a more equitable situation. Indeed, there are many 'win-win' options identified in the report that improve the well-being of the poor whilst reducing the loss of biodiversity and ecosystem services. Valuing the potential benefits of different resource use strategies can help identify such opportunities (see Box 10.17).

10.4.2 SETTING INCENTIVES IN LINE WITH THE DISTRIBUTION OF NATURE'S BENEFITS

Biodiversity is concentrated in specific areas and hotspots. However, the collapse of ecosystem services

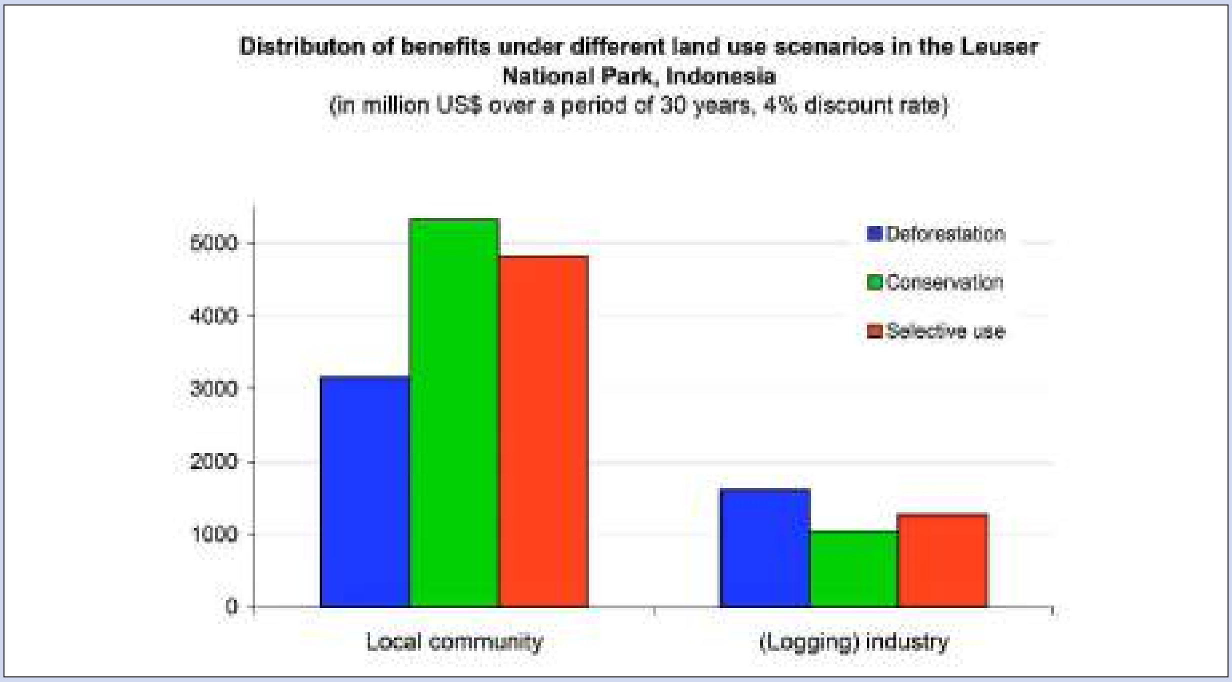
Box 10.17: Comparing impacts of resource use strategies across user groups in Indonesia

Faced with rapid degradation of Leuser National Park, its Scientific Director commissioned a valuation study to compare the impact of different ecosystem management strategies on the province's potential for economic development until 2030.

The study estimated that conservation and selective use of the forest would provide the highest return for the region over the long term (US$ 9.1-9.5 billion, using a 4% discount rate). Continued deforestation would cause the degradation of ecosystem services and generate a lower overall economic return for the province (US$ 7 billion).

The monetary difference between the deforestation and conservation options amounted to US$ 2.5 billion over a period of 30 years. Most of this would have to be borne by local communities who benefited from forest conservation (mainly through water supply, non-timber forest products, flood prevention, tourism and agricultural production). According to this study, they would lose US$ 2 billion out of their share (US$ 5.3 billion) of ecosystem services available under the conservation scenario. This corresponds to a loss of 41%.

