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Study on understanding the causes of biodiversity loss and the policy assessment framework

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Executive Summary

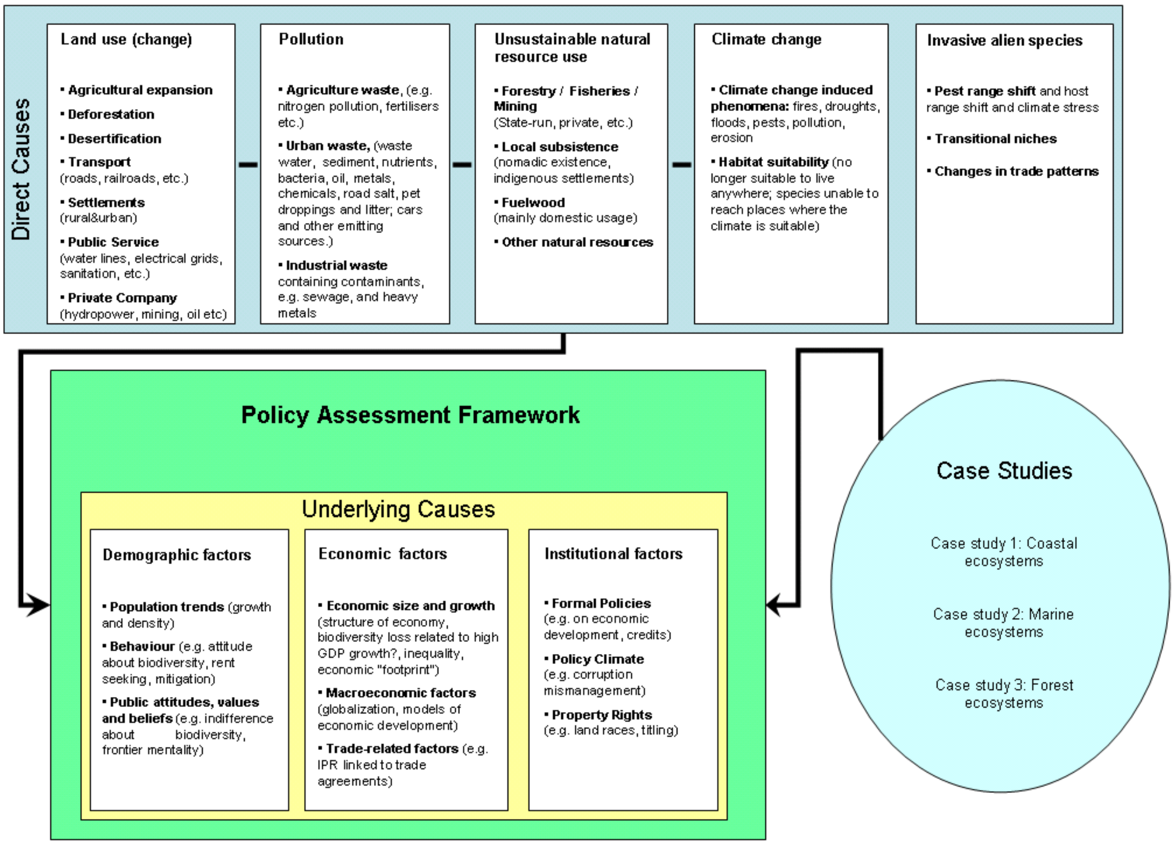
This report examines some real world situations where causes of biodiversity loss are explained by an interaction of a variety of socio-economic forces and, what turns out to be, **poor decision-making** and policy choices for a range of ecosystem contexts. By concentrating on marine, coastal, wetlands and forest ecosystems, the focus in this study is on real examples and giving perspective to the substantial literature and on-going research on biodiversity loss taking place at the moment.

Biodiversity is crucial to the maintenance of many ecosystem services such as regulation of chemical composition of the atmosphere, food production, supply of raw materials, water provision, nutrients' recycling, biological control of populations of flora and fauna, use of genetic resources, leisure activities and others. Biodiversity continues to decrease at unprecedented rates as human development and expansion result in the fragmentation and loss of habitat for flora and fauna. The loss of biodiversity is expected in most scenario studies to continue at an increasing pace in the coming decades – with projections estimating a decrease from about 70% in 2000 to about 63% by 2050 - as **key underlying causes such as economic and market failures are unlikely to be eliminated in the short run**.

A number of frameworks for assessing the complex interplay of pressures and drivers affecting biodiversity have been developed in the past. The common thread amongst these frameworks is that **most of the pressure on biodiversity stems from human-induced disturbance to ecosystems** via a number of complicated pathways across different physical and temporal scales. Specific mechanisms whereby biodiversity is lost differ according to biome, geography, climate, type of pressure (i.e. over-exploitation of wildlife as opposed to habitat conversion), economic context in the biodiversity host country, trade patterns, type of governance structure, and other factors.

The following diagram summarises these interlinkages between direct and underlying causes and the policy assessment framework for biodiversity loss. The diagram also shows how the selected case studies feed into the analysis of the policy assessment framework.

Overview of the direct and underlying causes of biodiversity loss and the policy assessment framework



Source: ECORYS

Based on an extensive review of the data relating to pressures and drivers of biodiversity loss, the present study has identified:

- the **major *direct* causes of biodiversity** loss to be: land use change and conversion of habitat to other land uses, pollution, unsustainable natural resources use, climate change and invasive alien species.
- ***Underlying these causes*** are failures in governance, appropriate decision-making and institutional functioning, as well as economic and market failures. Lack of adequate knowledge and understanding of the processes in ecosystems which conserve biodiversity and provide ecosystem services is pervasive throughout all interference of humans with ecosystems.

Naturally, various direct and underlying causes play a more or less significant role depending on the ecosystem under review:

- Habitat change, overexploitation as well as nitrogen and phosphorus pollution have had the greatest and an increasing impact on biodiversity loss in **forest ecosystems** over the past 100 years.
- For **inland wetlands** as well as **coastal ecosystems** habitat change and pollution have been the most influential drivers for biodiversity loss over the past century. Furthermore, invasive species have also had a high impact on biodiversity in these biomes.

- For **marine ecosystems** on the other hand, over-exploitation has been the single most influential driver of biodiversity loss in the past, followed by habitat change.

Evidence of some of these failures is borne out by the examination of forest, marine and coastal ecosystems in developing countries, emerging economies and developed nations in the annex to this study. This study has shown that marine areas suffer the most from a lack of adequate governance structure; and are susceptible to negative effects from economic growth. Freshwater ecosystems are increasingly under threat from the direct effects of climate change and water pollution, made worse by continued urbanisation. Coastal ecosystems suffer from pollution and eutrophication directly while underlying causes are over-population, fast population growth, as well as transport, economic growth and international trade. Forest ecosystems are directly threatened by climate change, land conversion such as agriculture and bio-fuels, infrastructure development, timber extraction and wood-fuel. Underlying causes include economic growth, increasing demand for food and the growth in the international bio-fuels market.

Frameworks for mitigating biodiversity loss results are inadequate, i.e. contributing to "unplanned" declines in species and populations. A lack of a systemic approach to capturing the true costs and benefits of ecosystem services, distributing these benefits and allocating conservation resources is common to many of the case studies. Underlying causes such as market failure, externalities and inadequate property rights can result in biodiversity loss even though biodiversity often figures in cost-benefit analyses. Underlying socio-economic factors are usually not taken into account and it usually falls to policy makers to address the issue of biodiversity loss. However, the information policy makers require to make adequate decisions is also often unavailable, too complex or disaggregated, making it extremely difficult to translate policy goals into policy measures. Moreover, poor governance means that much **biodiversity is lost due to illegal activity**. For example, land use change which is unsanctioned cannot be undone or prevented if institutional controls and mechanisms are inadequate. This is highlighted throughout the Congo Basin forestry case study.

It is usually through establishing broader **international agreements** that foster long-term commitments to maintaining biodiversity or reducing the loss of biodiversity such as the CBD that one can actually start talking about "planned" biodiversity loss and biodiversity conservation. However, conflicting positions of the contracting parties, lack of sufficient data to support negotiations and to establish a level playing field between parties make it difficult for such biodiversity agreements to develop ambitious yet meaningful targets with associated implementation measures.

Solutions for the continuing decline in biodiversity need to be developed and implemented as the targets set to stop the decline in biodiversity by 2010 are most likely not going to be reached by the international community. This study identifies some of the **possible options to halt and reverse the trend towards decreased levels of biodiversity**. Further development of an international market for ecosystem services in which the benefits of ecosystems are captured, valued and paid for to mitigate the negative effects on biodiversity from development projects is one such option. This requires close cooperation between ecologists and economists in order to obtain acceptable valuations of these services, and moreover requires strong institutions to implement regulatory control.

Other options for addressing the underlying causes of biodiversity loss can be done **using available knowledge** and following a process similar to the framework that has developed out of the need to address climate change, i.e. raising awareness of the effects of climate change and its implications for human populations in all countries, underpinned by scientific consensus. The process of raising awareness of the economic, social and environmental value of biodiversity is indeed already underway in Europe, with the TEEB process being an important example. Making sure the value of nature, ecosystems and biodiversity is profiled as highly as climate change has been in recent years will create a global platform from which further development of solutions can be pursued.

Yet another approach is to **pursue enforcement of current biodiversity policy**, and implement conservation strategies and agendas more effectively. Protection of conservation areas (with financial or land compensation for the local/ regional/ national human populations) requires adequate enforcement (somewhat like blue helmet UN interventions against poaching). Moreover, to develop an international payment system of ecosystem services will require control and enforcement. In other words payment of ecosystem services through the World Bank or through regional development banks to those parties affected requires suitable methods for host countries to apply for compensation, control and enforcement.

Long-term education of the importance of biodiversity is another option that should be pursued by the international community. Teaching the next generation (including school children and students) about the complexities of the world economy, ecosystem services, ecological footprints and inequality etc. is required to make sure the actions required to stop the halt in biodiversity are met now and in the future. Educational material is plentiful, expertise is available and current staff at schools and universities can easily be trained. However, this approach also requires adequate financing of education in developing countries.

1 Introduction

1.1 Background

ECORYS has been commissioned by the European Commission to undertake a study on understanding the causes of biodiversity loss and the policy assessment framework. The main objectives of this study are twofold:

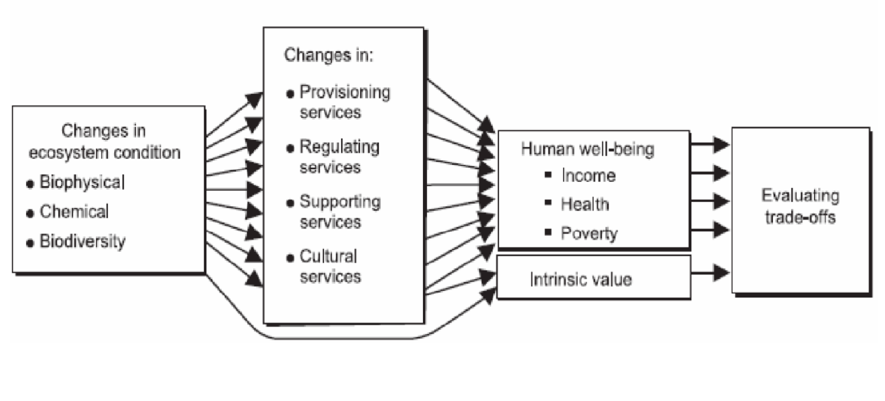
- Identify and map out the direct and underlying causes of biodiversity loss today;
- Provide the Commission with a mapping of the decision-making frameworks which drive current global policy making with regards to ecosystems and biodiversity and identify where these processes fail to account for the latter's importance in the broader policy framework.

1.1.1 Context

Building on the Millennium Ecosystem Assessment (MEA) and on the ongoing 'Economics of Ecosystems and Biodiversity[1]' (TEEB) study, it is apparent that current losses of biodiversity worldwide will have substantial and potentially severe consequences, on economies as well as on global health and welfare. The world's poor will most likely bear the immediate and direct costs of biodiversity losses, although it is clear from these and many other international studies that the world as a whole will be impacted. Biodiversity directly provides or is a major factor in maintaining the critical 'ecosystem services' on which development depends, including air and water purification, soil conservation, disease control, and reduced vulnerability to natural disasters such as floods, droughts and landslides. Biodiversity loss exacerbates poverty, and likewise, poverty is a major threat to biodiversity. Indeed, the services to humans provided by biodiversity and functional ecosystems have been identified as a key reason for paying attention to, and acting on, the need to preserve a global biodiversity and ecosystem balance (Figure 1.1).

1 TEEB: "The Economics of Ecosystems and Biodiversity" is a global review which evaluates the costs of the loss of biodiversity and the associated decline in ecosystem services worldwide, and compares them with the costs of effective conservation and sustainable use.

Figure 1.1 Mapping the link between biodiversity, ecosystem services, and human wellbeing



Source: Review of the Economics of Biodiversity Loss – Phase 1. 2008

Recent evidence such as that documented in the state of the planet reports[2], reveals the dramatic loss of our natural assets and the degradation of the services they provide. For the private sector, these changes implicate complex new challenges. Operational, regulatory, and public risks are matched by opportunities emerging from the development of new technologies, new markets, and new business models.

Under the UN Convention on Biological Diversity (CBD), governments worldwide have signalled their commitment to involve the private sector in the development of the appropriate enabling regulatory framework to harness the power of markets in designing and implementing innovative solutions to the issue of the loss of biodiversity. The recognition that human, economic and natural well-being are inextricably linked requires that objectives be set and appropriate public policy enacted within a constructive framework for action. It is partly for this reason that having a clear mapping of the causes and driving factors behind biodiversity loss today is a fundamental pillar for sound and informed policy decisions and implementation today and in the future.

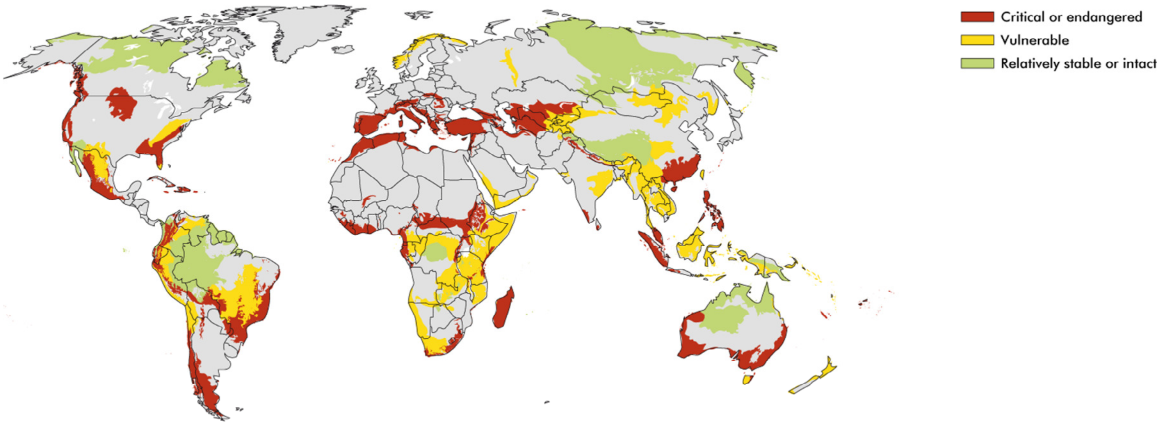
1.1.2 Current state of play

The loss of biodiversity is expected to continue at an unchanged increasing pace in the coming decades. Key underlying drivers, global population and economic activity are expected to keep on growing. Between 2000 and 2050, the global population is projected to grow by 50% and the global economy to quadruple. The need for food, fodder, energy and wood will unavoidably lead to a decrease in and unsustainable use of natural resources. The negative impacts of climate change, nitrogen deposition, fragmentation, infrastructure and unchecked human settlement on biodiversity will further expand. As a result, global biodiversity[2] is projected to decrease from about 70% in 2000 to about 63% by 2050. According to this projection based on the CBD OECD baseline scenario (2008), the rate of biodiversity loss over the coming decades will increase instead of decrease.

2 The fourth UNEP Global Environment Outlook: environment for development (GEO-4) assessment is a UN report on environment, development and human well-being, providing analysis and information for decision making.

The following map provides an overview of worldwide critically endangered, vulnerable and relatively stable or intact biodiversity hotspots.

