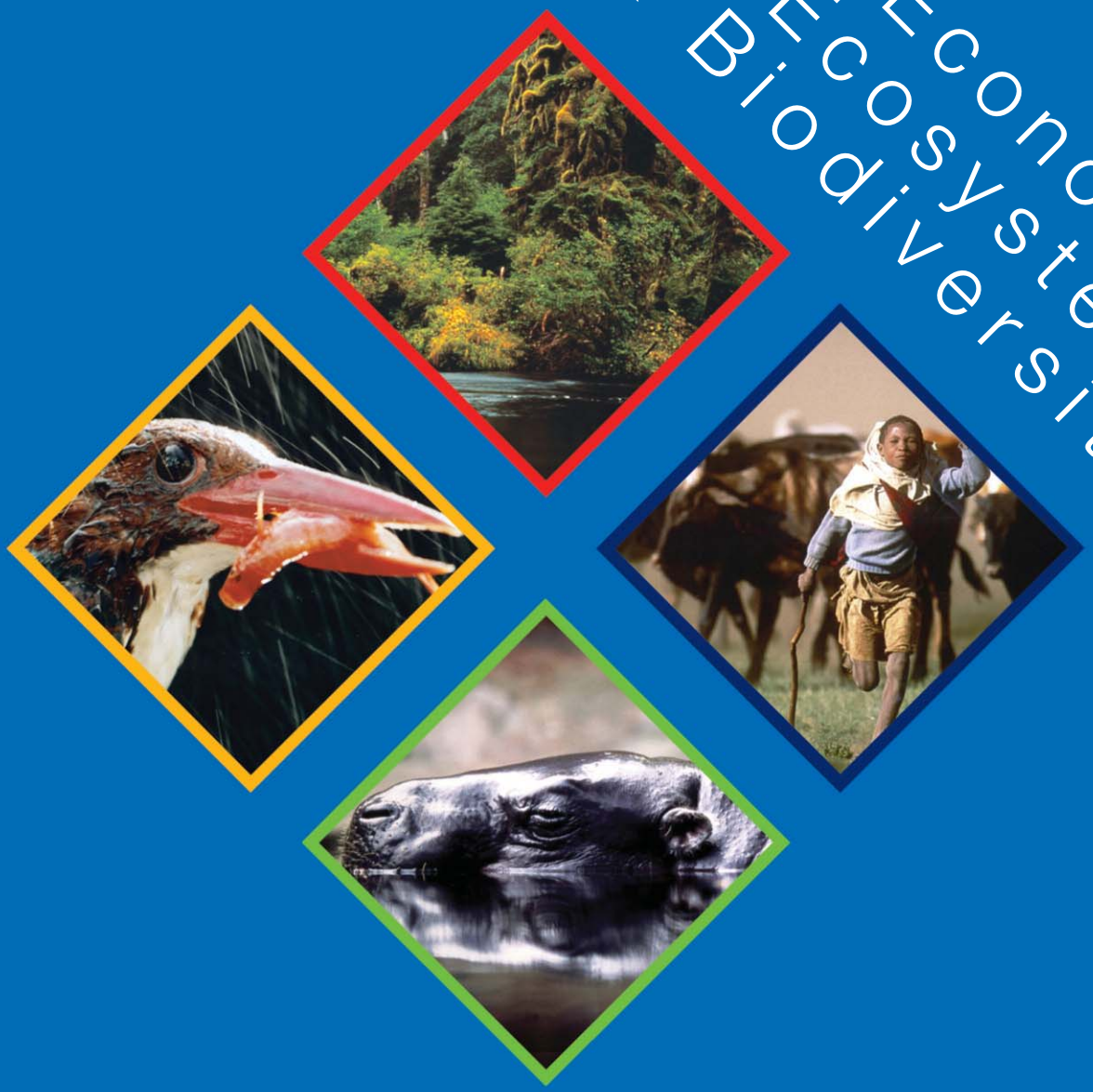
The Economics of Ecosystems & Biodiversity



TEEB FOR POLICY MAKERS

SUMMARY: RESPONDING TO THE VALUE OF NATURE

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The Economics of Ecosystems & Biodiversity

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY FOR NATIONAL AND INTERNATIONAL POLICY MAKERS

SUMMARY: RESPONDING TO THE VALUE OF NATURE

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Authorship

This executive summary has been put together by:

Patrick ten Brink, Augustin Berghöfer, Christoph Schröter-Schlaack, Pavan Sukhdev, Alexandra Vakrou, Stephen White, and Heidi Wittmer, with the valuable input from Rudolf de Groot, Marianne Kettunen, Pushpam Kumar, Georgina Langdale, Markus Lehmann, Helen Mountford, Aude Neuville, Sander Van der Ploeg, Clare Shine, Benjamin Simmons, Graham Tucker, James Vause, François Wackenhut, the TEEB Coordination Group and a range of others. It is a summary of the TEEB for Policy Makers report; chapter authors and contributors are noted at the start of each chapter. For a full list see also the inside back cover of this summary.