The valuation exercise clearly demonstrated that logging the tropical forest not only worked against overall economic growth and development but also produced a negative impact on hundreds of rural forest dwelling communities compared to the limited private gain by a few logging companies.



Source: adapted from van Beukering et al. 2003 has origins and impacts beyond borders. **Local ecosystems generate benefits in a wider area – and even globally – but are rarely rewarded for doing so.** Caring for local biodiversity can secure ecosystem services nationally and internationally (e.g. carbon, pharmaceuticals, food security). These benefits depend on local stewardship, local knowledge and, in some cases, foregoing opportunities for economic development – yet people on the ground often receive little or no payment for the services they help to generate. This can make it more economically attractive to exploit theresource rather than preserveassets of global worth. Policy needs to address this unequal distribution and the fact that local biodiversity produces global benefits. **Distributive issues can and need to be addressed both nationally and internationally.**

Several policy tools discussed in this report allow policy makers to address equity concerns. In particular, **payments for ecosystem services (PES)** reward providers of benefits that have so far been taken for granted (e.g. water utility companies pay for protecting water catchments). PES provides land users with incentives to protect natural environments (see Box 10.18 and Chapter 5). They typically apply to water, carbon, soil protection or biodiversity actions (offsets, restoration and enhancement of quality).

PES can be used for local or international transfer. In Europe, the EU spends about 2 billion EUR/year supporting PES schemes (known as agri-environmental and forest-environmental schemes), including incentives for more biodiversity-friendly land uses and soil management practices by farmers and forest owners (EC 2003). The most promising international PES scheme is the proposal for REDD-Plus (see section 10.3).

PES requires careful design and favourable conditions if it is to produce high returns on investment without unintended distributional side effects. These include the definition of property rights and addressing possible imbalances of power between local and non-local users. Any market scheme should differentiate between traditional (frequently subsistence) and intensive resource (usually for commercial purposes) use systems and their protagonists. Where favourable conditions exist – such as an active civil society, a well-functioning legal and judicial system, stable funding flows and strong complementary policies for maintaining the public nature of goods – ecosystem services markets have the potential to provide significant additional income to local stewards of nature.

Box 10.18: PES, erosion and the Giant Panda: rewarding local communities in China

China runs one of the largest PES schemes worldwide, the **Grain-to-Greens Programme** (GTGP). Its main objective is to tackle soil erosion, believed to be the principal cause of extreme flooding in 1998, by planting trees or maintaining pasture on cropland with steep slopes to prevent soil erosion. By the end of 2006, the GTGP had contributed to the conversion to forest of 9 million ha of cropland.

The GTGP is expected to generate conservation benefits and improve degraded ecosystem services, especially in regions in global biodiversity hotspots such as Wolong Nature Reserve (one of the largest reserves for endangered giant pandas). Participating households receive an annual payment equivalent of US$ 450 per ha for a fixed 8-year period for converting cropland to forest and keeping the converted plots forested. The GTGP has already generated positive impacts on panda habitat.

Adapted from: Chen et al. 2009

10.4.3 CLARIFYING RIGHTS TO RESOURCES: GOOD FOR PEOPLE AND FOR THE ENVIRONMENT

Policy makers concerned with equity issues can make a strong contribution to increasing social benefits derived from nature by focusing on sound distribution and recognition of property rights to resources. Property rights encompass the rights to use, own, rent or sell land, its resources and benefit flows and so determine how they are used. Their fair distribution is essential from an equity perspective.

Where the free provision of ecosystem services is regulated, we tend to better recognise their value – but we also modify the rights to such services. Use rights to water, fish or grazing grounds are often informally distributed and well managed under community-based regimes. When external interventions change such informal rights – either to create markets or for other purposes linked to sustainable use – policy makers need to carefully consider whose livelihoods depend on these services.