Figure 1.2 Worldwide depiction of threatened biodiversity hotspots

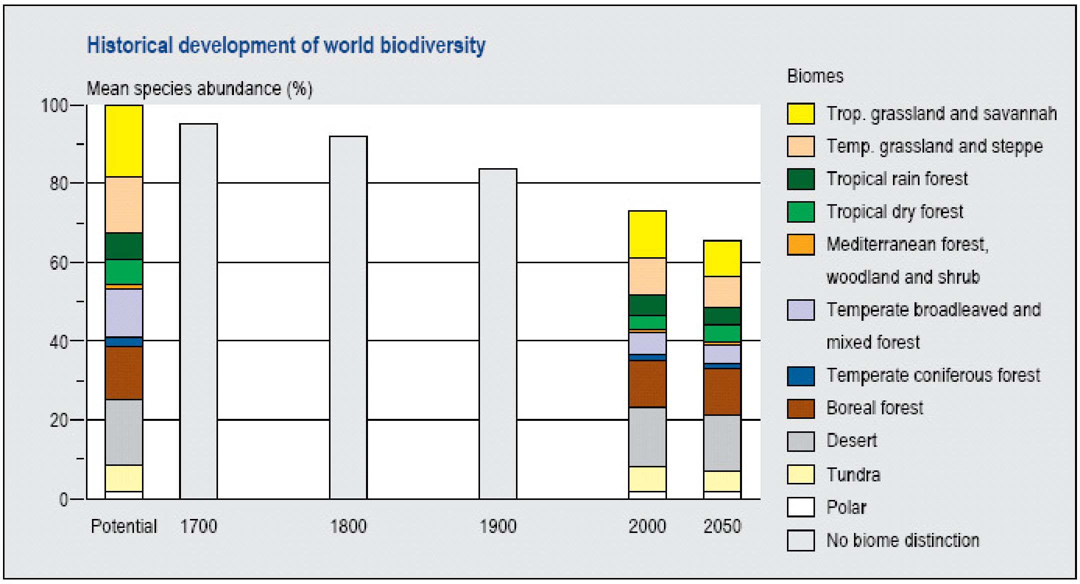


Source: UNEP-GRID

As can be seen from this map, almost all of the critically endangered biodiversity hotspots are situated in developing countries and transition economies, primarily in the southern hemisphere. However, also the United States of America, the European Union and Australia face severe degradation of some of their biodiversity hotspots. This highlights the fact the biodiversity loss is an urgent global phenomenon.

The next diagram shows the historical development of world biodiversity across various biomes. As can be seen from this diagram, biodiversity – measured as the percentage of mean species abundance – has been rapidly decreasing across biomes over the past.

Figure 1.3 Trends in biodiversity from 1700-2050



Source: Braat & Ten Brink, 2008

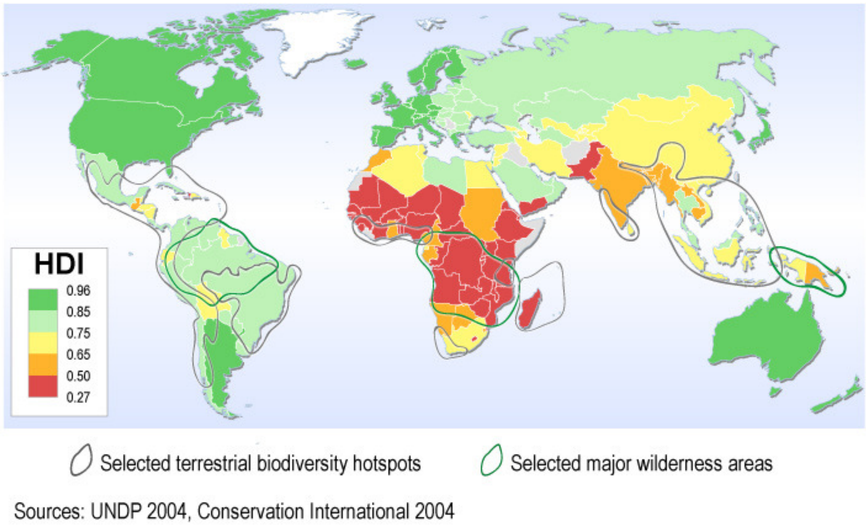
1.1.3 The debate on economics and biodiversity in a nutshell

The cause of the decline in biodiversity can be (and has traditionally been) viewed as a result of the expansion of human society coupled with economic development. This view holds that the expansion of human society needs to be stopped and reversed to stop biodiversity loss. Another viewpoint associates biodiversity loss with *underdevelopment* of certain sections of human society. For example deforestation and degradation of ecosystems can be traced to poverty that forces peoples into areas where a lack of institutional control results in a decline of diversity resident in these regions.

Economists and biodiversity conservationists tend to agree on one central point regarding the relationship between the economy and biodiversity: damage to biodiversity increases dramatically in the course of economic development until, at a certain level of wealth, opportunities for biodiversity conservation can potentially be improved, but there is always the risk of irreversible damage to biodiversity maintaining and regenerating ecosystem processes. There is also strong agreement about the central importance of development for the eradication of poverty.

The following graphic shows global human development and biodiversity. This map displays the Human Development Index (UNDP) by country and hotspot regions overlaid on that. As the graphic shows, some of the world's least developed countries are located in hotspot areas of high importance for biodiversity. It can be argued that because most of the world's biodiversity persists in some of the world's poorest countries where conservation is not a top priority and where human encroachment into high value biodiversity areas is more likely, there is a need to develop strategies for maintaining biodiversity that include human-disturbed landscapes and not just major wilderness areas, especially as climate change could well cause species to shift their ranges outside areas that are currently protected. New strategies should include new protected areas, but that these should be selected based on more comprehensive criteria than species richness or where biodiversity hot spots occur. For example, new protected areas should be selected because of their concentrations of endemic or endangered species, their complementarity with and representation of local populations, and protection of ecosystem services.

Figure 1.4 Global biodiversity hotspots and development levels



There is increasing recognition that apart from setting aside additional protected areas and making human-altered habitats more hospitable to biodiversity, making efforts to reduce human pressures on biodiversity and remaining ecosystems are key to long-term success. As a lot of conservation biologists point out, attempting to find ways of reducing the basic drivers of biodiversity loss, including stemming population growth and finding solutions for socio-economic-political failures is a priority.

1.2 Current research on biodiversity loss

Many past and present research efforts and models exist to not only measure the extent of biodiversity loss, but also its causes, as well as associated environmental, social and economic impacts.

1.2.1 Latest biodiversity research and models

In recent years, several studies[3] on global biodiversity loss have been carried out. These studies described the biodiversity situations at that time, or used expert opinions to estimate potential future impacts. In the Global Environment Outlook 3[4], the consequences of four socio- economic scenarios on biodiversity were assessed, using the approaches of both the IMAGE Natural Capital Index (NCI) and the GLOBIO2 model.

In IMAGE—NCI, biodiversity loss, defined as a deviation from the undisturbed pristine situation, was related to increased energy use, land-use change, forestry, and climate change, whereas in GLOBIO2 the human influence on biodiversity was based on relationships between species diversity and the distance to roads and other infrastructure. The Millennium Ecosystem Assessment (MA) used a combination of IMAGE 2.2 and Species Area Relationships to predict biodiversity loss, resulting from expected changes in land use, climate change, and nitrogen deposition[5].

GLOBIO3, the next generation model is built on GLOBIO2, NCI and a large database of species-response relationships, is built on a set of equations linking environmental drivers and biodiversity impact (cause–effect relationships). The cause–effect relationships are derived from available literature using meta-analyses. GLOBIO3 describes biodiversity as the remaining mean species abundance (MSA) of a set of original species, relative to their abundance in pristine or primary vegetation, which are assumed to be not disturbed by human activities for a prolonged period. MSA is similar to the Biodiversity Integrity Index[6] and the Biodiversity Intactness Index[7] and can be considered as a proxy for the

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3 Alkemade,R., M. van Oorschot, L. Miles,C. Nellemann, M. Bakkenes and B. ten Brink (2009) GLOBIO3: A Framework to Investigate Options for Reducing Global Terrestrial Biodiversity Loss. Ecosystems DOI: 10.1007/s10021-009-9229-5

4 UNEP. 2002. Global environment outlook 3. London: Earthscan Publications Ltd.

5 MA. 2005. Millennium ecosystem assessment. Ecosystems and human well-being . Policy Summary. Washington, DC: Island Press.

6 Majer JD, Beeston G. 1996. The Biodiversity Integrity Index: an illustration using ants in Western Australia. Conserv Biol 10:65–73.

7 Scholes RJ, Biggs R. 2005. A biodiversity intactness index. Nature 434:45–9.

CBD indicator on trends in species abundance[8]. It should be emphasized that MSA does not completely cover the complex biodiversity concept, and complementary indicators should be included, when used in extensive biodiversity assessments. For a more detailed discussion of the MSA indicators see Chapter 4 in Tucker & McConville[9] (eds.)(2009). Individual species responses are not modelled in GLOBIO3; MSA represents the average response of the total set of species belonging to an ecosystem. The current version of GLOBIO3 is restricted to the terrestrial part of the globe, excluding Antarctica.

Global environmental drivers model

Global environmental drivers of biodiversity change are input for GLOBIO3.

GLOBIO (Global methodology for mapping human impacts on the biosphere) is a simple transparent global model developed under the GLOBIO project, coordinated by the Norwegian Institute for Nature Research (NINA), UNEP-GRID Arendal, UNEP-WCMC and UNEP/DEWA. It is used to visualize, at a scale of 1 x 1 km, the cumulative impacts on biodiversity and ecosystem function of growth in human resource demand and associated infrastructure development. The model provides a statistical risk assessment of probability of human impacts using buffer zones from infrastructure that vary with type of human activity and density of infrastructure, region, vegetation, climate and sensitivity of species and ecosystems. Satellite imagery is used to derive overviews of cumulative impacts of ongoing development. Future scenario situations are derived from data on existing infrastructure, historic growth rates of infrastructure, availability of petroleum and mineral reserves, vegetation cover, population density, distance to coast and projected development. More information on GLOBIO can be found at http://www.globio.info.

GLOBIOM, G4M and other findings from ECORYS/IIASA study on avoided deforestation

The ongoing ECORYS/IIASA study for DG ENV on the evolution of some deforestation drivers and their potential impacts on the cost of an avoided deforestation scheme provides interesting results related to biodiversity to be discussed and further elaborated in this study. While much of the direct and indirect driver analysis of the ECORYS/IIASA study confirms findings for biodiversity drivers in this study, it is particularly interesting to have a closer look at some of the modelling results for various policy shock scenarios analysed via the GLOBIOM and G4M models and their implications for projected future deforestation levels and associated biodiversity loss, in particular the meat, infrastructure, biodiversity protection and governance scenarios.

CBD Report on Connecting Biodiversity and Climate Change

The report was published as CBD Technical Series No.41, *Connecting Biodiversity and Climate Change Mitigation and Adaptation – Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change* in October 2009. The main messages in the report focus on:

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[8] UNEP. 2004. Decisions adopted by the conference of the parties to the convention on biological diversity at its seventh meeting (UNEP/CBD/COP/7/21/Part 2), decision II/30 (CBD 2004). http://www.biodiv.org/decisions/.

[9] Tucker, G. and A.J. McConville (eds.)(2009) Scenarios and models for exploring future trends of biodiversity and ecosystem services changes. Final report to the European Commission, DG Environment on Contract ENV.G.1/ETU/2008/0090r. Institute for European Environmental Policy, Alterra Wageningen UR, Ecologic, Netherlands Environmental Assessment Agency, United Nations Environmental Programme-World Conservation Monitoring Centre.

- The impacts of climate change on biodiversity;
- The role of biodiversity in climate change adaptation;
- The links between biodiversity conservation and sustainable use and climate-change mitigation;
- The ways and means to value biodiversity with regard to climate-change responses.

The report is the outcome of scientific and technical deliberations conducted by experts from 23 countries as well as United Nations organisations, intergovernmental and non-governmental organisations and representatives from indigenous communities. Key results of the study are analysed in this report whenever relevant.

Second DIVERSITAS Open Science Conference: Biodiversity and society: understanding connections, adapting to change. 13-16 October 2009 - Cape Town, South Africa.
DIVERSITAS is an international, multidisciplinary network of scientists that addresses the linkages between biodiversity and human activity. In recent research DIVERSITAS has released statements to coincide with the meeting of the DIVERSITAS group of global experts on biodiversity in Cape Town October 2009. They have warned of an alarming increase in the extinction of species because of threats to biodiversity and ecosystems caused in particular by pollution, climate change and urban spread. Group members say world leaders have failed to honour commitments on reducing the loss of biodiversity.

In addition they have found that that the extinction rates of species are much higher than had been predicted only a few years ago. The worst affected - according to DIVERSITAS - are freshwater species like fish, frogs, turtles and crocodiles, which are becoming extinct six times faster than their terrestrial and marine cousins. In addition, some of the group's experts predict that by 2025 not a single river in China will reach the sea - except during floods. The scientists lay the blame of these increased threats to animal species on world leaders as they say world leaders have failed to implement the policies needed to make good on their commitments - drafted at the Earth Summit in Johannesburg seven years ago - to significantly reduce the loss of biodiversity by 2010.

1.2.2 Biodiversity frameworks and assessments

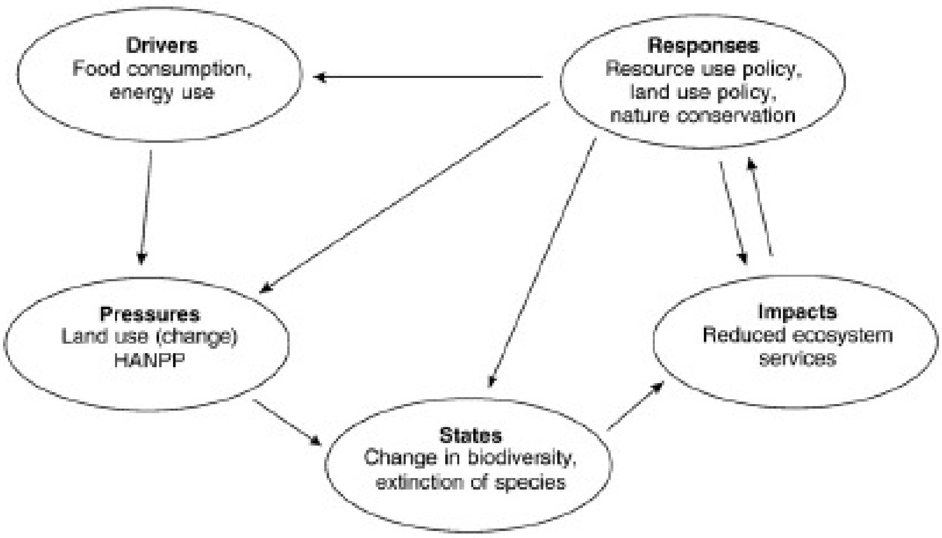
In recommendation to the European Environment Agency (EEA) on how they should proceed with the development of a strategy for Integrated Environmental Assessment, RIVM[10] proposed the use of a framework, which distinguished driving forces, pressures, states, impacts and responses. This became known as the DPSIR framework and has since been more widely adopted by the EEA, acting as an integrated approach for reporting, for example this has been used in the EEA's State of the Environment Reports[11]. The framework is seen as giving a structure within which to present the indicators needed to enable feedback to policy makers on environmental quality and the resulting impact of the political choices made, or to be made in the future. According to the DPSIR framework there is a chain of causal links starting with 'driving forces' through 'pressures' to 'states' and 'impacts' on ecosystems, human health and functions,

[10] RIVM: Rijks Instituut voor Volksgezondheid en Milieu (The Dutch Environment Agency)
[11] State of the Environment Reports: The European environment - State and outlook 2005, European Environent Agency

eventually leading to ‘responses’. Driving forces are the socio-economic and socio-cultural forces driving human activities, which increase or mitigate pressures on the environment. Pressures are the stresses that human activities place on the environment. State, or state of the environment, is the condition of the environment. Impacts are the effects of environmental degradation. Responses refer to the responses by society to the environmental situation.

The DPSIR framework (Driving Forces-Pressures-State-Impacts-Responses) is often used to assess and manage many environmental problems, and as such is often used by (social) scientists in biodiversity-related studies. For example, the recent study on the “Cost of Policy Inaction (COPI I)[12]” uses this framework as applied to biodiversity. The causal chain linking driving forces to impacts and responses is a complex one, and is tended to be broken down into sub-tasks, e.g. by considering the pressure-state relationship. In Figure 1.5, the DPSIR framework is displayed for biodiversity with an overview of how the different pressures, states and drivers etc. causally relate to each other (seen by the direction of the arrows), while Figure 1.6 shows the same DPSIR framework, but focussing on providing examples of the drivers, pressures etc.