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Rijksoverheid

TEEB D1 Summary

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A WORD OF THANKS

We would like to thank each and every contributor from the TEEB team and its many global partners. The 'TEEB for Policy Makers' Report is a product of tight-knit collaboration. It has had the good fortune to be steered by a core team of motivated and skilled professionals, supported by a wide range of authors and reviewers from many disciplines and all continents. Without the strategic input, personal commitment and genuine interest of our core team and the Advisory Board of TEEB, this report would not have seen the light of day. Without the impressive substance and experience of our authors, and the honest insights from our generous reviewers[1], it would not have carried conviction.

The next stage is to share its ideas and suggestions with policy makers across the world. We look forward to deepening our understanding of country experiences, ambitions and needs and reflecting these in 'TEEB for Policy Makers'. Thus we would also like to thank, in advance, all those who will help us to create an increasingly rich understanding of policy practice that can help address the biodiversity challenge that we face together.

Pavan Sukhdev,
Study leader TEEB

Patrick ten Brink,
Coordinator, TEEB for Policy Makers

[1] The full list of the TEEB Team, authors, contributors, and reviewers is presented in the inside back cover of this report, and specific contributors for each chapter are duly acknowledged in the chapters, available on www.teebweb.org.

Background

TEEB – a study on The Economics of Ecosystems and Biodiversity was launched by Germany and the European Commission in response to a proposal by the G8+5 Environment Ministers (Potsdam, Germany 2007) to develop a global study on the economics of biodiversity loss. This independent study, led by Pavan Sukhdev, is hosted by the United Nations Environment Programme with financial support from the European Commission, Germany and the UK, more recently joined by Norway, the Netherlands and Sweden.

TEEB draws together experience, knowledge and expertise from all regions of the world in the fields of science, economics and policy. Its aim is to guide practical policy responses to the growing evidence of the impacts of ongoing losses of biodiversity and ecosystem services.

In May 2008, we released the TEEB Interim Report at the Convention on Biological Diversity's ninth meeting of the Conference of the Parties. This paved the way for the series of TEEB reports that will follow until our final findings are presented in autumn 2010.

One of the key messages highlighted in the TEEB Interim Report was the inextricable link between poverty and the loss of ecosystems and biodiversity. It showed how several Millennium Development Goals were at risk due to neglect and deterioration of these aspects of our natural capital.

The second phase of TEEB work is divided into five interconnected strands. These include the Report on Ecological and Economic Foundations (parts of which were published online in September 2009) and four targeted end-user reports that build on this baseline. This group of reports offers tailored insights and advice for national and international policy makers, local and regional administrators, businesses and consumers and citizens.

This TEEB D1 Report is our work for national and international policy makers. It should be seen in the context of our continued efforts to engage a wider audience when this is both constructive and timely. In September 2009, for example, we released our Climate Issues Update (CIU) with the December climate change negotiations in Copenhagen in mind. The TEEB CIU demonstrated that analysing the value of biodiversity and ecosystem services not only enhances the case for strong international action to curb greenhouse gas emissions, but also highlights the inherent value for money in investing in natural capital to help both climate change mitigation and adaptation.

As we approach the International Year of Biodiversity in 2010, the aim of this TEEB D1 Report is to highlight the relevance of our work to mainstream policy making. We show that the failure of markets to adequately consider the value of ecosystem services is of concern not only to environment, development and climate change ministries but also to finance, economics and business ministries. Evidence presented here shows pro-conservation choices to be a matter of economic common sense in the vast majority of cases.

At the heart of this complex problem is a straightforward and well-recognised issue in standard microeconomics. The lack of market prices for ecosystem services and biodiversity means that the benefits we derive from these goods (often public in nature) are usually neglected or undervalued in decision-making. This in turn leads to actions that not only result in biodiversity loss, but also impact on human well-being. The scale of current losses is imposing. The loss of tropical forest ecosystems alone accounts for about one fifth of global greenhouse gas emissions, yet the impact of such losses goes way beyond climate

change. Loss of other valuable ecosystems also directly impacts food, fresh water and energy security, all of which are likely to be growing global issues affecting all countries in years to come.

The TEEB D1 Report for policy makers takes as its starting point that by failing to account for the value of ecosystems and biodiversity, we will make the wrong choices in responding to these and other challenges. It demonstrates that understanding and capturing the value of ecosystems can lead to better informed and possibly different decisions; accounting for such value can result in better management; investing in natural capital can yield high returns; and sharing the benefits of these actions can deliver real benefits to those worst off in society. This evidence and the arguments we develop in the Report provide a strong case for broad policy action. Put simply, making the benefits of biodiversity and ecosystem services visible to economies and society is necessary to pave the way for more efficient policy responses.

The Report builds on real examples from across the world that show how appreciating the value of biodiversity has led to policy changes, how investment in natural capital can be more cost-effective than man-made solutions and how conservation can deliver a range of economic advantages. It provides concrete examples of ways to make policies work, whether this involves reform of subsidies, charges for resource use or payments for ecosystem services. Practical guidance for better managing the transition during policy reform is provided, based on lessons learnt in different counties. The TEEB D1 Report is a compendium of practice, a synthesis of insights and a source of ideas for ways forward.