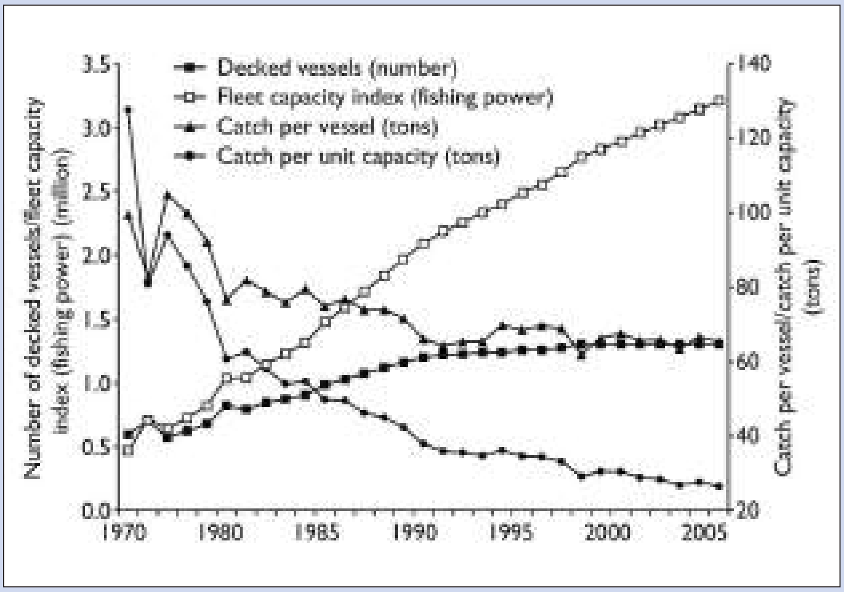
Where traditional rights are not registered, they risk being ignored unless new rules explicitly respect former uses. This process of defining and officially recognising rights to resources is fundamental for conservation and sustainable use and will determine the level of social impact that any new instrument will have – it is of particular importance for implementing PES schemes. This is highlighted in Paraguay's experience with a new PES scheme where official recognition of such rights added financial value to land of low conventional economic value but of high importance for subsistence (Global Forest Coalition et al. 2008).

Recognition of rights to resources is also about protecting collective rights – i.e. rights to enjoy public goods. Biodiversity and ecosystems are often public goods or common goods: even if they provide services and private benefits for some individuals, they still deliver collective benefits to the rest of society like fresh air, rainfall and pollination. However, when land cover is changed and some ecosystem services exploited under mere consideration of private gains, public good ecosystem services may be disturbed, (e.g. erosion control, water supply). Another case is that of common goods where regulation of access is crucial. Marine fisheries provide a challenging example: **over-exploitation has turned fisheries into an 'under-performing natural asset'** (see Box 10.19).

Box 10.19: Fish stocks – an underperforming natural asset

Global marine capture fisheries are yielding far lower harvests and contributing far less to the global economy than they could do under stronger policies to manage fish stocks. Since industrial fishing began, the total mass of commercially exploited species has been reduced by 90% in much of the world. This tragedy results from an economic race to the sea-bottom in a ruthless competition between industrial fishing companies. **Poorly regulated access to the resource and insufficient enforcement of regulations** worsen the situation.

The industry currently has an annual value (landed catch) of US$ 86 billion (FAO 2008). Using a stylised and simple model, a World Bank report estimates the lost economic benefits to be in the order of US$ 50 billion annually – representing the difference between the potential and actual net economic benefits from global marine fisheries.



Source: World Bank and FAO 2008: 21

The 'Nobel Prize'*-winning economist Elinor Ostrom has shown in her work that collective community ownership of resources by traditional rural communities can foster the evolution and adaptation of sustainable resource use regimes. **Along with clear rights and functioning policies for public goods, fostering collective rights to common property helps to secure the future provision of ecosystem services.**

Box 10.20: Enhancing collective rights for sustainable fisheries

Norway: The traditional fishing practices of the indigenous Coast Sami support harvesting of marine resources in a sustainable way. During the 20th century industrial fishing practices virtually eradicated most of the fish stocks, including herring and cod. In 1989-1990 a fishing quota was introduced. However, the required amount of cod that had to be caught in previous years in order to qualify for a quota was too high for small-scale fisheries and most of the Coast Sami were subsequently excluded from traditional fishing. In 2008 new regulations allowed the Coast Sami to obtain exclusive fishing rights inside the fjords and thus at least partly maintain their sustainable resource use practices.