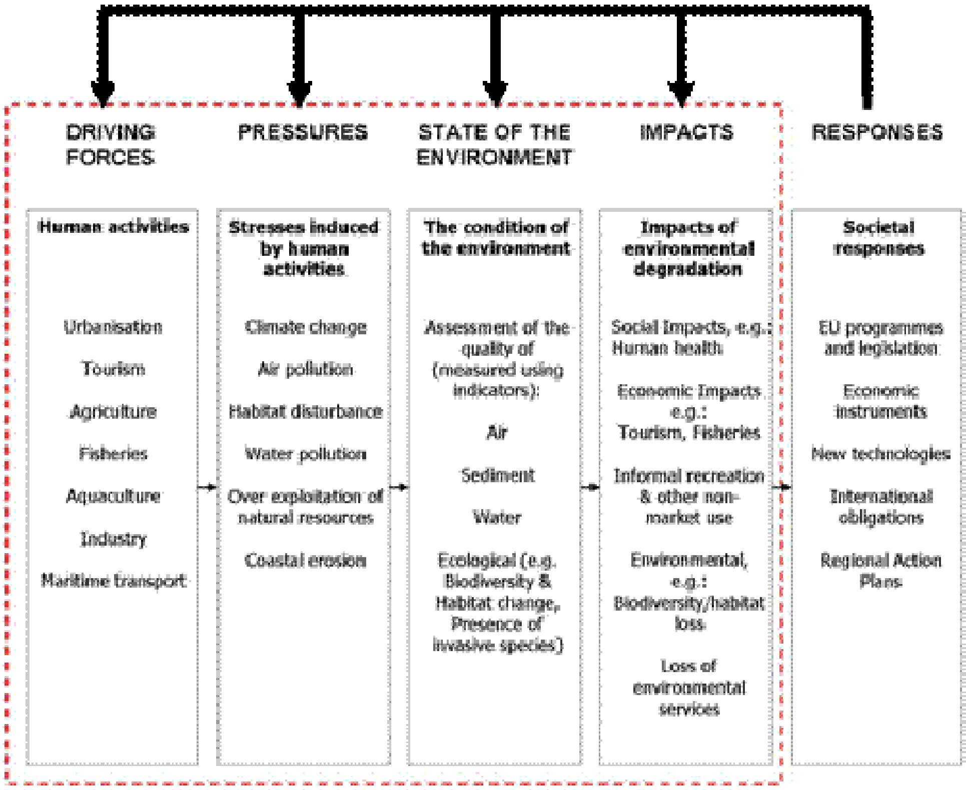
Figure 1.5 The drivers-pressures-states-impacts-responses (DPSIR) framework applied to biodiversity



Source: Haberl et al. Towards an integrated model of socio-economic biodiversity drivers, pressures and impacts. A feasibility study based on three European long-term socio-ecological research platforms; Ecological Economics Vol. 68 2009

12 COPI: “The cost of policy inaction: the case of not meeting the 2010 biodiversity target” (L. Braat & P. ten Brink (eds.)) has been produced by a consortium led by Alterra. This study for the European Commission, DG Environment, was part of the Review of the Economics of Biodiversity Loss, which was developed by Germany and the European Commission. This is itself part of a global study, The Economics of Ecosystems & Biodiversity (TEEB).

Figure 1.6 DPSIR framework with examples



Source: Rijks Instituut voor Volksgezondheid Milieu (RIVM) for EEA.

1.3 Approach

Identification of core tasks

The Terms of Reference provide a clear overview of the objectives and expected results of the study and describe the tasks foreseen to meet those objectives and results. Overall, the study is divided into three main tasks:

- Task 1;
- Task 2; and
- Task 3.

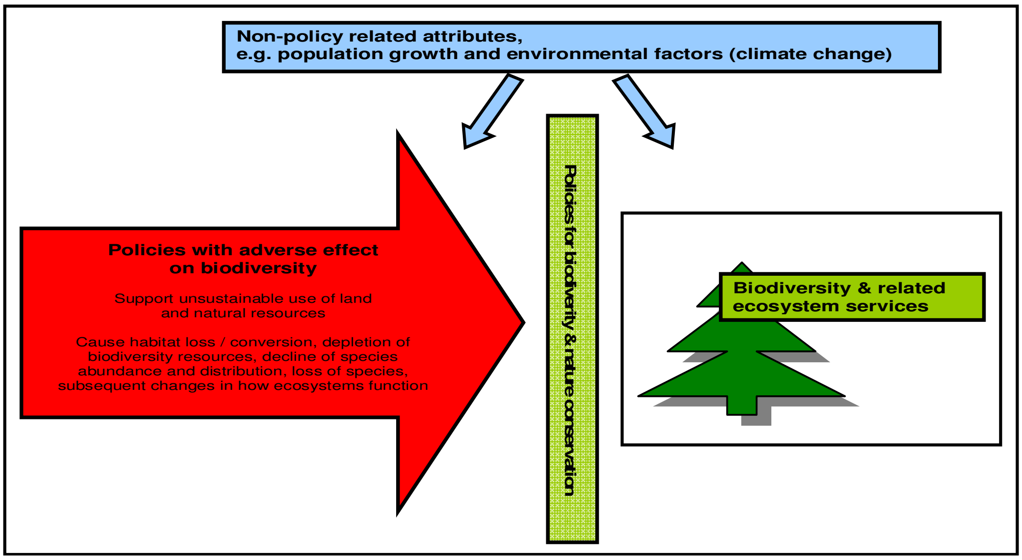
Framework for analysis

Given the rather complex relationship between the underlying causes of biodiversity loss and how these are manifested as direct causes of biodiversity loss, what follows is a brief explanation of the point of departure for this study and how this study will be presented.

Firstly, the impact humanity has on biodiversity is largely determined by the social and economic activities of humans. How these activities are coordinated is based on economic theories of resource allocation. Economic theory suggests that resources are not allocated efficiently by a free market in the face of imperfect information. Indeed, much socio-economic activity generates *significant* negative externalities or market failures where the presence of negative externalities is indicated by a divergence between private cost and social cost, or private benefit and social benefit. Negative externalities represent or reflect 'market failure', i.e. a non-priced effect on the welfare of one actor in the economy resulting from the activities of another. A major market failure is connected with biodiversity loss (in the form of habitat destruction or degradation). Thus, for this study, a major component will be to assess the underlying reasons that market failures connected to biodiversity occur and assess what the possible solutions are.

Secondly, biodiversity loss occurs at the local level, while many of the underlying causes are remote. The local actor is most likely acting rationally within the individual's particular set of limits and possibilities, including any social, cultural, political, economic, and environmental constraints applicable. This notion that actions on the ground affecting biodiversity are directed by underlying regional, national and global rules, procedures and organisations as shown in Figure 1.7. It illustrates that in a broad sense, biodiversity is affected by global, national and local policies that have not been designed to factor in its effects on biodiversity (red arrow), The green box shows that policies which *do* have a planned effect, such as nature conservation policies etc. have to contend and be responsive to those policies with adverse effects on biodiversity, which in turn are formulated after dealing with a non-policy related attributes of biodiversity loss (blue arrow).

Figure 1.7 Linking non-policy and policy-related causes of biodiversity loss



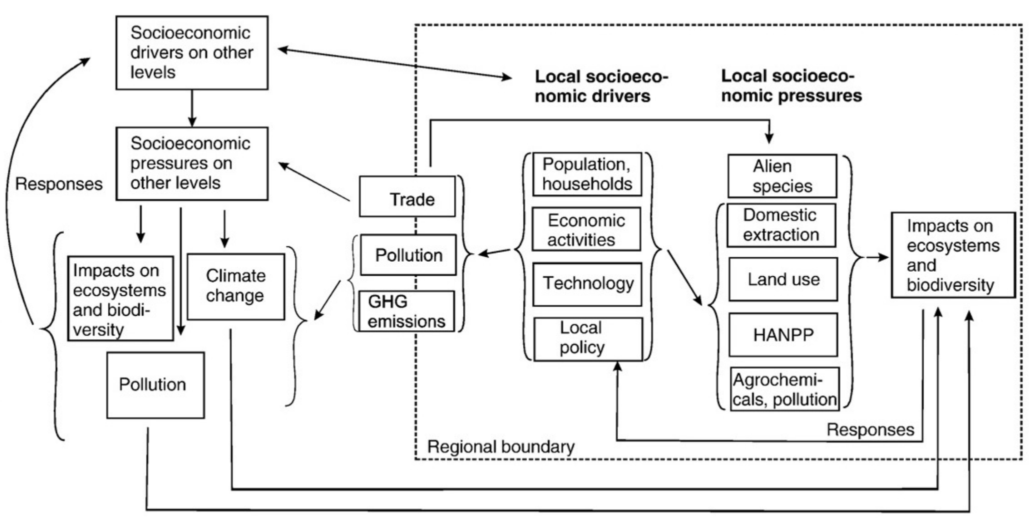
Source: Braat & Ten Brink (eds.) 2008

In the TEEB process, it has been highlighted that if the right policies are not adopted, the current decline in biodiversity and the related loss of ecosystem services will continue and in some cases even accelerate. TEEB's intention is to sharpen awareness of the value of biodiversity and ecosystem services and facilitate the development of cost-effective policy responses, by for example, preparing a 'valuation toolkit'.

The distinction between direct and underlying causes is thus often not as clear as it appears. In reality, there are long, complex causation chains that eventually lead to a loss of biodiversity. Causes may be hierarchical. Few cause-effect chains are linear or unidirectional. Instead, there are many branches that constitute secondary cause-effect loops leading to biodiversity loss. Feedback loops complicate analyses of the causes of biodiversity loss. Causal factors are likely to vary over time, sometimes drastically.

In very recent work by Heberl et al.[13], a conceptual model is developed that tries to close the gap in the understanding of inter-relationships between drivers, pressures and impacts in the DPSIR scheme. The overview depicted in Figure 1.8 is based on the notion that all major pressures on biodiversity are more or less directly linked to human use of resources such as materials, energy and land. The conceptual overview tries to differentiate different driver scales or levels. In other words, that local socioeconomic driver such as human population, households, economic activities, technology and local policy are influenced by socio-economic drivers on other scales. The essence of the concept depicted here is that impacts on ecosystems within a region "that primarily or even exclusively result from socio-economic systems beyond its boundary may be very important or even dominant". In this model for example, extra-regional pollution is shown as flowing into a region and thus may be important as a factor of biodiversity-loss, while pollution that is created locally may also have an impact.

Figure 1.8 Socioeconomic biodiversity pressures and drivers – a conceptual model



Higher system levels

Source: Haberl et al. Towards an integrated model of socio-economic biodiversity drivers, pressures and impacts. A feasibility study based on three European long-term socio-ecological research platforms; Ecological Economics Vol. 68 2009

For the present study, the main schematic representation of the direct and underlying causes is given in Figure 1.9. The direct causes of biodiversity loss as defined in this study are connected to the direct negative effects that human activity has on biodiversity and ecosystem integrity. The direct causes of biodiversity loss in natural ecosystems are human induced actions that directly destroy the natural systems or reduce their quality. The range of various direct causes is diverse, and varies according to the ecosystem characteristics. It is almost impossible (and probably not overly useful) to try and establish a comprehensive list of human activities that affect biodiversity. What is more useful is to characterize the direct and underlying causes, and to relate them to socio-economic processes.

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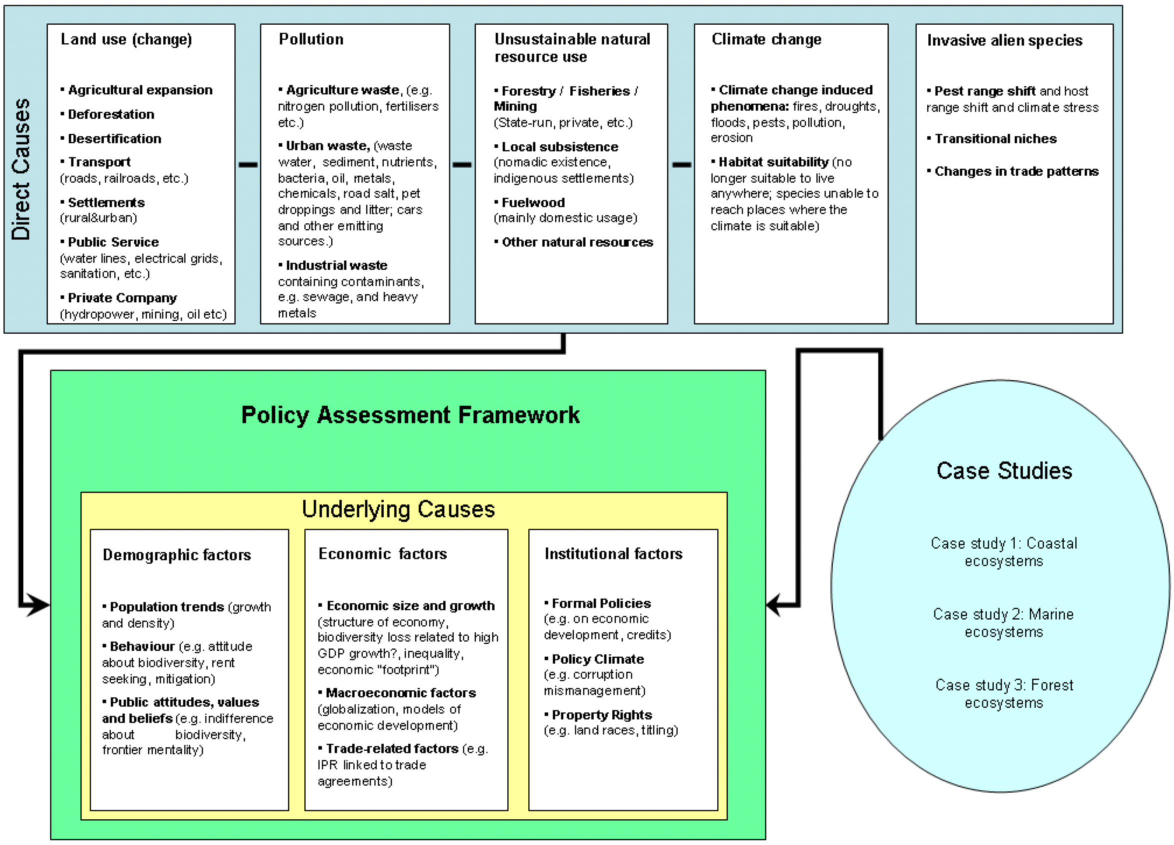
13 Helmut Haberla, Veronika Gaubea, Ricardo Díaz-Delgadob, Kinga Krauzec, Angelika Neunerd, Johannes Peterseild, Christoph Plutzare, Simron J. Singha, Angheluta Vadineanuf; "Towards an integrated model of socioeconomic biodiversity drivers, pressures and impacts. A feasibility study based on three European long-term socio-ecological research platforms" in Ecological Economics. 68. 2009 pp 1797 -1812

Figure 1.9 Overview of the direct and underlying causes of biodiversity loss and the policy assessment framework



Source: ECORYS

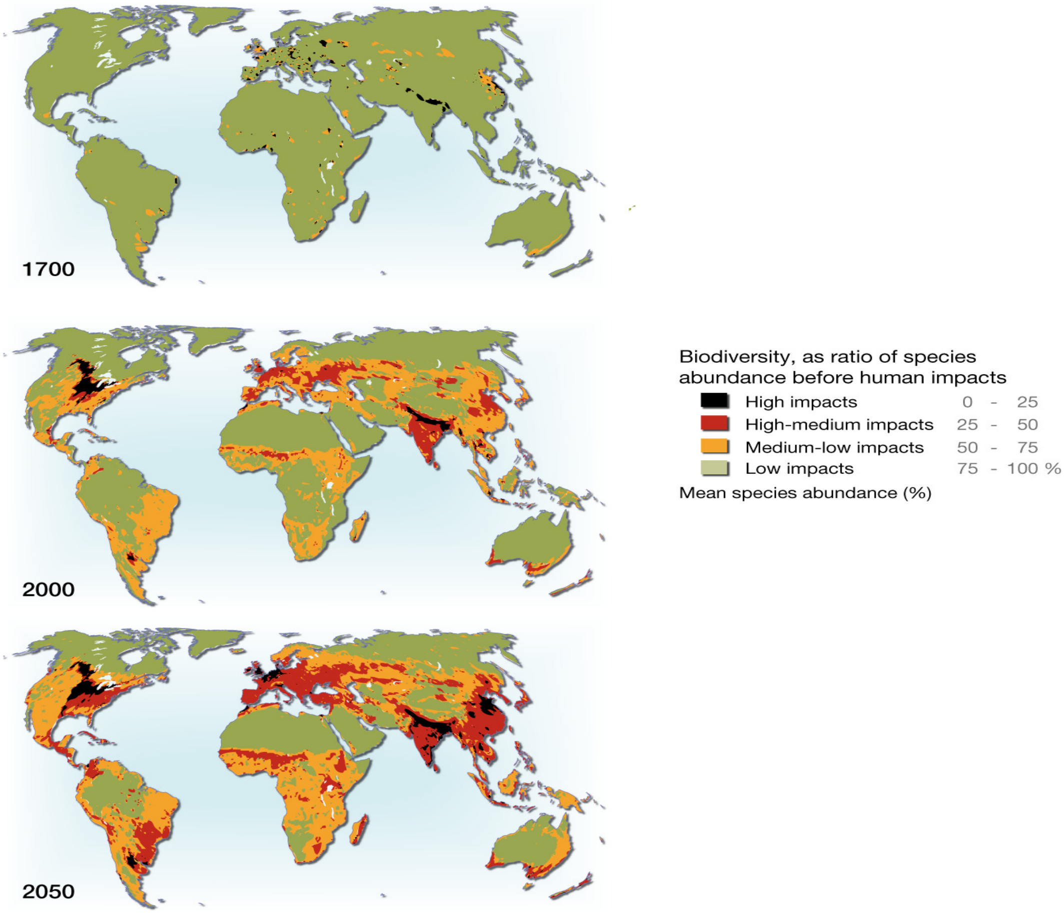
The approach used for the present study is thus not an attempt to re-invent or further develop an existing model for biodiversity loss that perfectly captures the complex interaction of multiple level pressures and drivers, but rather one that focuses on understanding the social, economic and scientific factors that underlie biodiversity losses in different biomes. In the following chapters, these issues will be explored in depth.