Many argue that society does not have or use the right tools to measure human well-being, growth that is within the natural limits of ecosystems or what is needed for the next generation to inherit a world at least as rich in opportunities as today's world. In the TEEB Interim Report, we likened this situation to "sailing unexplored and choppy waters with a defective compass". It is our hope that this TEEB D1 Report – by sharing practice across nations and stimulating debate nationally and internationally to address identified challenges – will help get us back on course.

TEEB Delivery Timeline

Phase II of TEEB will provide five deliverables. The study is underpinned by a volume on the ecological and economic foundations of TEEB (TEEB D0), for which draft chapters are available for public comment on the TEEB website. This volume will include a synthesis of the empirical economic valuation literature in the form of a matrix of values for the main types of ecosystems and ecosystem services.

TEEB D0 is followed by four 'end-user' reports:

TEEB D1: TEEB for national and international policy makers, online November 2009
TEEB D2: TEEB for local policy makers and administrators, to be published in mid-2010
TEEB D3: TEEB for business, to be published in mid-2010
TEEB D4: TEEB for citizens, a website to be launched in mid-2010.

The final findings of the complete TEEB study will be presented in October 2010 at the CBD COP10 Meeting in Nagoya, Japan. Currently a number of draft chapters of the TEEB D0 report, as well as the complete TEEB D1 report are online in order to facilitate ongoing dialogue for TEEB final findings. More information can be found at: www.teebweb.org.

The Economics of Ecosystems and Biodiversity - for National and International Policy Makers

An Executive Summary

Part I: The global biodiversity crisis: challenges and opportunities for policy makers

Natural capital – our ecosystems, biodiversity, and natural resources – underpins economies, societies and individual well-being. The values of its myriad benefits are, however, often overlooked or poorly understood. They are rarely taken fully into account through economic signals in markets, or in day to day decisions by business and citizens, nor indeed reflected adequately in the accounts of society.

The steady loss of forests, soils, wetlands and coral reefs is closely tied to this economic invisibility. So too are the losses of species and of productive assets like fisheries, driven partly by ignoring values beyond the immediate and private. We are running down our natural capital stock without understanding the value of what we are losing. Missed opportunities to invest in this natural capital contribute to the biodiversity crisis that is becoming more evident and more pressing by the day. The degradation of soils, air, water and biological resources can negatively impact on public health, food security, consumer choice and business opportunities. The rural poor, most dependent on the natural resource base, are often hardest hit.

Under such circumstances, strong public policies are of the utmost importance. These policy solutions need tailoring to be socially equitable, ecologically effective, and economically efficient.

Solutions are already emerging from cooperation between economists and scientists – and being tested and refined around the world. They point to four urgent strategic priorities:

- **to halt deforestation and forest degradation** (i) as an integral part of climate change mitigation and adaptation focused on 'green carbon' and (ii) to preserve the huge range of services and goods forests provide to local people and the wider community;
- **to protect tropical coral reefs** – and the associated livelihoods of half a billion people – through major efforts to avoid global temperature rise and ocean acidification;
- **to save and restore global fisheries** and related jobs, currently an underperforming asset in danger of collapse and generating US$ 50 billion less per year than it could;
- **to recognise the deep link between ecosystem degradation and the persistence of rural poverty** and align policies across sectors with key Millennium Development Goals.

Two related challenges lie ahead. The first is to understand the values of natural capital and integrate them into decision-making. The second is to respond – efficiently and equitably.

Part II: Measuring what we manage: information tools for decision-makers

Unlike economic and human capital, natural capital has no dedicated systems of measurement, monitoring and reporting. This is astonishing given its importance for jobs and mainstream economic sectors as well as its contribution to future economic development. For instance, we have only scratched the surface of what natural processes and genetic resources have to offer.

As part of good governance, decision-making affecting people and using public funds needs to be objective, balanced and transparent. Access to the right information at the right time is fundamental to coherent policy trade-offs. Better understanding and quantitative measurement of biodiversity and ecosystem values to support integrated policy assessments are a core part of the long-term solution.

The first key need is to improve and systematically use science-based indicators to measure impacts and progress and alert us to possible 'tipping points' (sudden ecosystem collapse). Specific ecosystem service indicators are needed alongside existing biodiversity tools. Another key need is to extend national income accounts and other accounting systems to take the value of nature into account and monitor how natural assets depreciate or grow in value with appropriate investments. New approaches to macroeconomic measurement must cover the value of ecosystem services, especially to those who depend on them most – 'the GDP of the Poor'.

Part III: Available solutions: instruments for better stewardship of natural capital

TEEB's analysis highlights existing and emerging solutions suitable for wider replication.

Rewarding benefits through payments and markets: Payments for ecosystem services (PES schemes) can be local (e.g. water provisioning) up to global (e.g. REDD-Plus proposals for Reduced Emissions from Deforestation and Degradation, as well as afforestation, reforestation, and effective conservation – if designed and implemented properly). Product certification, green public procurement, standards, labelling and voluntary actions provide additional options for greening the supply chain and reducing impacts on natural capital.