Adapted from: Pedersen 2008

Pakistan: Dwindling fish population and environmental degradation led Pakistan fishermen from the community of Ganz to shift to community-based fisheries management and follow sustainable catchment principles. In contrast to neighbouring communities, Ganz fishermen re-adopted traditional techniques and jointly agreed on limiting fishing by fish size and season, resulting in stock recovery and increased landings as well as a reduction of discards. The community also benefits from the lengthened fishing season and stabilised market price due to improved quality of catchments.

Adapted from: WWF Pakistan 2005

10.4.4 MANAGING TRANSITION AND OVERCOMING RESISTANCE TO CHANGE

Shifting towards a more sustainable regime of resource use is essentially about managing transition. Policy shifts raise at least three challenges: (i) those who benefited from the status quo will be against change; (ii) time periods between new rules and their tangible pay-offs may be substantial; and (iii) where new rules require habits and lifestyle to change, people often need positive first experiences to get used to new ways.

Policy makers typically meet resistance when introducing policies based on the polluter pays principle to safeguard the provision of ecosystem services. This is because such **policies change the distribution of benefits and costs between different groups**. For example, farmers who are no longer allowed to use harmful pesticides lose their previous perceived 'right' to pollute and thus incur higher production costs: on the other hand, society at large benefits from improved stream water quality. Knowing that farmers are likely to protest against such a change in the rules, governments have a range of options. They can either build broader consensus around the need for change (e.g. drawing on communication tools that integrate insights on benefits) or decide to (partly) buffer the distributive impacts (e.g. by means of compensation for a defined period). The same is true for subsidy reform where a 'culture of entitlement' can develop over time. Here, experience has shown that an emphasis on reform rather than removing the subsidy can be a constructive way forward. A gradual process and flanking measures for social impacts can be essential for public acceptability and to avoid unacceptable social costs.

Government intervention is particularly helpful where the benefits of a conservation policy become effective only after a time lag. Time lags can be quite substantial e.g. in reforestation projects or when restoring degraded wetlands. During this transition period, targeted governmental support is required – otherwise the upfront costs may be prohibitively high. Public compensation mechanisms, such as tax breaks, ecological fiscal transfers or special credit lines, can help to provide the necessary incentives. In other cases government intervention would take the form of direct expenditure (e.g. regional funding for ecological infrastructure).

Where resource users need to **change accustomed practices**, this can create additional problems on top of the time lags in the return on investment. The Cape Horn lobster fishery is an example (Pollack et al 2008). In this fully exploited archipelago in Southern Chile, mussel cultivation has been suggested as an alternative source of income. However, this requires dissemination of market opportunities, capacity building, a critical mass of 'innovators' and good timing in order to motivate and successfully accompany lobster fishers to get involved in mussel cultivation: these measures need significant up-front government investment.

The period between a policy shift – e.g. towards stricter protection of the Cape Horn lobster breeding grounds – and its promised results is a difficult time which can be dominated by opposition. **Managing transition is clearly a challenge in its own right, meriting the particular attention of policy makers.**

* The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel.

10.5 NATURAL CAPITAL THAT DELIVERS PROSPERITY

Biodiversity and ecosystem services are natural assets with a key role to play in future economic strategies seeking to promote growth and prosperity. Developing and further strengthening policy frameworks to manage the transition to a resource efficient economy is the way forward.