2 Direct causes of biodiversity loss

2.1 Introduction

According to most sources, the major direct causes of human-induced biodiversity loss are the fragmentation, degradation or loss of habitats (land-use change in Figure 1.6); the over-exploitation of natural resources; pollution of air and water (by several activities such as agriculture); the introduction of non-native (alien, or exotic) species and climate change-induced biodiversity loss - these factors being inextricably linked with some or all of the other direct causes and in turn are driven by underlying causes. In Figure 2.1, the long-term pattern of global biodiversity loss is depicted.

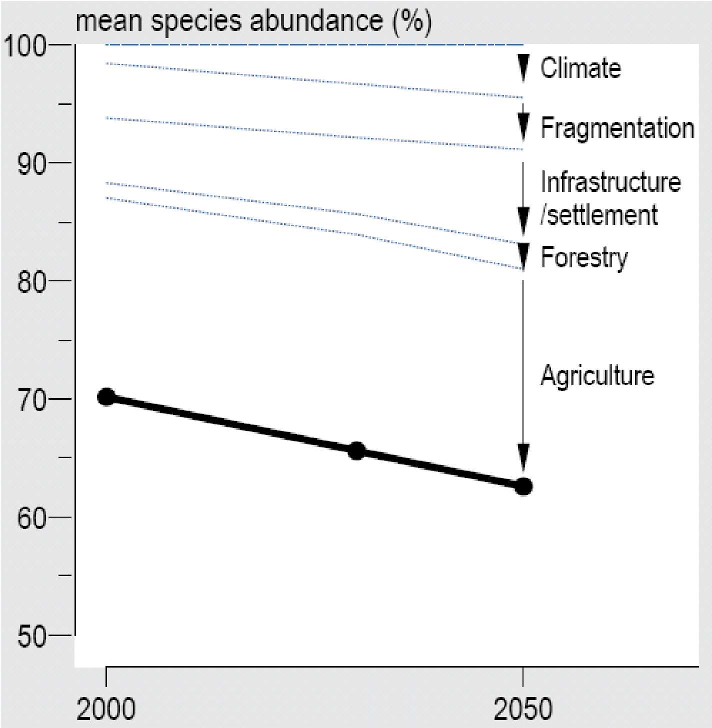
Figure 2.1 Loss of biodiversity with continued agricultural expansion, pollution, climate change and infrastructure development



Source: GLOBIO; Alkemade et al., 2009

The following CBD figure provides a projection of worldwide biodiversity developments until 2050.

Figure 2.2 Development of mean species abundance worldwide in the baseline scenario from 2000 to 2050 and the contribution to this decline from various environmental pressures

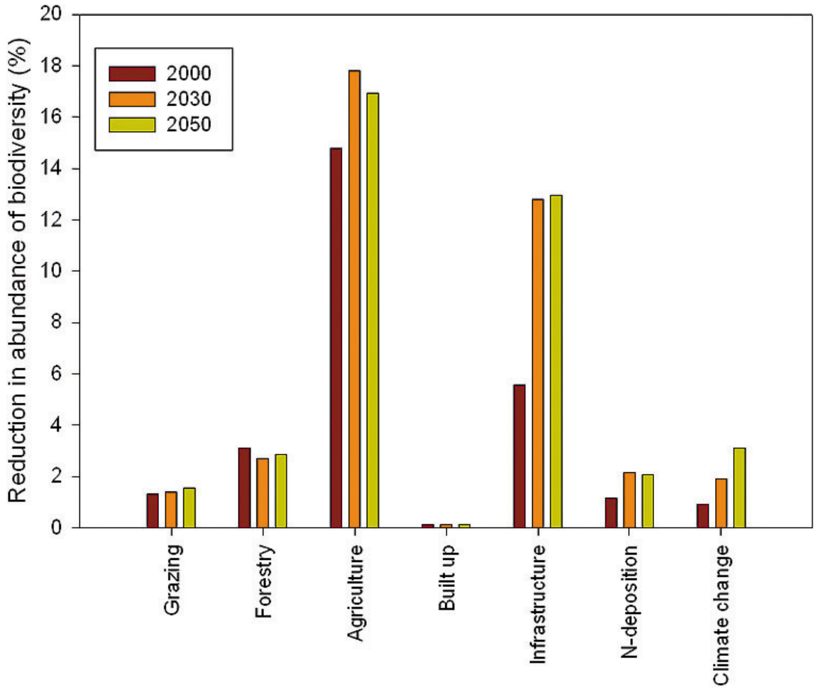


Source: CBD (2007), Global Biodiversity Outlook 2

As can be seen from this figure, one major cause of future species loss will be land use change from agriculture. Further, infrastructure development and settlement expansion as well as the consequences of climate change will be significant contributors to future biodiversity loss if no new policy measures are being implemented.

Naturally, the relative significance of these different direct causes of biodiversity loss varies from region to region. The following figure provides an example of South Asia: in this region, agriculture and infrastructure development are predicted to be by far the most influential factors causing biodiversity loss in the coming decades.

Figure 2.3 The relative significance of different direct causes for projected biodiversity loss in South East Asia, 2000-2050 (GLOBIO 3.0).

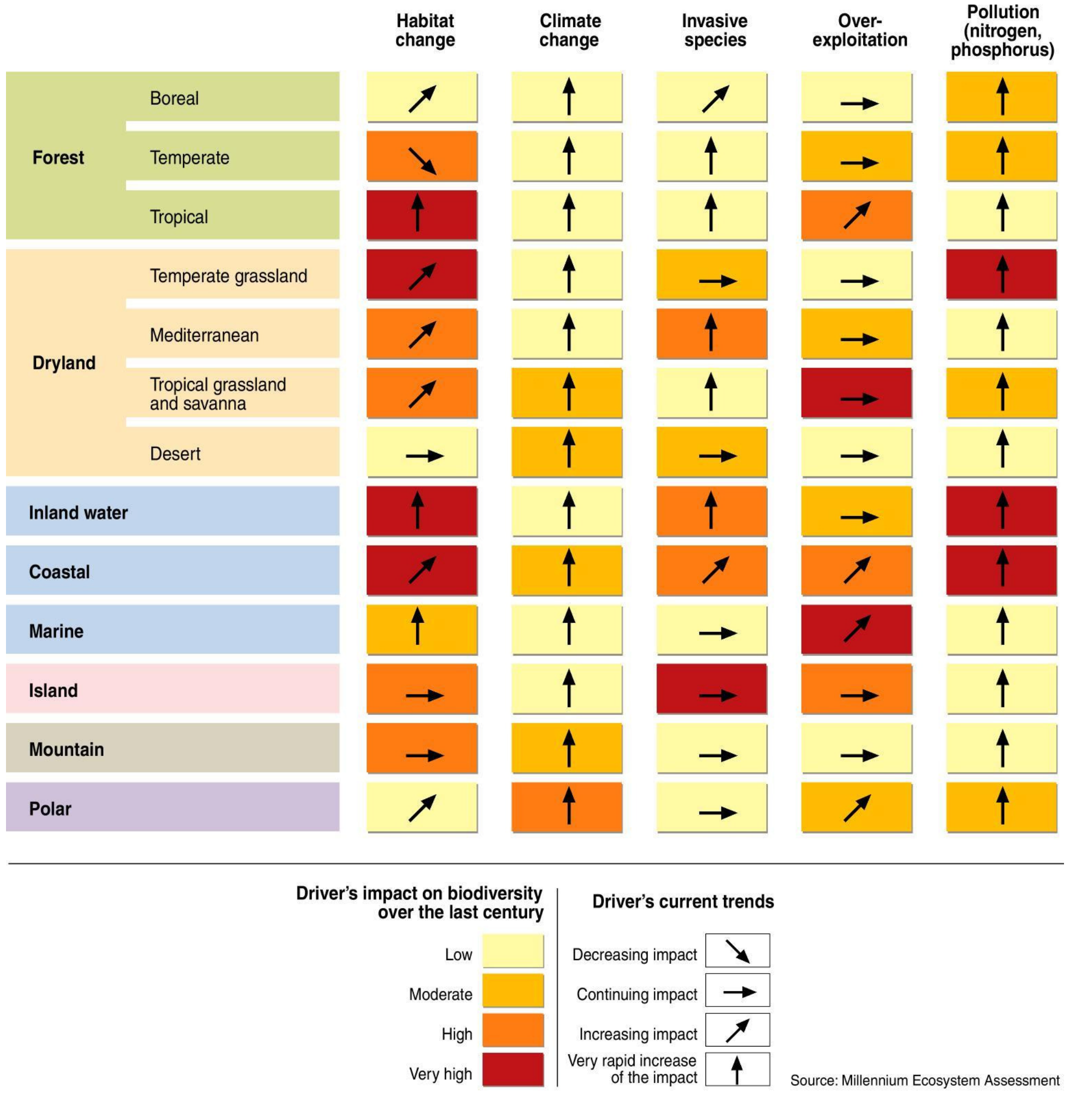


Source: GLOBIO 3.0, UNEP GRID-Arendal

The next diagram (Figure 2.4) provides a summarised overview of key biodiversity loss drivers per biome. The cell color indicates impact of each driver on biodiversity in each type of ecosystem over the past 50–100 years. High impact means that over the last century the particular driver has significantly altered biodiversity in that biome; low impact indicates that it has had little influence on biodiversity in the biome. The arrows indicate the trend in the driver. Horizontal arrows indicate a continuation of the current level of impact; diagonal and vertical arrows indicate progressively increasing trends in impact.

What can be deducted from this diagram in general terms is the habitat change has been the single most important driver of biodiversity loss across biomes over the last century, followed by overexploitation and nitrogen and phosphorus pollution. And while the diagram indicates that climate change has not been a significant driver of biodiversity loss in any biome (except the polar regions) in the past, its impact is increasing very rapidly and thus is likely to become a key driver of biodiversity loss across all biomes in the future.

Figure 2.4 Main direct drivers of change in biodiversity and ecosystems



Source: Millennium Ecosystem Assessment

As can be seen in this figure habitat change, overexploitation as well as nitrogen and phosphorus pollution have had the greatest and an increasing impact on biodiversity loss in **forest ecosystems** over the past 100 years.

Similarly, for **dryland ecosystems** habitat change, overexploitation and pollution have been the main drivers of biodiversity loss in the past. For this type of ecosystem, particularly in the Mediterranean, invasive species have also had a considerable impact on biodiversity loss.

For **inland wetlands** as well as **coastal ecosystems** habitat change and pollution have been the most influential drivers for biodiversity loss over the past century. Furthermore, invasive species have also had a high impact on biodiversity in these biomes. For **marine ecosystems**, on the other hand, overexploitation has been the single most influential driver of biodiversity loss in the past, followed by habitat change.

For **island ecosystems**, invasive species, followed by overexploitation and habitat change have been driving biodiversity loss. But pollution and climate change are both increasing rapidly in terms of their impact.

While habitat change has been the steady and most significant driver of biodiversity change in **mountain ecosystems** in the past, both climate change and pollution are increasing rapidly in their importance as a driver for biodiversity loss.

The **polar ecosystem** is the only biome in which already over the past century, biodiversity loss has primarily been driven by climate change. However, pollution and overexploitation also pose considerable and rapidly increasing risks to polar biodiversity.

2.2 Land-use change

Changes in landscape due to such activities as agriculture, urban sprawl and transportation infrastructure are generally recognized in the literature as major causes of the loss of biodiversity. Urban sprawl for example affects land change elsewhere through the transformation of urban-rural linkages. Given that urban life-styles tend to raise consumption expectations and that 60% of the world's population will be urban by 2025, the rural–urban linkage or the urban 'ecological footprint' is critical to land change assessments.[14]

There have been a number of studies that try to capture the effects of changing land use patterns on biodiversity, but as yet there is no standardized methodology for measuring these impacts. In addition, there has been little work that attempts to link indicators of land use that at the local level (i.e. the level of the individual land owner) to the regional and national level indicators that are important to the public policy debate.

The lack of a consistent measurement tool or suitable indicators makes it difficult to assess relative impacts and direct programs towards better conservation practices. It makes it difficult for the individual stakeholder to take action to promote biodiversity. In addition, it makes it difficult for policy makers as well, as it is often necessary to aggregate different measures of land use to achieve a single indicator of impacts. For example, one might want to aggregate land use decisions on farms with decisions for forests, as policy makers tend to need aggregated data that helps to represent regional or national interests rather than individual-level or local interests. As TEEB[15] points out, the question becomes in practice a choice between the uncertain value of biodiversity and ecosystem services and the relative certainty of an alternative land use. Such a choice will almost always be weighted towards the alternative land use.

Agricultural expansion is the most important proximate cause of land use change globally, followed by infrastructure development and deforestation. Driven by global population growth, pressures for increased food as well as fuel production have been one of the primary drivers to convert nature into land for agricultural use.

[14] United Nations data.
[15] The Economics of ecosystems and Biodiversity. European Communities, 2008. Brussels.

2.2.1 Agricultural expansion: growing food production in developing countries

Food production and the development of arable land in developing countries are projected to increase considerably over the coming years.

Table 2.1 FAO projections for the development of the are arable land [16]

		Arable land (million ha)
Developing countries	*1997-99*	956
	2015	1 017
	2030	1 076
Sub-Saharan Africa	*1997-99*	228
	2015	262
	2030	288
Near East and North Africa	*1997-99*	86
	2015	89
	2030	93
Latin America and Caribbean	*1997-99*	203
	2015	223
	2030	244
South Asia	*1997-99*	207
	2015	210
	2030	216
East Asia	*1997-99*	232
	2015	233
	2030	237

[FAO database]

Agricultural expansion in particular to address predicted increases in the demand for meat in the coming decades are predicted to increase the level of land use change, converting forests into grazing land. Current GLOBIOM predictions indicate that a 10% increase in meat demand by 2020 and a 15% increase by 2030 only in the BRIC countries would lead to an additional deforested area of 16.5 million hectares compared to the baseline.

2.2.2 Agricultural expansion: the case of biofuels

With the increasing recognition of the environmental damaged caused by fossil fuel use in transport and the depletion of global reserves, to some extent reflected in rising prices, the search for alternative, renewable sources of energy has moved to the top of the agenda in many countries, particularly those most dependent on imports or of fossil fuel energy sources, such as the EU and the United States. Bio-fuels are seen as an important

[16] FAO. World agriculture: towards 2015/2030 Summary report: http://www.fao.org/docrep/004/Y3557E/y3557e00.HTM

contribution in reducing fossil fuel use and helping the global transport sector transition from fossil fuels to alternative energy sources.

So called 'first generation biofuels' are renewable fuels which are produced from renewable organic materials, also known as biomass. Agricultural crops such as wheat, barley, corn, rapeseed, soy, palm oil and sugar cane can be used to make liquid biofuels. These can subsequently be blended at low rates with fossil fuel to run conventional transport vehicles. Biofuels fall into two broad categories, biodiesel and bio-ethanol.

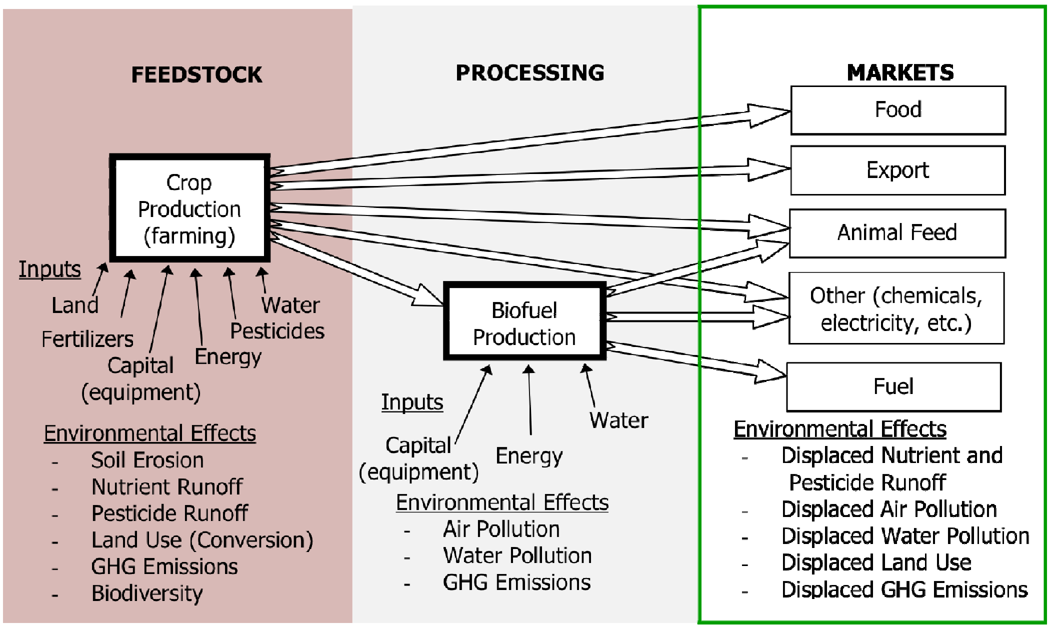
Second generation biofuels are produced from non-food feedstock, also known as ligno-cellulosic material. These include wood, wood residues, grass, straw and fast growing trees. Although second generation biofuels are more promising in terms of costs, quality and environmental impacts, they are still about 10 years away from commercialization. There are a series of new forms of biofuels (second generation, algaeoleum) that may be promising and have the potential to offset some or many of the issues raised with the current form of biofuels produced today. However, a discussion about the benefits of biofuels that are not widespread today, and in addition are costly and in the initial stages of development is irrelevant to the purpose of this study.