Reforming environmentally harmful subsidies: Global subsidies amount to almost US$ 1 trillion per year for agriculture, fisheries, energy, transport and other sectors combined. Up to a third of these are subsidies supporting the production and consumption of fossil fuels. Reforming subsidies that are inefficient, outdated or harmful makes double sense during a time of economic and ecological crisis.

Addressing losses through regulation and pricing: Many threats to biodiversity and ecosystem services can be tackled through robust regulatory frameworks that establish environmental standards and liability regimes. These are already tried and tested and can perform even better when linked to pricing and compensation mechanisms based on the 'polluter pays' and 'full cost recovery' principles – to alter the status quo which often leaves society to pay the price.

Adding value through protected areas: The global protected area network covers around 13.9% of the Earth's land surface, 5.9% of territorial seas and only 0.5% of the high seas: nearly a sixth of the world's population depend on protected areas for a significant percentage of their livelihoods. Increasing coverage and funding, including through payment for ecosystem services (PES) schemes, would leverage their potential to maintain biodiversity and expand the flow of ecosystem services for local, national and global benefit.

Investing in ecological infrastructure: This can provide cost-effective opportunities to meet policy objectives, e.g. increased resilience to climate change, reduced risk from natural hazards, improved food and water security as a contribution to poverty alleviation. Up-front investments in maintenance and conservation are almost always cheaper than trying to restore damaged ecosystems. Nevertheless, the social benefits that flow from restoration can be several times higher than the costs.

Part IV: The road ahead: responding to the value of nature

The need to move our economies onto a low-carbon path and the benefits of doing so are now widely acknowledged – yet the need to move towards a truly resource efficient economy, and the role of biodiversity and ecosystems in this transition, are still largely misunderstood or under-appreciated. Building momentum for the transition to a resource efficient economy calls for international cooperation, partnerships and communication. Every country is different and will need to tailor its responses to the national context. However, all may stand to gain – countries, businesses, people on the ground – by sharing ideas, experience and capacity. Policy champions can lead this process and use windows of opportunity to forge a new consensus to protect biodiversity and ecosystems and their flows of services. The TEEB studies and analysis hope to contribute to this new momentum.

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 well-being). 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.

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

Figure 1: Evaluation sequence building on scientific information

Source: Stephen White, own representation

marine 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 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.

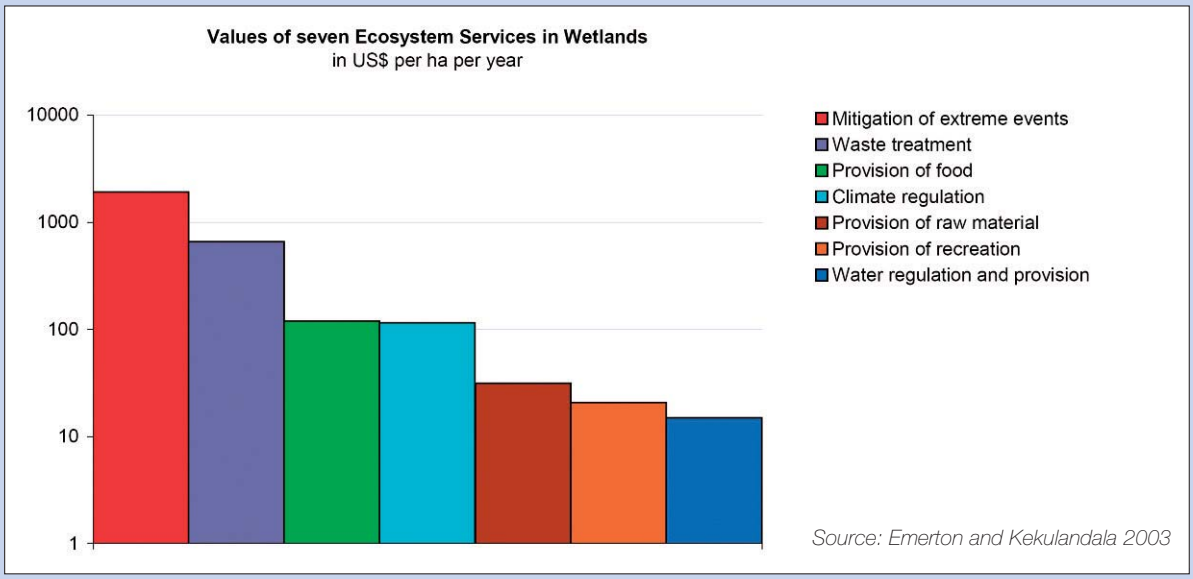
Many ecosystem service values, especially those relating to local benefits, are context specific. This reflects the natural environment's sheer diversity and the fact that economic values are not a natural property of ecosystems but are integrally linked to the number of beneficiaries and the socio-economic 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 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 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.



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 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.