The TEEB studies build on and take forward the groundbreaking work already carried out by other international efforts. The Millennium Ecosystem Assessment showed how natural capital is critical to human survival and well-being. A series of subsequent assessments – like UNEP's Global Environment Outlook (UNEP GEO-4 2007), the IPCC's 4th Climate Change Report (IPCC 2007), the OECD's Environment Outlook 2030 (OECD 2008), the International Assessment of Agricultural Knowledge Science and Technology for Development (IAASTD 2009), the FAO/World Bank's Sunken Billions report (World Bank and FAO 2008) and the 3rd UN World Water Development Report (UN WWAP 2009) – have all highlighted the rapidly evolving crisis threatening our natural assets. When we examine all of this evidence together, we are faced with significant economic costs that should be reflected in our policy choices.

10.5.1 POLICIES MAKE A DIFFERENCE

Natural capital is the web that provides services to humanity and supports our economies. It can make a significant contribution to resolving current crises related to climate change, food security and water scarcity while simultaneously addressing development options for overcoming poverty (see section 10.4). TEEB builds on best practice and lessons learnt so far in order to provide inspiration on how this can be achieved.

There is no single 'solution' as each country is different, each economy relies on nature in a different way and each country starts with a different set of policies already in place. However, the following two recommendations may apply in almost all cases, irrespective of the specific setting:

- The policy response should not be limited to 'environmental' policy-making processes, but also needs to come from other **sectoral policies** like fisheries, agriculture, forestry, energy, food and beverages, extractive industries, transport, tourism and health – to name but a few.

- The value of our natural capital can be much better reflected in decision-making **if broadly considered** – from national accounting, regulation and fiscal policy, to public and private procurement and government spending. The application of single policy instruments may sometimes work, but more often the appropriate policy response will involve a flexible and 'smart' policy mix. Such a mix can be delivered through a step-wise approach that starts with the most easily available opportunities, i.e. the 'low hanging fruit'.

TEEB studies and analysis highlight various options for robust policy responses and describe what instruments and measures are already available. However, as noted above, different instruments will suit different situations and there is no single policy solution for all countries. It is therefore very helpful that each country **first review the situation** on the ground. This assessment can be done in the following steps:

- **Step I: Consider what ecosystem and bio diversity means for your economy:**
  Countries are urged to carry out their own reviews, of how ecosystem services relate to their economic growth, employment, and prosperity and what risks are associated with their loss. Several countries are already working on national assessments, such as France (Chevassus-au-Louis et al. 2009), the United Kingdom (UK NEA 2009), Japan and India.

- **Step II: Evaluate current policies and identify potential improvements:**
  Building on the insights of national reviews, the existing policy framework can be evaluated to reveal inconsistencies and identify the potential for better managing natural capital.

10.5.2 OPPORTUNITIES FOR IMPROVEMENT

Policy makers need to decide what works best for their country and prevailing circumstances. The policy toolkit is well-stocked with international examples and provides ample experiences to draw upon. The following list may serve to guide this selection.

The essential role of regulation

Regulation defines rights by setting out clear rules on the uses of biodiversity and ecosystems that are legally allowed, defining offences and deterring non-compliance. Regulations can also set limits and boundaries to the use of natural assets and resources through the issue of permits and prohibitions. These may provide an effective framework for ensuring the sustainable use of natural resources, reducing pollution and hazardous events that harm natural resources and for triggering urgent environmental improvements when needed. More broadly, a strong regulatory baseline is an essential precondition that other policy options can build upon, including payments for environmental services (see Chapter 5), liability rules for prevention and remediation of damage and offsetting requirements (see Chapter 7).

The complementary role of market-based instruments

Regulation, however, can only go so far. Market-based instruments, such as taxes, charges or tradable permits can, if carefully designed and implemented, complement regulations by changing economic incentives, and therefore the behaviour of private actors, when deciding upon resource use. When set at accurate levels, they ensure that the beneficiaries of biodiversity and ecosystem services pay the full cost of service provision. Experience shows that environmental goals may be reached more efficiently by market-based instruments than by regulation alone. Some market-based instruments have the added advantage of generating public revenues that can be earmarked for biodiversity-friendly investments, similar to the use of resources collected through the EU emissions trading scheme.