The increased production of biofuels globally has raised issues of sustainability of production methods, and in general has created a debate as to whether the net impact of biofuel production is a mitigating factor on the environment. It is important to note, as is highlighted in chapter 1 of this report, that direct and indirect causes of biodiversity losses from biofuel production, as well as the underlying framework related to biofuel policies at all governance levels, are linked to each other. An effort is made here to segregate the causes of biodiversity losses into direct/indirect causes and underlying framework factors. However, it should be kept in mind that each of these categories feeds into and off of each other. Falling into direct causes of biodiversity loss sparked by biofuel production is:

- Direct land use changes and biodiversity loss from degradation of high conservation value areas;
- Displacement effects (also known as "indirect land use changes or "leakage effects").

The broad environmental impacts of biofuel production can be summarized in the figure below:

Figure 2.5 General biofuel pathway with inputs and environmental impacts



Source: OECD 2007. Biofuels: Linking Support to Performance.

Land Use Changes from biofuels

A main concern of increased biofuel production is land-use change. Two potential detrimental environmental effects of land-use changes are the release of greenhouse gas emissions from land-use change and the destruction of biodiversity.

Land use change may lead to a change in above ground and below ground carbon stock. Above ground change in carbon stock is immediate once biomass is planted (e.g. deforestation). Below ground carbon stock disappears over a period of time once land is actively used for biomass production. Factoring in the loss of below ground carbon stocks in the greenhouse gas emissions of biomass production is central in determining the net environmental impact of biofuel production. The time required for biofuels to overcome the loss of carbon stocks ("carbon debt") has been estimated to range from one hundred to over a thousand[17] years depending on the ecosystem, the land involved in biomass production as well as the biomass above and below ground. N2O and CH4 emissions from fertilizer use also add to the emissions balance of biofuels and relate more to actual land management practices than land use "change" per se.

The loss of biodiversity from biomass production is another central factor to be considered in the production of biofuels. Biomass produced on previously "idle land" (as opposed to crop substitution – see next subheading) may lead to biodiversity loss. It should be noted however that there does not exist an internationally accepted definition of "idle land", making the analysis of biodiversity loss from production of biomass on previously unexploited land more complex. Where idle land is also an area of "High Conservation Value" as defined by the Forest Stewardship Council, then biodiversity loss

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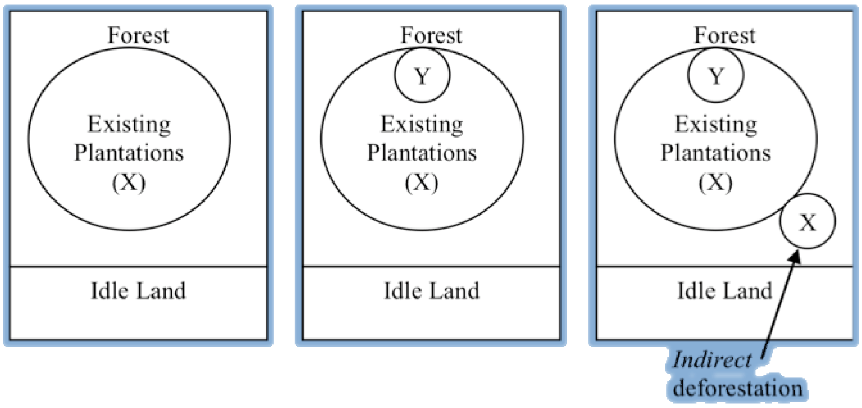
[17] Fargione, J., Hill, J., Tilman, D., Polasky, S and Hawthorne, P. (2008) Land Clearing and the Biofuel Carbon Debt. Science Express, DOI: 10.1126/science.1152747. Also see: Dehue, B., Meyer, S., Hamelinck, C., (2007) Towards a Harmonised Sustainable Biomass Certification Scheme, ECOFYS.

ensues. Thus, the conversion of areas with high biodiversity such as rainforests and peat lands to the production of biomass results in the loss of habitat and ecosystem services, most importantly the capture of carbon. In addition, the use of pesticides, genetically modified crops may also endanger wildlife and biodiversity.

Displacement Effects
Direct land use changes are, for all the challenges they present broadly understood with regards to their effects on the environmental impacts of biofuel production. However, indirect land use change, also known as displacement effects is perhaps the most daunting, complex and consequential aspect of increasing biomass production globally.

Figure 2.6 Example of displacement mechanism causing indirect deforestation



Y is new demand from biofuel sector from existing plantations. X is expansion of existing plantations as a result of displacement effects.

Displacement effects may take place when the production of energy crops displaces economic activities to other areas causing environmental degradation as a result of the new activity (in this case biomass production). These effects can range from local to larger and more complex global consequences. If for instance a soy plantation was previously used primarily for food purposes and converted the same production to energy crops, then that same demand for food from soy would have to be met elsewhere in the long run. In the short run, prices of food derived from soy would rise. Conversion of soy plantations from food to energy will spark the supply of soy plantations for food elsewhere. Consequently higher pressure for expanding land use for agricultural production will increase, and thus heighten the risk of environmental degradation.

Because agricultural markets today are global in their nature (even considering current tariffs and barriers to trade), indirect land use changes from biofuel production is a global phenomenon. Establishing causal links is therefore more difficult and national policies aimed at mitigating environmental damage from land use is not a panacea to addressing what is in essence a transnational problem. The same problems found in direct land use change are found again in displacement effects, the only difference being tracing the exact cause of degradation is substantially more complex.

There is uncertainty surrounding the causal factors behind the performance of biofuels. Indeed local conditions and production practices weigh strongly in the final greenhouse balance of a given biofuel and make it hard for making broader generalizations about biofuels. There is currently an effort being put in place to establish international biofuel sustainability standards on top of existing ones (e.g. the EU Renewable Energy Directive, the UK's Renewable Transport Fuel Obligation) through the Roundtable on Sustainable Biofuels. Biomass certification (e.g. Round Table on Sustainable Palm Oil) is also an important equalizing variable in the analysis of international biofuel performance which can help reduce uncertainty surrounding how to assess the environmental performance of biofuels by creating equal, accountable and certifiable standards and practices in international biofuels production.

Current predictions of future land use change impacts of various biodiversity scenarios based on the GLOBIOM model indicate major additional deforestation occurring throughout the world.

Table 2.2 Deforested area without REDD between 2020-203 in Mha and for various policy shock scenarios

Scenario → / Region ↓	Baseline	BIOF1	BIOF2	BIOF3	BIOF4	BIOF5
Sub-Saharan Africa	*7,7*	8,4	8,1	9,1	8,9	7,5
Other Pacific Asia	*10,5*	12	11,9	14	13,9	9,5
Latin America/Caribbean	*62,9*	79,3	75,4	92,8	86,5	52,6

[Source: IIASA, 2009 model runs]
BIOF1 = 15% increase in biofuels in the form of a mix of all three types of biofuels (1st generation biodiesel and ethanol and 2nd generation bioethanol).
BIOF2 = 15% increase in biofuels in the form of 1st generation ethanol only in 2030.
BIOF3 = 15% increase in biofuels in the form of 1st generation biodiesel only in 2030.
BIOF4 = 15% share of biofuels in transport in 2030 from 1st generation (mix of biodiesel and bioethanol) only.
BIOF5 = 15% share of biofuels in transport in 2030 from 2nd generation only.

As can be seen from these figures, worldwide biofuels policies could potentially have major impacts on land use change and thus biodiversity loss, if policy and governance factors to ensure protection of certain land uses (e.g. forests) from land conversion.

The effects of monocultures on biodiversity
The effect of monocultures has been proven to have potential negative impacts on biodiversity. Changing local and in some cases regional biodiversity balances runs the risk of eliminating certain faun and flora while at the same time introducing an invasive species of predators. The net effect is a loss of biodiversity in certain cases. Where biomass is produced must account for the conservation value area where it is planted. Such a consideration constitutes the core of a series of initiatives on biofuel sustainability standards being developed today.

2.2.3 Infrastructure development

Infrastructure development involves both settlement expansion as well as the expansion of transport networks. The impact of infrastructural development can be measured via relationships between the distance to roads and mean species abundance for different biomes. These relationships in the GLOBIO2 model are based on 300 reviewed articles, comprising information on 200 different species. The impact of infrastructural development includes: i) the direct effects on wildlife by disturbance and avoidance; ii) fragmentation effect due to barrier effects; iii) increased hunting activities, and iv) small-scale settlements along roads. The dose-response relationships were used to construct impact zones along linear infrastructure (roads, railroads, power lines, pipelines), based on data from the Digital Chart of the World[18]. The following table shows the biodiversity mean species abundance for the different impact zones for different biomes. GLOBIO2 furthermore offers the calculation of the fraction of species loss was calculated for each impact zone (depending on local occurring natural land cover), and aggregated to 0.5 by 0.5 degree grid cells.

Table 2.3 Zones (in km) along linear infrastructural objects, showing impacts from infrastructure on mean species abundance in different biomes

VEGETATION COVER	HIGH IMPACT (MSA=50%)	MEDIUM IMPACT (MSA=75%)	LOW IMPACT (MSA=90%)	NO IMPACT (MSA=100%)
Croplands	0.0-0.5	0.5-1.5	1.5-5.0	>5.0
Grasslands	0.0-0.5	0.5-1.5	1.5-5.0	>5.0
Boreal forests	0.0-0.3	0.3-0.9	0.9-3.0	>3.0
Temperate deciduous forests	0.0-0.3	0.3-0.9	0.9-3.0	>3.0
Tropical forests	0.0-1.0	1.0-3.0	3.0-10.0	>10.0
(semi-)deserts	0.0-0.5	0.5-1.5	1.5-5.0	>5.0
Wetlands	0.0-0.5	0.5-1.5	1.5-5.0	>5.0
Arctic tundra	0.0-1.0	1.0-3.0	3.0-10.0	>10.0
Ice and snow	0.0-0.5	0.5-1.5	1.5-5.0	>5.0

Source: CBD (2007), Global Biodiversity Outlook 2

In Africa, for example, commercial logging and timber production is closely connected to development of infrastructure. Logging is mostly carried out by large international companies, which normally buy or rent the land in order to harvest the timber required for infrastructure development. These companies are also responsible for creating new roads in the areas they operate in. Though transport extension was not directly aimed at promoting human settlement, road construction creates easy access for settlers, who colonise the areas around the newly implemented roads right after the logging is finished.

In Latin America and the Caribbean, infrastructural development also plays an important role in deforestation in Latin America. A strong link between road building and logging activities exists throughout Latin American countries, e.g. in Brazil. This link is furthermore supported by the fact that countries, in which the costs for building roads are rather high, such as Bolivia, experience comparatively low rates of deforestation.[19] In addition, the construction of dams for the generation of hydroelectric power as well as oil and gas pipelines and new settlements can be seen as a cause of deforestation.

[18] DMA (1992). Digital Chart of the World.
[19] Jaramillo,C.F. and T. Kelly. 1998. Deforestation and Property Rights in Latin America. IDB. Washington D.C. Mimeo.

Recent GLOBIOM modelling results indicate that the impacts of infrastructure development on land use change and deforestation / fragmentation are heavily dependant on regional circumstances. A predicted 10% increase in infrastructure development in emerging economies and a 5% increase in developing countries by 2020 will likely not have significant effects in Sub-Saharan Africa and South Asia biodiversity hotspots, whereas additional land use change in Latin America and the Caribbean will likely be more significant: 0.8 million hectares more deforested area compared to the baseline.

2.2.4 Deforestation

Despite policy efforts on reducing deforestation, around 13 million hectares of forests continue to be lost annually.[20]

To assess the types and severity of biodiversity impacts this level of deforestation has on biodiversity, it is important to differentiate between the highest deforestation rate (in %) and the highest overall annual losses of forest (per hectares). The table below presents the ten countries with the largest annual net negative change rate and the largest net loss in forest area for the period from 2000 to 2005.[21]

Table 2.4 Highest deforestation rate and highest annual area change per country globally

Deforestation rate 2000-2005		Annual loss 2000-2005	
Country	Annual change rate in % (in 1000 ha/year)	Country	Annual change in 1000 ha/year (in % negative change)
Comoros	-7,4 *(-1)*	Brazil	-3.103 *(-0,6%)*
Burundi	-5,2 *(-9)*	Indonesia	-1.871 *(-2,0%)*
Togo	-4,5 *(-20)*	Sudan	-589 *(-0,8%)*
Mauritania	-3,4 *(-10)*	Myanmar	-466 *(-1,4%)*
Nigeria	-3,3 *(-410)*	Zambia	-445 *(-1,0%)*
Afghanistan	-3,1 *(-30)*	Tanzania	-412 *(-1,1%)*
Honduras	-3,1 *(-156)*	Nigeria	-410 *(-3,3%)*
Benin	-2,5 *(-65)*	DR Congo	-319 *(-0,2%)*
Uganda	-2,2 *(-86)*	Zimbabwe	-313 *(-1,7%)*
Philippines	-2,1 *(-157)*	Venezuela	-288 *(-0,6%)*
World	-0,18 *(-7.317)*	World	-7.317 *(-0,18%)*

Source: FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38.

Thus, it can be concluded that while Comoros, Burundi, Togo and Mauritania experience worrisomely high deforestation rates which definitely affect local biodiversity levels, the total size of the deforested area in Brazil and Indonesia is almost 200 times as large as the area destroyed in the three countries that experience the highest deforestation rate.

[20] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38.

[21] Ibid.

Tropical forests host half of all global biodiversity, and their preservation is essential for maintaining the richness of life on Earth. Deforestation is thus a direct cause of biodiversity loss due to the associated loss of natural habitat. Next to the fact that deforestation leads to biodiversity loss, it also can play a role in both global warming and cooling, and it leads to reductions in water regulation, and the destruction of the resource base and livelihoods for many of the world's poorest.[22]

Deforestation has a wide range of appearances ranging from selective logging to complete clear-cutting of forest. Deforestation, technically defined as "the reduction of tree canopy to less than 10% crown cover" (FAO), is closely related to the conversion of forestlands to alternative uses, often devoid of or with negligible presence of trees in the converted land. Forest degradation, on the other hand, - defined as a reduction in tree-canopy cover (but not below 10%) or other forms of increased disturbance - is less of an investment process, but typically reflects a story of unsustainable harvesting for a multitude of private or commercial reasons.

Deforestation is caused by multiple drivers and pressures, including conversion for agricultural uses, infrastructure development, wood extraction, agricultural product prices, and a complex set of additional institutional and place-specific factors, which can be extremely important in certain localities. [23] Most importantly, the specific characteristics and magnitude of (in particular) the socio-economic drivers behind deforestation vary widely across continents, regions and countries.

Next to the fact that deforestation is a direct cause of biodiversity loss, the various consequences of deforestation also trigger other factors impacting on biodiversity. One only has to think of climate change as an example. Tropical deforestation is considered the second largest source of anthropogenic greenhouse gas emissions[24] and is expected to remain a major emission source for the foreseeable future.[25] The reduction of greenhouse gas emissions from tropical deforestation is now recognised as an essential component of international efforts to mitigate climate change. Soares-Filho et al. (2006)[26], for example, suggest that protecting around 130 million hectares of land from deforestation in the Amazon could reduce global carbon emissions by 17 GtC over the next 50 years and thus indirectly reducing the impacts of climate change on biodiversity levels.

Locally, deforestation contributes significantly to increasing sedimentation in surrounding coastal areas. In South East Asia, for instance, these sediments reduce coral growth in one of the most important biodiversity hot spots.

Current predictions of likely future deforestation rates and levels vary widely depending on policy and demand developments of various land use change and wider demographic

[22] Williams, J.R. 1995. *The EPIC Model.* In *Computer Models of Watershed Hydrology* (Ed.: V.P. Singh). Water Resources Publications, Highlands Ranch, Colorado, 1995, pp 909-1000.

[23] Fearnside, P.M. 2006. Containing destruction from Brazil's Amazon highways: Now is the time to give weight to the environment in decision-making. *Environmental Conservation* 33(3).

[24] IPCC 2007 estimations.

[25] Millennium Ecosystem Assessment Report (2005).

[26] Soares-Filho, B. S.; Nepstad, D. C.; Curran, L. M.; Cerqueira, G. C.; Garcia, R. A.; Ramos, C. A.; Voll, E.; Mcdonald, A.; Lefebvre, P.; Schlesinger, P. Modelagem da Conservação na Bacia Amazônica. **Nature**, 2006.

and economic factors. Recent GLOBIOM outcomes included a baseline deforestation level of 81.1 million hectares worldwide between 2020 and 2030. However, various policy scenarios tested during the ECORYS/IIASA study have shown that real deforestation rates may range between 69.5 million hectares and 115.8 million hectares depending on future driver as well as policy developments.