MARKETS LIMITATIONS AND THE ROLE OF PUBLIC POLICIES

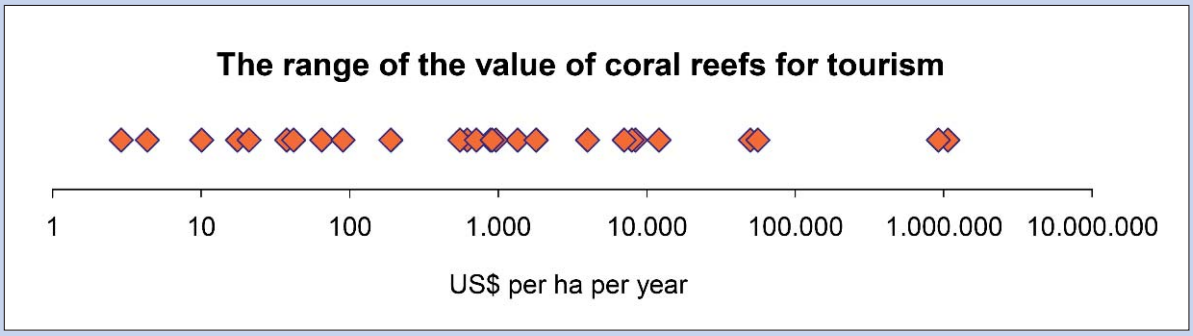
Markets fail to capture most ecosystem service values. Existing price signals only reflect – at best – the share of total value that relates to provisioning services like food, fuel or water and their prices may be distorted. Even these services often bypass markets where carried out as part of community 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 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

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 4 to 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 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).

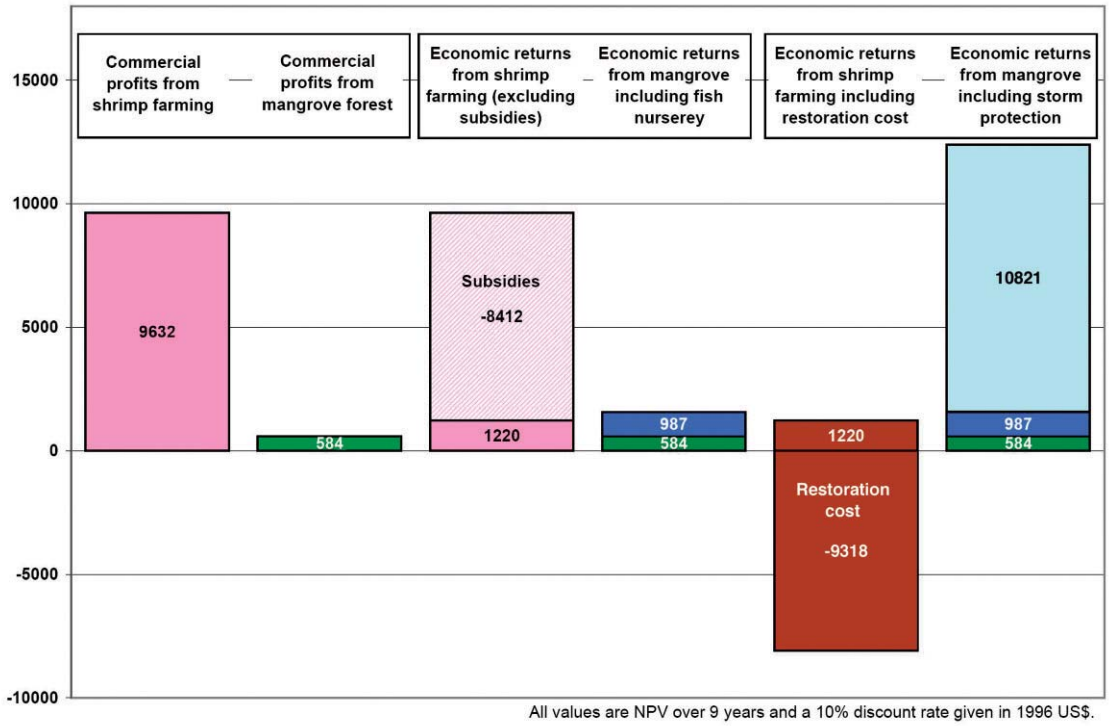
Valuation is also increasingly used to inform impact assessments of proposed legislation and policies. Examples include the EU Water Framework Directive and the UK's upcoming marine legislation which provides for Marine Conservation Zones because of the ecosystem benefits they supply (see Chapter 4). 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 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 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 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 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 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

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.

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.

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 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 eco-systems 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.

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 8): prevention often costs a fraction of subsequent damage and control costs to protect natural assets (crops, forests) or terrestrial and water-based infrastructure.

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.

Box 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

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 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.

INVESTMENT FOR CLIMATE CHANGE MITIGATION AND ADAPTATION

'Green carbon' policies (see Box 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 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 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

Box 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 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

hazards helps to decrease society's vulnerability and cushion the impacts of global warming. Policy-makers need to develop strategies that recognise these risks as well as the value for money and additional co-benefits generated by these alternative investment approaches.

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 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 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 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 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.

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 13).