However, market-based instruments do not work in all situations and for all ecosystem services. For instance, they often carry high administrative and transaction costs given the need for monitoring of compliance and prosecution if rules are broken. Their implementation may also be hampered by political resistance (see Chapter 7).

Reforming subsidies when these contribute to environmental harm

One of the most urgent steps for ensuring coherent and efficient policies is the reform of subsidies, in particular those that are harmful to biodiversity and ecosystem services to correct the economic signals we send to private sector actors and to society as a whole. Subsidies to key sectors (i.e. agriculture, fisheries, mining and energy) are currently running at around one trillion dollars per year. Collectively, subsidies represent 1% of global GDP yet many of these contribute directly to biodiversity and ecosystem damage (see Chapter 6). Coincidentally, the Stern Review of the Economics of Climate Change found that 1% of global GDP should suffice to prevent future climate change damage expected to cost 5% to 20% of global GDP (Stern 2006).

Reforming environmentally harmful subsidies can free up public funds to promote resource efficient and equitable growth. It is important to tackle subsidy reform in a holistic way that focuses on those subsidies that have clearly outlived their purpose, are not targeted towards their stated objectives or do not reach their objectives in a cost-effective manner. From the TEEB perspective, freed-up funds should as a priority go to rewarding the unrecognised benefits of ecosystem services and biodiversity (see Chapter 5 and 6).

Rewarding the provision of services

In order to stimulate ecosystem service provision, it is critical to reward those involved in managing and securing these services. Over the years, a number of options have been developed to provide financial and technical support to communities and individuals committed to sound stewardship of natural resources. Policy options range from supporting community-based management over well equipped agricultural extension services to tax breaks and easements.

If suitably designed and implemented, payments for ecosystem service (PES) are ready to deliver benefits and can address distributional aspects (see section 10.4 and Chapter 5). Evaluation of their performance to date has identified ways to make them even more effective and cost-efficient. PES are adaptable and can be flexibly linked to e.g. protected area networks or environmental challenges like water management. There already exists a wide range of experience that can be relatively easily replicated and adapted for use in other countries.

REDD presents the opportunity to establish the very first global system of payments for ecosystem services. The adoption of a REDD-Plus agreement in the ongoing climate change negotiations and its implementation is a unique win-win solution that could offer cost-effective climate change mitigation with significant environmental co-benefits.

Supporting natural capital investments

Well-targeted investment in natural capital can provide high rates of return and deliver co-benefits (see section 10.3 and Chapters 8 and 9). All countries – to a varying degree – will have to respond to climate change impacts by strengthening their adaptive capacities. Investing to strengthen the resilience of ecosystems is an obvious path to take. Protected areas and ecological infrastructure already provide us with the basic building blocks for this purpose. Combining protective management policies with restoration of degraded areas can help us safeguard the ingredients for economic prosperity and sustained livelihoods.

10.5.3 THE ROAD AHEAD

As discussed in section 10.4, transition will be a difficult task and a gradual approach will be helpful – firstly, to provide the time necessary for this 'learning by doing process' and secondly, because policy action will lead to costs for those who benefit from the current situation and who can be expected to argue against change. Here, it can help to communicate the links between natural capital and economic activity, social well-being and prosperity in ways adapted to target audiences. Changing operational mentalities, recognising the value of biodiversity and moving away from short-term decision-making are all part of the road ahead. Many options will depend on collaborating across levels and on creating partnerships.

Creating policy change at all levels

While many of the opportunities identified above allow policy makers to act at the national level, others will require countries to collaborate much more closely on implementation. Over the past decades, several international conventions and institutions have been set up with the Convention on Biological Diversity (CBD) the most prominent one in this area.

Our experience with the IPCC shows us, encouragingly, that cooperative international efforts can leverage real change in political priorities and social attitudes. Action on climate change has opened the way for a broader portfolio of actions to protect our natural capital stock. The new Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) aims to provide a launching pad for this purpose.