2.3 Pollution

2.3.1 Air pollution

Air pollution affects biodiversity on a great scale. The atmosphere, lithosphere, and hydrosphere are all negatively affected by pollution. Air pollution affects lower life forms more than higher life forms. Plants are generally more affected than animals on land, but not in fresh water. A decline in most species due to pollution is evident except for a minority that increase. Plants constantly take up atmospheric gases i.e. air everyday to sustain their biological processes. Pollution can be derived from two kinds of sources namely, stationary and multiple point sources. Stationary point sources include for example wood-burning fires (on a small scale) and the burning of coal in coal-fired electrical power plants (on a large scale). Multiple point sources are usually mobile and include automobiles and other vehicles. The vehicles are the most important source of atmospheric pollutants as they release carbon monoxide. This is followed by industrials sources which release sulphur oxides, steam and electric power plants, space heating and lastly refuse burning.

2.3.2 Water pollution

Most water pollution is the result of the introduction of various substances into water bodies that have negative effects on ecosystems, health and water-based activities (swimming, diving, fishing, etc.). Heated water from nuclear power stations for example and microorganisms from untreated waste cause serious water pollution. Its effects are far-reaching and include contamination of underground and surface fresh water, the oceans and rainwater (in the form of acid rain). In most modern industrial societies industry is the greatest source of pollution, accounting for more than half the volume of all water pollution and for the most deadly pollutants. Thousands of manufacturing facilities use huge quantities of freshwater to carry away wastes of many kinds. The waste-bearing water, or effluent, is discharged into streams, lakes, or oceans, which in turn disperse the polluting substances.

Along the North Sea coasts, for instance, many large cities and industrial areas cause pollution of several kinds, such as litter and chemical and radioactive waste.[27] The ecological effects of organotin compounds, as well as PAHs, PCBs and some metals are well known. Major European rivers such as the Rhine, Elbe and Thames discharge large quantities of chemicals, nutrients and organic material, including nitrogen, which

[27] Walday, M. & Kroglund, T., 2002, Europe's biodiversity, The North Sea, European Environmental Agency.

originates from agricultural fertilization, and phosphorus from urban waste water and soil erosion. But also in developing countries pollution of rivers and marine areas is a growing problem. Several coastal zones in South- East Asia, for instance, have developed rapidly resulting in pollution of along others chemical waste and eutrophication.[28] This may seriously affect tropical coral reefs. Normally, these reefs have low nutrient levels, but at present agriculture and urbanisation cause high levels of pollution by nutrients. Because many coastal communities in this region lack adequate sewage treatment systems, population growth and increased production or exploitation result in the release of high levels of nitrogen and phosphorus. More nutrients reduce coral growth significantly, directly or indirectly.

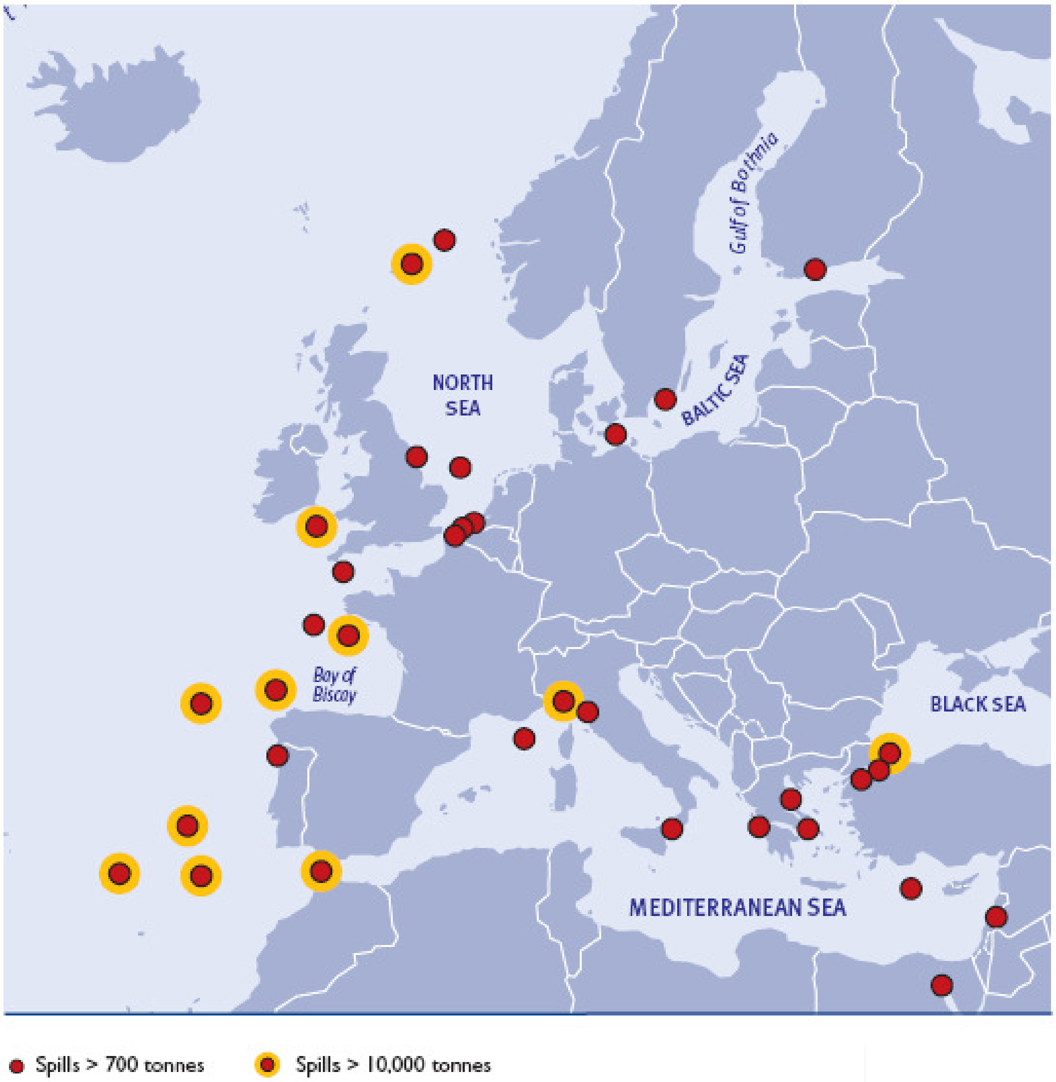
Water pollution has, among other consequences, the tendency to cause long-term modifications of biodiversity. Eutrophication is one of the most noticeable long-term alterations. This phenomenon occurs within aquatic environments that are fed only little new water: lakes, ponds, slow rivers, river mouths. The constant supply of nutrients (essentially phosphorus and nitrogen) contributes to the proliferation of certain algae. The decay of these algae results in an excessive consumption of oxygen. Such asphyxia of the aquatic environment reduces the number of species that it can support. Some techniques, such as phyto-remediation, have been implemented in order to limit eutrophication.

2.3.3 Marine pollution from oil spills

Nowadays, there are approximately 8,000 tankers transporting crude oil and oil-related products around the world, most of which operate without incident. However, major spillages due to tanker accidents, though infrequent, have had profound consequences for marine and coastal biodiversity. The map below (Figure 2.7) depicts all large tanker spills in European waters since 1984. As can be seen based on these past disasters, certain regions seem to be more vulnerable to large spills than others.

[28] Burke, L. Selig, E. & M. Spalding (ed.), 2002, Reefs at Risk in Southeast Asia, WRI/UNEP/WCMC/WFC/ICRAN.

Figure 2.7 Large tanker spills since 1984



N.B. The most affected area over the last 35 years has been the Galician coasts in Spain with 7 tanker spills of more than 10,000 tonnes (DG Tren: Maritime Sector: Vademecum No. 6, 2004).

[Source: EMSA Action Plan]

Various parts of the marine environment experience different sensitivity and vulnerability to marine pollution (oil spills).

Open waters are generally considered as less sensitive to oil spill damage, particularly if spills occur further offshore. This can mainly be attributed to the fact that there are sparser populations of sea birds and marine mammals in open waters and that these open waters are typically not used as habitats, spawning or breeding grounds. On the other hand, oil pollution is less detectable in vast open sea areas and, once the oil has disappeared from the water surface, it is far more difficult to detect. Moreover, oil compounds and pelagic biota are easily movable by ocean currents. Without baseline data and information the assessment of oil spill damage to environments and ecosystems is almost impossible and consequently the estimation of sensitivity and vulnerability is almost impossible.

Coastal waters and zones are the most biologically diverse marine environments; this applies to the water column, the shoreline and the seabed. These are also the areas in which spilled oil naturally tends to accumulate[29]. Taking this into consideration, one can easily see why large and very visible damage occurs to coastal zones in case an oil spill reaches the shoreline. Seabirds breeding and feeding in coastal areas are faced with a high rate of mortality. The same applies to various mammal species although their mortality rates are usually lower. Benthic organisms are usually heavily damaged, as are fish spawning areas and coastal and seabed vegetation. Human assets, such as aquaculture installations, tourism and leisure facilities but also infrastructure and industrial installations are affected in the short and medium term. On a more general level, this might even lead to an interference of work and social life.

Polar regions, more specifically offshore sub-Arctic and Arctic areas temporarily or permanently covered with sea ice, are subject to an increasing amount of oil and gas exploration and sea transport activities. For this reason, oil spill damage and the mitigation thereof is essential in marine environmental protection. Due to the cold temperature and the consequently reduced chemical reaction, the capacity for evaporation, decomposition and degradation of the spilled oil is greatly reduced or delayed.

When oil is spilled in icy waters it diffuses into the various cracks and pockets, further spreading under the ice and between ice sheets. Thus, oil spilled in the polar regions is widely diffused and dispersed by means of ice drift and mechanical properties. Stranded or sunken oil compounds can easily be remobilised by ice action. For example, when oiled ice melts by drifting into warmer waters or by seasonal warming the enclosed oil is remobilised and released into the water surface and water column. Due to the slow growth and decay process typical for arctic environments, biodegradation as well as recovery and re-growth of oiled coastal areas is greatly delayed. In general, the long-term damages to the environment and ecosystem are almost impossible to estimate as there is still relatively little knowledge on arctic lifecycles and ecosystems.

Increasing oil exploration and production activities along continental margins and in **deep water areas** have raised concerns on oil spill risks for these regions. Oil production in deep water brings along the risk of a new type of incident – an oil spill in great water depth. This type of spill may occur when a deep water oil well explodes or risers leak in great water depths. At present, very little is known on oil spill behaviour in great water depths and under high water pressure.

Impacts of oil spills

Oil spills have had a major impact on biodiversity in recent decades. In 1998 alone, a total of 108 000 tonnes of oil were spilled worldwide into marine and inland environments as a result of 215 incidents (Etkin 1999). The 2002 Prestige incident occurred when the Bahamas registered tanker PRESTIGE began leaking oil some 30 nautical miles off Cabo Finisterra. The PRESTIGE was carrying a large amount of IFO 650 heavy fuel oil, of which 63,000 tonnes are estimated to have been spilled.

[29] International Tanker Owners Pollution Federation – Oil spill scenario info (http://www.itopf.org)

This year Australia has been coping with an on-going spill in the Timor Sea from a damaged oil rig that has gradually been contaminating the marine environment. An approximate 400 gallons of oil a day have been released into the ocean that poses a significant threat to wildlife.

Various ecological, social and economic effects are likely to occur from oil spills. According to ITOPF, the exact nature and duration of these impacts depend, among other factors, on the type and amount of oil spilled, on its behaviour once spilled, on the characteristics of the area, on the weathering conditions and on the type and effectiveness of clean-up.[30]

- 'Light' oils when spilled often do not persist on the surface of the sea for long due to the rapid evaporation process. These oils are more likely to diffuse and dissolve naturally. As such, these oils may taint edible fish, shellfish and other marine products. However, these effects will usually be limited to a small area and will be relatively short-term because the toxic components are also the ones that evaporate the most easily.[31]
- 'Heavy' oils are generally lower in toxicity but are considerably more persistent in the marine environment. They do not readily evaporate, disperse or dissipate naturally. Because of their highly persistent nature, they have the potential to cause a long-lasting threat to seabirds and other wildlife.[32]

The EMSA mentions similar factors: type of oil; weather and sea conditions; effectiveness of clean-up operations; psychological, biological and economic characteristics of the spill location; amount and rate of spillage; and time of year[33]. In general, it should be noted that, although the short-term effects of oil spills on many marine species and communities are often reasonably predictable, very little is known about possible long-term effects.[34]

Typical environmental effects range from toxicity to smothering and impact various species and areas. Well known environmental effects include toxic and sub-lethal effects on plankton, seabird drowning or body heat loss following fouling of plumage by oil and the long-term tainting of commercial species caused by oil becoming incorporated into bed sediments.[35]

Besides having the potential to cause large environmental damage, oil spills typically also result in considerable economic damage. Contamination of coastal areas can significantly reduce tourists' desire for recreational activities. Temporary losses for the tourism sector are a very common consequence. Furthermore, an oil spill has the potential to damage boats and gear used by the fishery and mariculture sectors. The ITOPF specifically notes that one should always thoroughly investigate the status of fishery and the alleged effects of a spill to be able to determine the real economic and social impacts.[36]

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[30] International Tanker Owners Pollution Federation – Oil spill scenario info (http://www.itopf.org)
[31] European Maritime Safety Agency – Action plan for oil pollution preparedness and response
[32] European Maritime Safety Agency – Action plan for oil pollution preparedness and response
[33] European Maritime Safety Agency – Action plan for oil pollution preparedness and response
[34] International Tanker Owners Pollution Federation – Oil spill scenario info (http://www.itopf.org)
[35] International Tanker Owners Pollution Federation – Oil spill scenario info (http://www.itopf.org)
[36] International Tanker Owners Pollution Federation – Oil spill scenario info (http://www.itopf.org)

2.4 Unsustainable natural resource use

This section briefly reviews the use of natural resources as a direct cause of biodiversity loss.

2.4.1 Fisheries

Fishing is central to the livelihood and food security of 200 million people, especially in the developing world, while one out of five people on this planet depends on fish as the primary source of protein. According to UN agencies, aquaculture - the farming and stocking of aquatic organisms including fish, molluscs, crustaceans and aquatic plants - is growing more rapidly than all other animal food producing sectors. But amid facts and figures about aquaculture's soaring worldwide production rates, other, more sobering, statistics reveal that global main fish stocks are in jeopardy, increasingly pressured by overfishing. Moreover, the problem is not exclusive for the fished species; due to declining populations, shifts through the whole food chain are disrupting the balance of the ecosystems, further enhanced by the complexity of the food web.

The magnitude of the problem of overfishing is often overlooked, given the competing claims of deforestation, desertification, energy resource exploitation and other biodiversity depletion dilemmas. The rapid growth in demand for fish and fish products is leading to fish prices increasing faster than prices of meat. As a result, fisheries investments have become more attractive to both entrepreneurs and governments, much to the detriment of aquatic animals all over the world.

In the last decade, in the north Atlantic region, commercial fish populations of cod, hake, haddock and flounder have fallen by as much as 95%, prompting calls for urgent measures. Some are even recommending zero catches to allow for regeneration of stocks, much to the ire of the fishing industry.

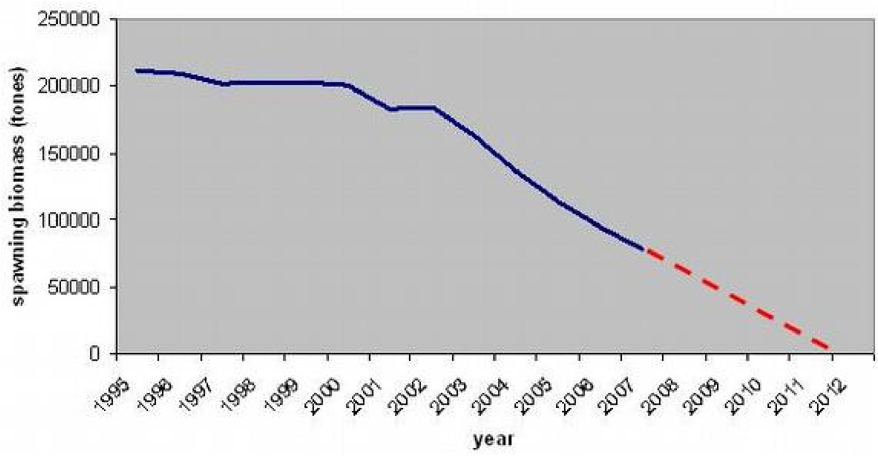
There are many examples of overfished species, divided over several biomes. In the rest of this section two examples will be discussed more elaborately; the cases of the bluefin tuna and the common cockle.

Bluefin tuna

Bluefin tuna disappeared from Danish marine waters in the 1960s. Now the species could become depleted throughout the northeast Atlantic and Mediterranean, according to analyses by the Technical University of Denmark (DTU Aqua) and University of New Hampshire. The species is highly valued as sushi. Bluefin tuna is a treasured delicatesse. A kilo of its much sought after meat can bring in prices reaching 130 Euros at fish auctions. The species in the Mediterranean Sea and northeast Atlantic is caught by fishermen from many countries, particularly France, Spain and Italy.