Protected areas provide benefits of various natures at all levels: locally, nationally and globally (see Table 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 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 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

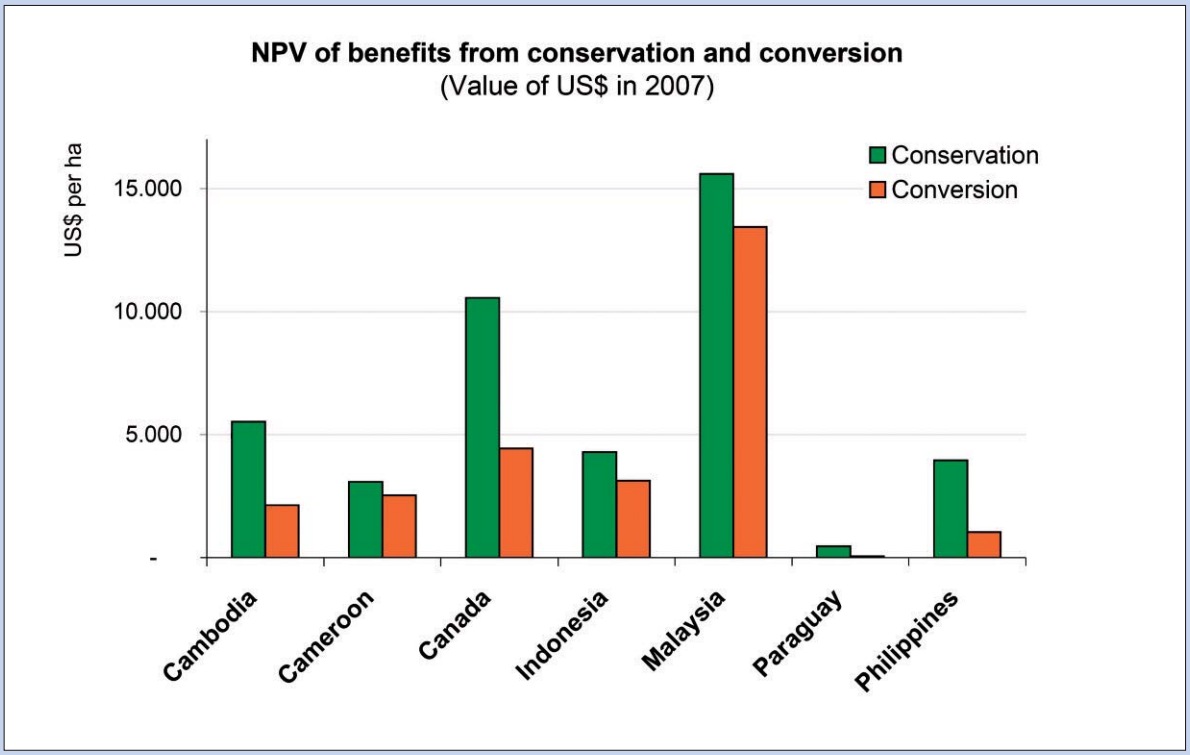
This result comes with a word of caution: in each case study, it reflects the present situation with regard to the relative scarcity of protected areas as compared to the abundance of agricultural, pasture and forest land for production of needed commodities. But if the balance shifts (and shifts are 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 14).

Figure 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.

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).

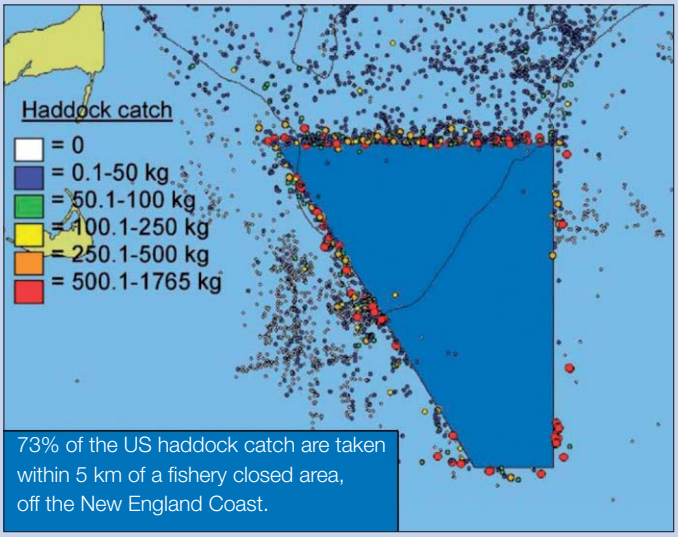
Another constraint is that the expected benefits, even when they are marketable (such as in the case of freshwater provision or waste treatment) can take time to materialise. Together with the high costs, this can put off private investment, meaning that **the role of governments and public budgets is critical**. Government support and coordination of stakeholders is particularly important for mega-sites of degradation with large-scale complex interactions

Box 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).

and far-reaching 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).