Global initiatives with importance for ecosystem services and biodiversity also come from other policy arenas. As discussed in section 10.3 and Chapter 5, a possible REDD-Plus agreement and any corresponding instrument at the climate negotiations in Copenhagen will constitute an important step forward. These will obviously require corresponding infrastructure, governance and political commitment to implementation at both national and international levels.

Local management is decisive for sustainable use of natural capital. However, national legislation and administrative culture sets the framework for local governance, including the scope for action at different levels, fiscal federalism and planning procedures. TEEB D2 (forthcoming) illustrates opportunities for action at the local level.

Building partnerships

More political will, planning and additional resources are all essential but long-lasting change can only come by working with and through people. Addressing and engaging the right actors, means identifying the very diverse range of stakeholders affected directly or indirectly by resource use decisions (see Chapter 2).

This starts with the public and communities – as biodiversity and ecosystem services are often public goods. Citizens and NGOs need to be actively engaged because the most vital issues are at stake (e.g. food security) and because individual patterns of behaviour and consumption ultimately determine the global ecological footprint. This link will be further explored in TEEB D4 for citizens and consumers.

Equally important are businesses, irrespective of size: for some, their very survival is linked to healthy ecosystems (think of agriculture and ecotourism). The TEEB D3 report will identify opportunities to work with and through business to deliver a more resource efficient economy.

International organisations have a key role to play e.g. in terms of capacity building and funding. A culture of assessment, transparency and appreciation of nature's value can help to improve governance and the delivery of policies. Several countries could require practical support to address the challenges ahead. International institutions – the Convention of Biological Diversity, The United Nations Environment Programme, the World Bank, many donor organisations and NGOs – are already actively involved in relevant programmes and training. REDD and similar initiatives will open up new opportunities for the international community to help policy development in key areas, especially where ecosystems provide local as well as global benefits.

10.5.4 BUILDING A MORE RESOURCE EFFICIENT ECONOMY

Faced with the growing threat from climate change, governments have started focusing on the need to move towards a low-carbon economy, an economy that minimises greenhouse gas emissions. There is a need and an opportunity to take this concept a step further towards a truly resource efficient economy. An economy that sends out signals that reflect the many values of nature, from the provision of food, raw materials, access to clean water, all the way up to recreation, inspiration and a sense of cultural and spiritual identity; an economy that makes the best use of the biodiversity, ecosystems and resources available without compromising their sustainability; an economy supported by societies that value their natural capital.

It is hard to think of any other asset where we would tolerate its loss without asking ourselves what we risk losing and why. The more that we ask these questions, the more uncomfortable we become with the current situation where nature is being lost at an alarming rate. We realise that we often fail to ask the big questions about what ecosystem services and biodiversity provide and their value or worth to different groups of people, including the poorest, across the globe and over time.

These questions are not easy to answer. This report is a contribution to the call by an increasing number of policy makers for ways to approach this multifaceted challenge. It shows that the accumulated policy experience is plentiful and provides a broad range of solutions. At present these are mainly carried out in isolation, creating pockets but also important starting points. The creativity and vision of international and national policy makers is now in demand to design coherent policy frameworks that systematically respond to the value of nature. These can open up new opportunities to address poverty, development and growth. At the same time, the act of making values visible through well-designed policies will empower consumers and business, communities and citizens to make much more informed choices and thus to contribute to this transition in their daily decisions.

Making this a reality will require tremendous effort and international co-operation, but the existing evidence shows that it will undoubtedly be worthwhile. The future is in all our hands and we have the potential to make the outlook much more positive. Although many uncertainties remain, good ideas are close at hand. Acknowledging and understanding the value of nature means decisions can be made now that will reap sustained environmental, social and economic benefits far into the future, supporting future generations as well as our own.

2010, as the International Year of Biodiversity, places the spotlight on these issues and creates a unique opportunity to begin this change.

"It is not enough to know, one should also use; it is not enough to want, one should also act."

Johann Wolfgang von Goethe, 1749-1832

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