But there are fewer tuna left in the sea, and those that are left are younger and smaller. In 2006, the organisation that manages bluefin tuna fisheries (ICCAT; International Commission for the Conservation of Atlantic Tunas) launched a recovery plan whose main objective is to rebuild the population by 2022. Rebuilding would be achieved by gradually lowering fishing quotas between 2007 and 2010 and implementing other fishery regulations.

Figure 2.8 Spawning biomass of Atlantic bluefin tuna, measured until 2007 (blue) and extrapolated till 2012 (red)



Source: FAO data 2004

The management plan is however insufficient to stop the population from getting even smaller in the coming years. That is evident from analyses done by Brian MacKenzie (DTU Aqua) together with colleagues Henrik Mosegaard (DTU Aqua) and Andrew A. Rosenberg (University of New Hampshire, USA). Their results will be published later this year in an article in the scientific journal Conservation Letters.

"Our calculations show that the present recovery plan has little chance of reaching its goal and will not be able to protect the population in the northeast Atlantic and Mediterranean from declining even further. The population is presently at its lowest level ever, and the adult biomass has fallen 10 years in a row. Every year we set a new record low," explains Professor Brian MacKenzie, National Institute of Aquatic Resources at The Technical University of Denmark (DTU Aqua).

Common cockle

The common cockle is a species of edible saltwater clams, a marine bivalve mollusc. The common cockle used to be one of the most abundant species of molluscs in tidal flats in the bays and estuaries of Europe. It is commercially overfished in the Netherlands and the British Isles. This cockle is eaten in several countries including the UK, France, Spain, the Netherlands and Germany. The number of young cockle in the Wadden Sea reached a historical nadir. At this moment, only 5 million kg of cockle seed is present. In 2001 this was 70 million kg.

According to Martijn de Jong, chairman of the foundation of the wild cockles, there is a severe overfishing causing a rapid decline of cockles. “The fishermen know that cockles only reproduce once in the few years. It is irresponsible to fish everything immediately, and not leave anything for the years to come. This causes the cockles to have ample opportunity to recover from the overfishing, and the decline of biomass”.

But the cockle fisheries do not only affect the common cockles themselves, but the food chain associated with this mollusc as well. According to the Royal Dutch institute for marine research, due to the overfishing of cockles there is a big decline in the number of knots and other sandpipers. These birds depend largely on the cockles as prey. Their numbers have declined with 50%, and some of the birds are migrating towards other areas where they disturb the local ecological equilibriums, threatening potential other prey or competing species. This is an example of the influence of overfishing on not only the target species but the surrounding species as well.

2.4.2 Mining

The impact of mining on the environment largely depends on the method of mining adopted, the geo-mining conditions of the area in question, and the size and duration of the mining operations. In contrast to underground mining, open-cast mining usually results in extensive damage to the environment. Even though the method adopted for mining is often selected according to the characteristics of the coal seam and geo-mining conditions, political and social considerations can exercise an influence in the choice of mining method adopted. Regardless of the method of mining chosen, coal mining affects the environment in a number of ways.

Coal, for example, is localized in its occurrence and is mined, processed and transported before it is put to use. These processes affect the environment through larger concentrations of people in a particular locality; increasing the demand for public facilities; damage to property, crops and livestock; disturbance of existing landscape; dereliction of land; felling of trees; building up of mine wastes and mill tailings; pollution of both ground water and surface water, air pollution; noise and vibrations due to mine blasting and earth movers; and many more similar effects on the natural environment.

The following table summarises the main stages of the mineral mining process, including the key activities and their potential negative impacts on the environment and thus biodiversity levels.

Table 2.5 Summary overview of potential biodiversity impacts of mining activities

Stage	Activities	Potential biodiversity impact
Exploration	• Surveying • Drilling / trenching • Exploration camp development • Road construction	• Habitat loss / fragmentation • Disturbance to wildlife • Increased demand for local water resources • Increased colonisation and associated species loss (also due to increased hunting)
Site preparation / mineral extraction	• Mine construction (vegetation removal, stripping of soils, etc.) • Mine infrastructure development (roads, powerlines, etc.) • Creation of waste piles	• Habitat loss / fragmentation • Chemical contamination of surface and ground waters • Declining species populations • Toxicity impacts to organisms • Altered landscapes • Increased erosion and siltation • Increased colonisation and associated

		species loss (also due to increased hunting)
Processing / smelting	• Processing / smelting of minerals	• Discharge of chemicals other wastes, emissions
Transport to final markets	• Packaging and transport of product	• Noise and dust disturbance • Emissions
Mine closure / post-operation	• Reseeding / revegetation • Re-contouring waste pits • Fencing off dangerous areas • Monitoring leakage	• Persistent contaminants in surface and groundwaters • Persistent toxicity to organisms • Loss of original vegetation / biodiversity

[Source: adapted from World Resources Institute report (2004): Mining In Critical Ecosystems: Mapping the Risks]

Water pollution

Large volumes of mine water are discharged through areas of the mine and carry with it any soluble minerals that may be present either in the coal or associated rocks, which causes degradation of water quality. The mine water may be acidic or neutral depending upon the pyrite content in the coal. Acid mine drainage occurs in those mines in which sulphur content is found in the range of 1–5% in the form of Pyrite (FeS2). It degrades the water quality of the region in terms of lowering the pH of the surrounding water resources and increasing the level of total suspended solids, total dissolved solids and some heavy metals. In non acidic mines, water quality shows high hardness and bacterial contaminants.

Particulate matter resulting from mining activities has been shown to be detrimental to local fish populations. Decreased densities of macro invertebrate- and benthic invertebrate populations have been associated with increased suspended solids[37]. Enhanced sedimentation within aquatic environments also has the effect of inhibiting spawning and the development of fish eggs and larvae, as well as smothering benthic fauna (fauna that inhabit the bottom/beds of rivers and lakes). In addition, high turbidity may impair the passage of light, which is necessary for photosynthetic activity of aquatic plants[38].

Exposed materials from mining operations, such as mine workings, wastes, and contaminated soils, may contribute sediments with chemical pollutants, including heavy metals. Contaminated sediments in surface water may pose risks to human health and the environment as a persistent source of chemicals to human and aquatic life and those non-aquatic life that consume aquatic life. Human exposure occurs through experiencing direct contact, eating fish/shellfish that have bio-accumulated toxic chemicals, or drinking water exposed to contaminated sediments. Continued bioaccumulation of toxic pollutants in aquatic species may limit their use for human consumption. Accumulation in aquatic organisms, particularly benthic species, can also cause acute and chronic toxicity to aquatic life. Finally, organic-laden solids have the effect of reducing dissolved oxygen concentration, thus creating toxic conditions.

[37] EPA (2000), Abandoned mine site characterization and cleanup handbook, Seattle U.S.A.
[38] Ibid

Water pollution and consequent negative impacts on the environment and biodiversity can also be attributed to mismanagement and industrial accidents such as the infamous case in January 2000 when a tailings dam failed at the Aurul gold mine near the town of Bai Mare in Romania. The failure released approximately 3.5 million cubic feet of water contaminated with cyanide and heavy metals into the Szamos and Tizsa Rivers in Romania, Hungary, and Yugoslavia, approximately 800kms of river, before flowing into the Danube, impacting approximately 1200 km of river. The total fish kill was estimated at over 1000 metric tonnes of fish. Australian miner Esmeralda spilt approximately 100 million litres of cyanide-contaminated water into Romanian rivers. The pollution flowed through Hungary to Yugoslavia and into the Danube, decimating fish populations and reducing the livelihoods of people along the river. The Hungarian government submitted a claim of USD 110 million for compensation, which shows the magnitude of damage. The cyanide killed over one million kilograms of fish in Hungary. Although this was not associated with a coal mine, this example *does* reflect the nature and scale of problems associated with mismanagement of mine operations.

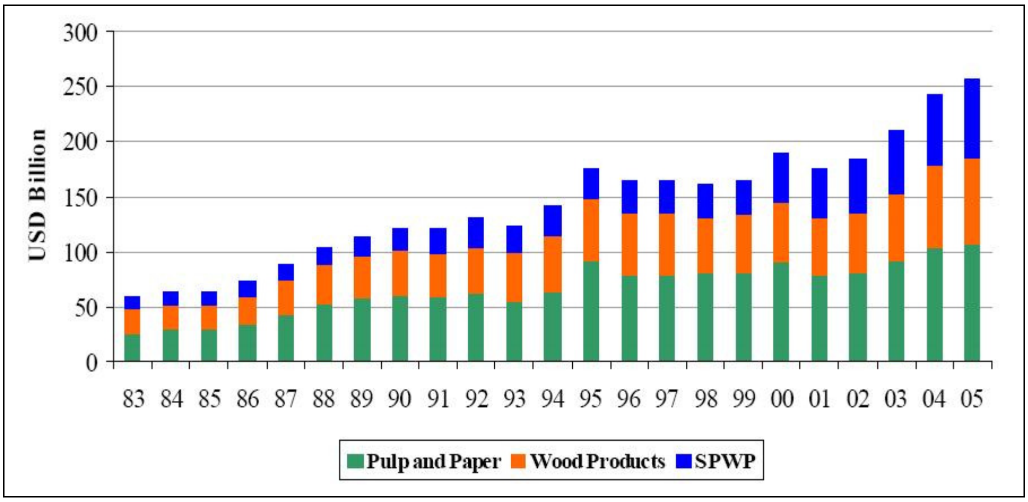
Impacts on land use and landscapes
Mining and in particular open-cast/surface mining, requires large areas of land to be temporarily disturbed. This raises a number of environmental challenges, including soil erosion, dust, noise and water pollution. Regardless of the type of mining, activity invariably results in land disturbance due to large scale excavation, removing of top soil, dumping of solid wastes, cutting of roads, creation of derelict land etc.

Impacts on marine biodiversity
Mining also affects biodiversity in many marine regions. In many coastal areas oil and gas companies extract huge quantities of gas and oil, for instance in the North Sea. This causes the discharge of oil and the disturbance of animals due to noise and light. In South East Asia, several oil companies extract oil from or in the vicinity of the for biodiversity very important Coral Triangle marine area (Burke, Selig & Spalding, 2002). Coral reefs can be threatened, for instance by oil spills. The activities and plans of oil and gas companies from Russia, Canada and the US close to the Arctic region may have a devastating and lasting impact on the Arctic wildlife and environment (Huebert & Yeager, 2008).

2.4.3 Commercial wood extraction

The international trade of forest products has experienced and average annual growth rate of 6% between 1983 and 2005 and is expected to continue a similar growth path in the future. The following figure presents this trend in international trade of forest products. It should be noted that these figures only present a part of the total wood demand as domestic wood product markets are not included.

Figure 2.9 International trade of forest products[39]



Source: FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38

The table below presents the trends of industrial- and fuelwood removals in Latin America, Africa and Asia. The FAO has outlined that the reported figures on fuelwood removals are particularly weak, as a large part of fuelwood gathering is informal.[40] The decrease in removals of fuelwood presents a reduced demand for this product in the region, but was partly offset by an increase in removals of industrial wood.

Table 2.6 Industrial- and Fuelwood removal figures from 1990, 2000 and 2005

	Industrial roundwood removals in 1990 (in million m³)	Fuelwood removals in 1990 (in million m³)	Industrial roundwood removals in 2000 (in million m³)	Fuelwood removals in 2000 (in million m³)	Industrial roundwood removals in 2005 (in million m³)	Fuelwood removals in 2005 (in million m³)	Fuelwood removals in 2005 in %of total
Latin America	144	302	207	183	224	173	44
Africa	54	445	69	547	75	591	88
Asia	239	215	192	195	174	189	52

Source: FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38

South America: The total net loss of forest area and associated biodiversity loss is very high in Latin America which is co-determined by the high levels of wood extraction in Brazil. Wood is extracted from approximately 1.5 million hectares per year in the Amazonian region of Brazil. Of the entire Brazilian wood production ca. 10 % are exported to the EU-27. These 10% represent 30% of the entire Brazilian wood exports.

[39] Advisory Committee on paper and wood products: GLOBAL WOOD AND WOOD PRODUCTS FLOW TRENDS AND PERSPECTIVES: http://www.fao.org/forestry/media/12711/1/0/

[40] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38.

The EU imports approximately 2% of the roundwood, 25% sawnwood, 20% veneer and 42% plywood from Brazil.[41]

Asia: the region has experienced a steady increase in the demand for wood products over the past years. A recent FAO outlook in 2009 predicts this trend to continue over the coming decades. In particular, the consumption of and demand for wood-based panels, paper and paperboard is likely to increase substantially. This trend can largely be attributed to the fast economic growth of the region and its increasing share in global trade.

Table 2.7 Production and consumption trends: wood products in Asia

Year	Industrial roundwood (million m³)		Sawnwood (million m³)		Wood-based panels (million m³)		Paper and paperboard (million tonnes)	
	Prod.	Con.	Prod.	Con.	Prod.	Con.	Prod.	Con.
2005	273	316	71	84	81	79	121	128
2020	439	498	83	97	160	161	227	234
2030	500	563	97	113	231	236	324	329

[Note: Prod. = production; Con. = consumption]
Source: FAO 2008 presentation "Contribution of the forestry sector to employment and GDP.

In case of wood extraction as a proximate cause for biodiversity loss, commercial logging is mostly mentioned and fuelwood collection is mentioned to a lesser extent. After the 1950s, increasing demand for Asian timber led to the extension of commercial logging activities.[42] Since the early 1970s, the Southeast Asia – Pacific region has become the main source of tropical timber trade in the world.

Nevertheless, it should be noted that the Asia and Pacific region as a whole has made substantial progress toward implementing sustainable forest management through measures as reduced-impact logging and the use of certification to target niche markets. ITTO (2006) reported that 14.4 million hectares of natural tropical production forests are now managed sustainably in this region, mostly in India, Indonesia and Malaysia.

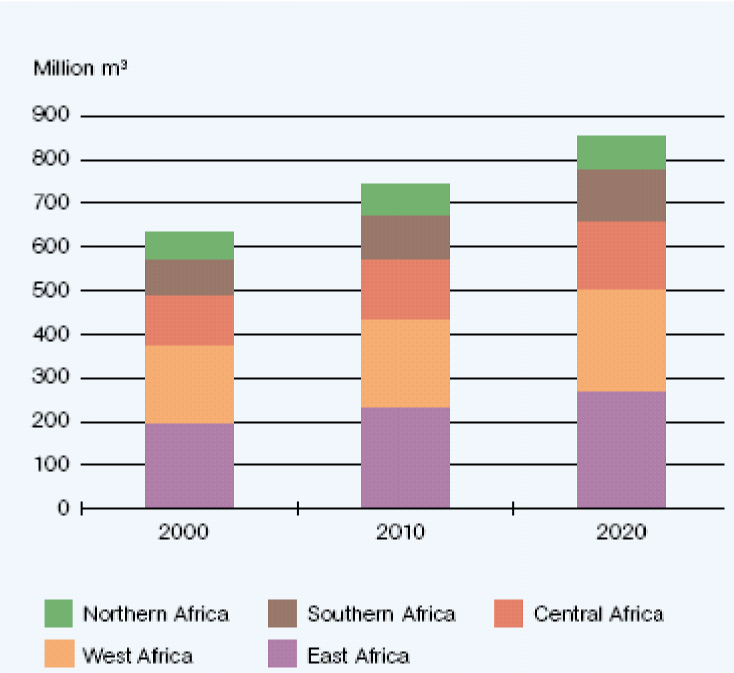
Local subsistence timber logging
Wood extraction for domestic fuel wood or charcoal production remains a major issue in the developing countries. In Africa, for example, most Africans still use wood and charcoal for cooking since there are no other affordable energy sources available. Only 7.5 % of the rural population has electricity.[43] Africa has shown a steady increase in wood removals in recent years, reporting a rise from 499 million m^3 yearly (1990) to 661 million m^3 (2005). It is estimated that the majority of the removed wood is used as fuel

[41] based on FAOSTAT and TTAP import data.
[42] Navjot S. Sodhi (2004). Southeast Asian biodiversity: an impending disaster. TRENDS in Ecology and Evolution Vol.19 No.12 December 2004.
[43] 2009 FAO data.

wood, but since most of the fuel wood collection activities are not usually recorded, the actual quantity of wood removals might be understated.[44]

As seen from the figure below, fuel wood is estimated to continue to represent an important energy source for the coming decades. Forecasts made by FAO show a 34 percent increase in fuel wood consumption from 2000 to 2020.

Figure 2.10 Woodfuel consumption in Africa



[Source: FAO, 2009]

2.5 Climate change

Biodiversity and climate change are closely inter-linked, and each impacts upon the other: on the one hand, biodiversity is threatened by human-induced climate change, but at the same time biodiversity resources can reduce the impacts of climate change on population and ecosystems.

To explore some of these interactions in more depth, one only needs to review one of the overall goals of the UNFCCC “conserving natural terrestrial, freshwater and marine ecosystems and restoring degraded ecosystems (incl. their genetic and species diversity). This goal is essential because ecosystems play a vital role in the global carbon cycle and in adapting to climate change, while at the same time providing a wide range of ecosystem services that are essential for human well-being and the achievement of the Millennium Development Goals.