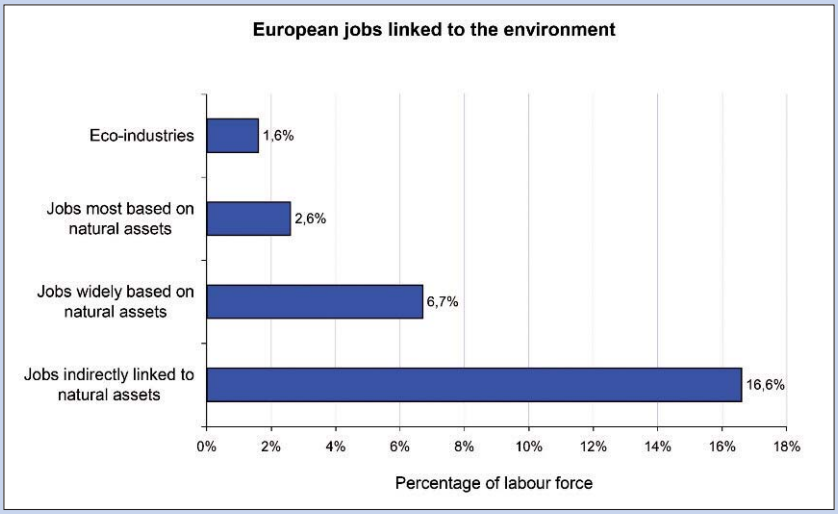
INVESTMENT IN ECOLOGICAL INFRASTRUCTURE SUPPORTS JOBS

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 15 and 16).

Box 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 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

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.

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 below-cost 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 17).

SETTING INCENTIVES IN LINE WITH THE DISTRIBUTION OF NATURE'S BENEFITS

Biodiversity is concentrated in specific areas and hot-spots. However, the collapse of ecosystem services

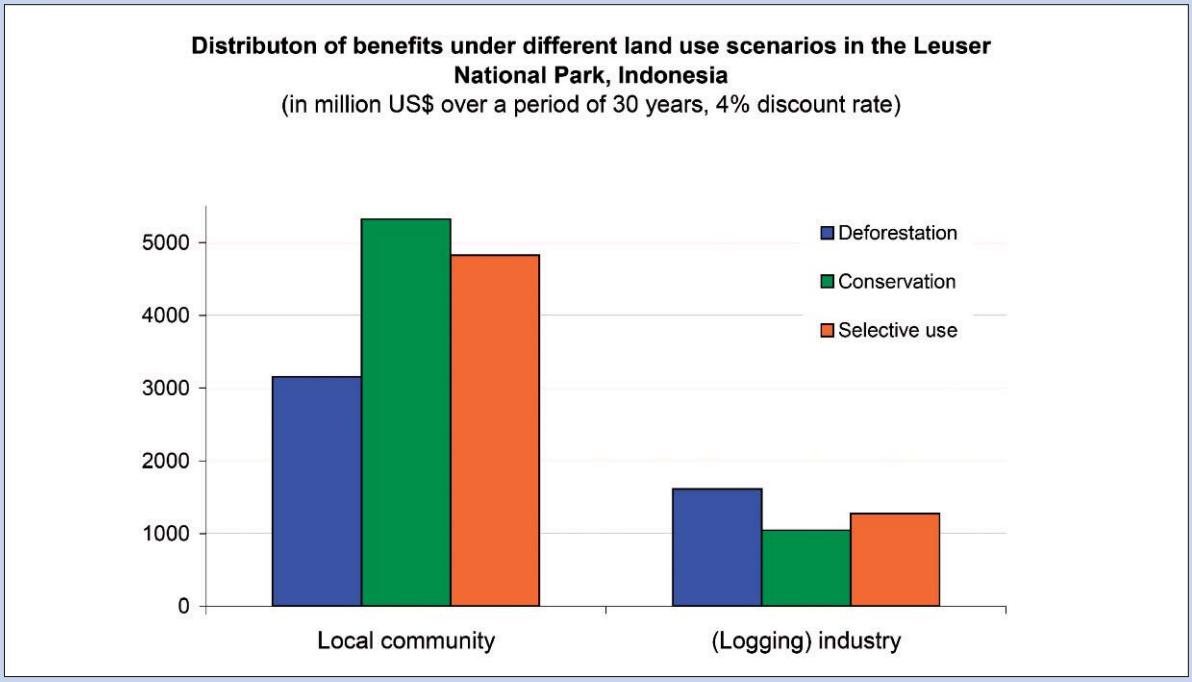
Box 17: Comparing impacts of resource use strategies across user groups in Indonesia

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 the resource rather than preserve assets 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 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 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 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

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.

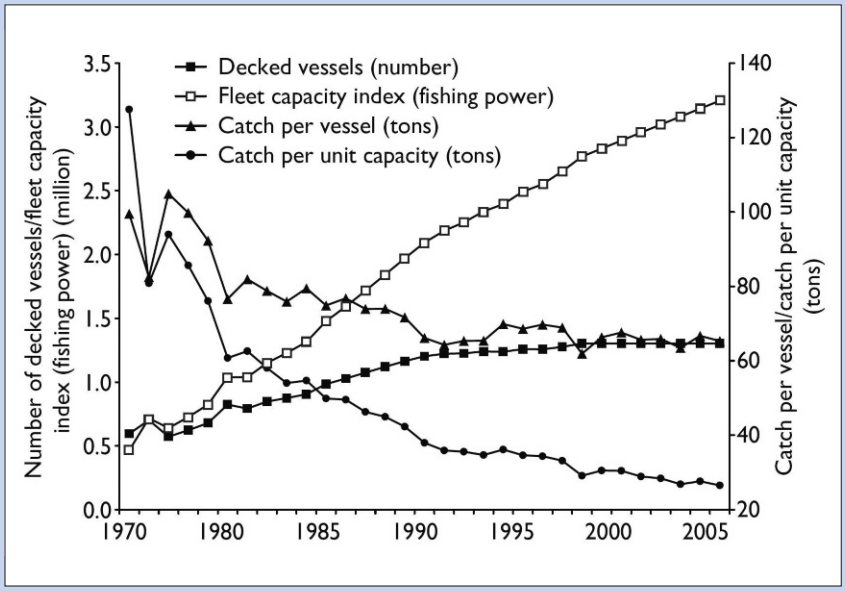
Where traditional rights are not registered, they risk being ignored unless new rules explicitly respect former uses. This process of defining and officially recognising rights to resources is fundamental for conservation and sustainable use and will determine the level of social impact that any new 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 'underperforming natural asset'** (see Box 19).

Box 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 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

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.

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.

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 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.

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 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 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.

THE ROAD AHEAD

As discussed in section 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 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.

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.

Structure of TEEB for Policy Makers

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Acknowledgements

TEEB for National and International Policy Makers

TEEB for Policy Makers Coordinator: Patrick ten Brink (IEEP)

TEEB for Policy Makers Core Team: Meriem Bouamrane (UNESCO), Bernd Hansjürgens (UFZ), Katia Karousakis (OECD), Sylvia Kaplan (BMU-Germany), Marianne Kettunen (IEEP), Markus Lehmann (SCBD), Helen Mountford (OECD), Alice Ruhweza (Katoomba Group, Uganda), Mark Schauer (UNEP), Christoph Schröter-Schlaack (UFZ), Benjamin Simmons (UNEP), Alexandra Vakrou (European Commission), Stefan Van der Esch (VROM, the Netherlands), James Vause (Defra, UK), Madhu Verma (IIFM, India), Jean-Louis Weber (EEA), Stephen White (European Commission), Heidi Wittmer (UFZ)

Lead Authors (in alphabetical order): James Aronson, Sarat Babu Gidda, Samuela Bassi, Augustin Berghöfer, Joshua Bishop, James Blignaut, Aaron Bruner, Nicholas Conner, Nigel Dudley, Jamison Ervin, Sonja Gantioler, Haripriya Gundimeda, Bernd Hansjürgens, Celia Harvey, Katia Karousakis, Marianne Kettunen, Markus Lehmann, Anil Markandya, Andrew J McConville, Katherine McCoy, Kalemani Jo Mulongoy, Carsten Neßhöver, Paolo Nunes, Luis Pabon, Irene Ring, Alice Ruhweza, Christoph Schröter-Schlaack, Benjamin Simmons, Pavan Sukhdev, Mandar Trivedi, Patrick ten Brink, Graham Tucker, Stefan Van der Esch, Alexandra Vakrou, Madhu Verma, Jean-Louis Weber, Sheila Wertz-Kanounnikoff, Stephen White, Heidi Wittmer

Contributing Authors*: Jonathan Armstrong, David Baldock, Meriem Bouamrane, James Boyd, Ingo Bräuer, Stuart Chape, Florian Eppink, Pablo Gutman, Sarah Hodgkinson, Alexander Kenny, Pushpam Kumar, Sophie Kuppler, Indrani Lutchman, Paul Morling, Aude Neuville, Laura Onofri, Ece Ozdemiroglu, Rosimeiry Portela, Matt Rayment, Andrew Seidl, Clare Shine, Sue Stolton, Anja von Moltke, Kaavya Varma, Vera Weick, Sirini Withana

Editing and language check: Clare Shine

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** Those already noted earlier not repeated here*

Wider TEEB

TEEB Study Leader: Pavan Sukhdev (UNEP)
TEEB Scientific Coordination: Heidi Wittmer, Carsten Neßhöver, Augustin Berghöfer, Christoph Schröter-Schlaack (UFZ)
TEEB Communications: Georgina Langdale (UNEP)
Report Coordinators: D0: Pushpam Kumar; **D2:** Heidi Wittmer & Haripriya Gundimeda; **D3:** Joshua Bishop
TEEB Office: Mark Schauer, Raghdan Al-Mallah (UNEP), Kaavya Varma (GIST)
TEEB Coordination Group: Pavan Sukhdev (UNEP), Mark Schauer (UNEP) , James Vause (Defra), Sylvia Kaplan (BMU), Benjamin Simmons (UNEP), Francois Wakenhut (European Commission), Heidi Wittmer (UFZ)
Advisory Board: Joan Martinez-Alier, Giles Atkinson, Edward Barbier, Jochen Flasbarth, Yolanda Kakabadse, Jacqueline McGlade, Karl-Göran Mäler, Julia Marton-Lefèvre, Peter May, Ladislav Miko, Herman Mulder, Walter Reid, Nicholas Stern, Achim Steiner