[44] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38.

Climate change over the past 30 years has produced numerous shifts in the distributions and abundances of species[45]; and has been implicated in at least one species-level extinction.

During the 1990s climate change emerged as one of the major potential threats to biodiversity. The IPCC concluded that climate change could lead to severe adverse impacts on ecosystems, and on the goods and services they provide. Some ecosystems might disappear altogether, while others could experience dramatic changes in species composition.

Climate change is a rapidly increasing stress on ecosystems and can exacerbate the effects of other stresses, including habitat fragmentation, loss and conversion, over-exploitation, invasive alien species, and pollution.

To date, direct impacts of climate change on biodiversity at the species and ecosystem level have already occurred and will continue to occur in the future. For example, changes in the climate and in atmospheric CO2 levels have already had observed impacts on natural ecosystems and species. Some species and ecosystems are demonstrating some capacity for natural adaptation, but others are already showing negative impacts under current levels of climate change (an increase of 0.75ºC in global mean surface temperature relative to pre-industrial levels), which is modest compared to future projected changes (2.0-7.5 ºC by 2100 without aggressive mitigation actions).

Obviously, climate change poses a major threat to the Arctic Ocean because it will dramatically affect its specific characteristics in turn affecting its fauna.[46] In the Coral Triangle area, activities such as deforestation contribute to the emission of gases which stimulate climate change. Climate change is perhaps one of the main threats to biodiversity in the Coral Triangle.[47] Although other factors have been mentioned, such as sedimentation, pollution and changes in salinity, climate change is most widely reported as the cause of coral bleaching. This process occurs when corals become stressed and they eject their zooxanthella, becoming pale or white. But also form other areas it is reported that that climate change affects the habitat quality and population dynamics of several species, for example in the Wadden Sea.[48]

Further, desertification may increase in some other areas and as a consequence some species could also become more vulnerable to extinction. Climate change has also been implicated in the decline of amphibians in tropical montane forests (Pounds, Fogden and Campbell 1999).[49]

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[45] Centre for Biodiversity and Conservation, School of Biology, University of Leeds, Leeds LS2 9JT, UK; and Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL, UK, and Conservation Biology Group, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK. Original source in Nature 427, 145–148 (2004).

[46] Huebert, R. & B.B.Yeager, 2008, A new Sea, the need for a regional agreement on management and conservation of the arctic marine environment, WWF, Oslo.

[47] Burke, L. Selig, E. & M. Spalding (ed.), 2002, Reefs at Risk in Southeast Asia, WRI/UNEP/WCMC/WFC/ICRAN.

[48] Walday, M. & Kroglund, T., 2002, Europe's biodiversity, The North Sea, European Environmental Agency.

[49] Pounds, J.A., Fogden, M.P.L., and J.H. Campbell 1999. "Biological response to climate change on a tropical mountain." Nature 398(6728): 611-615.

The total impact of climate change on biodiversity to date, however, is still unclear. There is still uncertainty about the extent and speed at which climate change will impact biodiversity and ecosystem services, and the thresholds of climate change above which ecosystems are irreversibly changed and no longer function in their current form. Currently, risks to biodiversity from climate change can be initially assessed using available vulnerability and impact assessment guidelines. However, further development and validation of tools is necessary because uncertainties limit the current ability to project climate change impacts on biodiversity and ecosystem services.

2.6 Invasive alien species

Invasive species can be defined as species that have overcome geographic or reproductive barriers and which threaten ecosystems, habitats or species with economic and/or environmental harm. Invasive species have been cited as being the second most important threat to global biodiversity loss, after land use change.[50] As the awareness of the significant repercussions of the scientific scenarios regarding biological invasions in Europe has grown[51], the European Commission has been increasingly active in formulating appropriate responses, e.g. the Commission published a Communication describing the policy options in response to the threat.[52]

Like other components of global environmental change, biological invasions are predominantly human-induced processes. Many studies have analyzed factors of successful invasions, taking into account either the ecological traits of the species concerned, the characteristics of the host ecosystem, or both. Ecological differences between invaders and native species, behavioural flexibility or the strength of association with the species assemblage that characterizes a particular region are some of the ecological factors. A review of quantitative studies recognized up to 23 characteristics that predispose a species to become an invader.[53] However, anthropogenic mechanisms underlying successful alien invasions are analyzed in only a few of these studies. Human processes that have been cited as underlying the success of such invasions include technical and economic developments and cultural preferences.

International trade and related policies are also major underlying causes for biological invasions and associated losses in biodiversity. Measures that have been introduced to protect against adverse effects of invasive species include the Agreement on the Applications of Sanitary and Phytosanitary Measures (the SPS Agreement), signed in 1994 during the negotiations of the World Trade Organization.[54] It allows members to

[50] O.E. Sala, F.S. Chapin III, R.H. Gardner, W.K. Lauenroth, H.A. Mooney and P.S. Ramakrishnan, Global change, biodiversity and ecological complexity. In: B.H. Walker, W.L. Steffen, J. Canadell and J.S.I. Ingram, Editors, The Terrestrial Biosphere and Global Change: Implications for Natural and Managed Ecosystems, Cambridge University Press, Cambridge (1999), pp. 304–328; After Beatriz Rodríguez-Labajos, Rosa Binimelisa and Iliana Monterrosoa “Multi-level driving forces of biological invasions” Ecological Economics Volume 69, Issue 1, 15 November 2009, Pages 63-75

[51] P.E. Hulme, P. Pyšek, W. Nentwig and M. Vilà, Will threat of biological invasions unite the European Union?, Science 324 (2009), pp. 40–41.

[52] European Commission, “Towards an EU strategy on invasive species”, COM(2008) 789, EC, Brussels 2008

[53] C.S. Kolar and D.M. Lodge, “Progress in invasion biology: predicting invaders”, Trends in Ecology & Evolution 16 (2001), pp. 199–204.

[54] Food and Agricultural Organisation of the United Nations, 2000

restrict international trade to protect human, animal or plant life health from pests and diseases, as long as the restriction is necessary and scientifically justified.

Several aspects of environmental degradation facilitate the establishment of invasive species, like the transformation of coastlines and changes in land use. Another underlying cause is in connection with the management of flora and fauna, such as forestry, agriculture, horticulture and gardening, aquaculture, angling, the pet and aquarium industry and the leather industry. These economic activities contribute either to spread the species or to modify the ecosystems. Many of them have secondary effects since they appropriate a part of the primary productivity and introduce biological 'pollutants' such as genetically modified organisms (GMO).

In many marine areas species composition is also changed because of the invasion of non-indigenous species. Best known is the introduction of invasive species by ship ballast water. More than 80 species have been introduced to the North Sea in this way for instance. These species have an impact on other species and sometimes reduce the numbers of indigenous species.[55]

[55] Walday, M. & Kroglund, T., 2002, Europe's biodiversity, The North Sea, European Environmental Agency.

3 Biodiversity and the policy assessment framework

3.1 Introduction

In this chapter a combination of global reviews and regional case studies will show that social, economical and political factors as well as institutional mechanisms are all inter alia underlying causes of the current significant decline in biodiversity levels across the globe. There are in fact many different cause-effect relationships that include feedback mechanisms amongst different underlying causes and direct causes, dependent on the specific environmental context. For example, increases in local population growth (often cited an underlying cause of biodiversity loss) can be manifested by an increased surface area of land brought into agricultural cultivation (direct cause of biodiversity loss). It is the opinion of the authors that exhaustively describing the various factors of biodiversity loss is useful up to a point, but it is probably more useful to identify the "deepest" underlying causes, i.e. where the root of the problem really lies. In so-doing, the authors point to ill-fitting policies, economic and market failures and inadequate governance mechanisms and institutions. These themes are therefore explored in some depth in this section of the report. Furthermore, the underlying factors that shape agreements on issues that impact on biodiversity will be explored, including how policy instruments can have positive and negative effects on biodiversity in sections 3.2, 3.3 and 3.4.

3.2 Economic drivers

It is well known among economists that markets alone do not assign appropriate monetary value to biodiversity. Hence, without policy intervention, market prices do not properly reflect the losses to society as a whole arising from biodiversity degradation. This failure leads individuals, companies and governments to use biodiversity in an unsustainable manner. Recognising the opportunity cost of biodiversity loss and biodiversity conservation is a first important step towards integrating appropriate knowledge into national economic infrastructures, enabling a more informed and effective program of sustainable development to be pursued. In this section, an overview of the economic factors affecting biodiversity will be given.

3.2.1 Market failures

Market failures or market "imperfections" include "missing markets" in the external benefits generated by biodiversity conservation and also pertain to a lack of adequate information for price setting. Market failures can either be of a local nature or on a global scale. The former refers to the inability of markets to capture some of the local or national benefits of biodiversity conservation. This can also be seen as the inability of markets to capture the *costs* of converting ecologically valuable land to other uses and losing biodiversity in the process. The latter refers to the fact that biodiversity conservation yields benefits to beneficiaries external to where conservation practices take place.

Value of biodiversity

A major problem in connection with losses of biodiversity in different biomes is that much of the biodiversity *value* is not directly usable. Direct uses are usually much easier to monitor, control and trade than indirect uses. Indirect values such as genetic information and aesthetic appreciation are less readily captured as their contribution is more scattered over space and time. Because these biodiversity values are not owned, bought, or sold, they are often at a competitive disadvantage in a market economy, leaving them undervalued and overused. The solution to this has been traditionally to create nature reserves or national parks where biodiversity remains unaffected by market forces. However, this type of solution is not always optimal, and is a rather ecologically static approach. An alternative solution is to try to capture the value of biodiversity through specifying appropriate property rights for all its uses, which is a problematic process in its own right. The issue of property rights is discussed in section 3.4.

3.2.2 Economic structure, size and growth

There has been a lot of research conducted on the relationship between socioeconomic factors and environmental change in general in recent years. These studies have typically examined the relationship between environmental change and gross domestic product (GDP) or GDP per capita. Some of the more recent studies have found that higher rates of economic growth are associated with greater biodiversity loss. It is doubtful such a simple relationship can explain biodiversity trends.

The structure of economic activity and how unequal a society is are also important underlying properties that drive biodiversity loss. In a recent study[56], an analysis of data from 50 countries compared different socio-economic models' ability to predict biodiversity loss. The results indicated that economic inequality is an important predictor of biodiversity loss. Specifically, statistical comparisons revealed that the 'economic footprint' (the size of the economy relative to the country area), together with 'income inequality' were the best predictors of the proportion of threatened species. For instance, most of the countries in South East Asia are developing countries, with substantial numbers of people living below national poverty lines. Marine resources still directly sustain the lives of over 120 million people, while overfishing is regarded the most pervasive threat to coral reef biodiversity.[57]

[56] Holland, T.G., Peterson, G.D., Gonzalez, A. "A Cross-National Analysis of How Economic Inequality Predicts Biodiversity Loss"; Conservation Biology, Vol., No.. (2009)

[57] Burke, L. Selig, E. & M. Spalding (ed.), 2002, Reefs at Risk in Southeast Asia, WRI/UNEP/WCMC/WFC/ICRAN.

3.2.3 Demand for ecosystem services

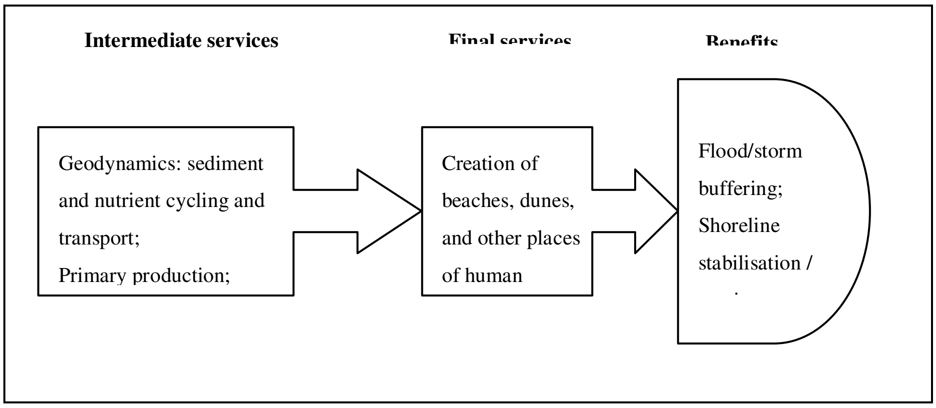
Many definitions and classification schemes for ecosystem services exist (Daily, 1997; Costanza *et al.*, 1997; Boyd and Banzhaf, 2007). One of the most widely cited is the Millennium Ecosystem Assessment definition, which describes ecosystem services as 'the benefits that people obtain from ecosystems'. It classifies ecosystem services into: *supporting* services (e.g. nutrient cycling, soil formation, primary production), *regulating* services (e.g. climate regulation, flood regulation, water purification), *provisioning* services (e.g. food, fresh water), and *cultural* services (e.g. aesthetic, spiritual, recreational and other non-material benefits). This framework provides an excellent platform for moving towards a more operational classification system which explicitly links changes in ecosystem services to changes in human welfare. By adapting and re-orienting this definition it can be better suited to the purpose at hand, with little loss of functionality. Wallace (2007), for example, has focused on land management, while Boyd and Banzhaf (2007) and Maler et al. (2008) take national income accounting as their policy context. For economic valuation purposes the definition proposed by Fisher *et al.* (2009) clarifies the distinction between ecosystem services and benefits: *ecosystem services are the aspects of ecosystems utilised (actively or passively) to produce human well-being*. Fisher *et al.* see ecosystem services as being the link between ecosystems and things that humans benefit from, not the benefits themselves. Ecosystem services include ecosystem organisation or structure (the ecosystem classes) as well as ecosystem processes and functions (the way in which the ecosystem operates). The processes and functions become services only if there are humans that (directly or indirectly) benefit from them. In other words, ecosystem services are the ecological phenomena, and the benefit is the realisation of the direct impact on human welfare.

Figure 3.1 Economic worldwide benefits coming from biodiversity

Source: TEEB, 2008.

The key feature of this definition is the separation of ecosystem processes and functions in intermediate and final services, with the latter yielding welfare benefits. Figure 3.2 portrays these various services and benefits for coastal ecosystems.

Figure 3.2 Relationships among representative intermediate services, final services and benefits



Source: adapted from Fisher and Turner (2009).

3.2.4 Macroeconomic factors

Macroeconomic factors are important underlying causes of biodiversity loss. There are arguments put forward by conservationists that claim models of economic development pursued by (foremost) developing countries are unsustainable. Specifically, it is claimed that such countries rely on foreign exchange to service debts and support imports, which provides an impetus for developing countries to mine their natural resources for exports. In addition, albeit to a lesser extent, private sector access to natural resources is often opened up to meet the demand for natural resource export earnings. Increased exploitation of natural resource products for export can lead to over-harvesting of certain species. With a few exceptional cases, the environmental costs of production or extraction are simply not valued in the marketplace. In other more isolated regions, trade expansion has the potential to facilitate both legal and illegal exports, as poor populations perceive new opportunities to generate income.

3.2.5 Trade-related biodiversity-loss

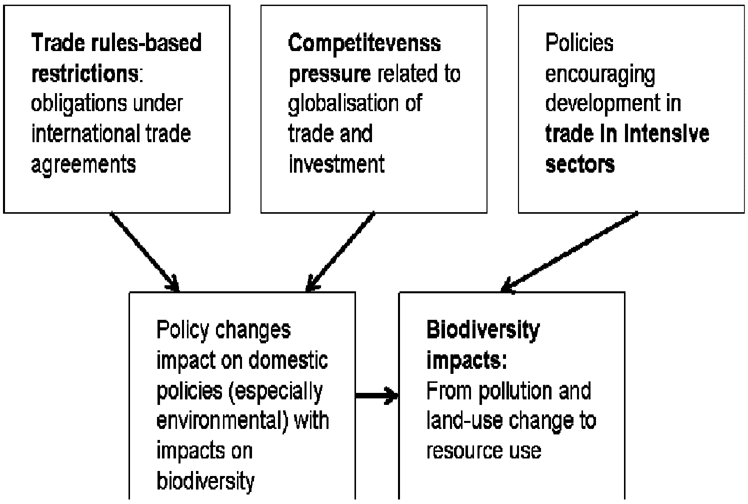
In recent years the commercial value attached to the planet's genetic resources stored in various organisms has increased as intellectual property rights have been assigned in conjunction with trade agreements. According to critics of the expansion of international trade agreements, this process creates incentives that may reduce biodiversity. Countries are deemed to be under pressure to change their IPR laws to conform to the TRIPS[58] agreement of the GATT[59]. These rules tend to supersede national laws and facilitate privatization of biological knowledge and resources. The ability of companies to gain monopolies over what were formerly freely available community resources in the form of seeds, plants and other organisms - has far-reaching effects on the protection of biodiversity. In addition, critics claim that the privatization of genetic resources that have been engineered and patented accelerates the trend toward monoculture cropping. An

[58] Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS)
[59] General Agreement on Tariffs and Trade (GATT)

example of this is in the Midwestern U.S. Corn Belt, where just a few varieties of patented hybrid corn now cover millions of acres land, where prairies once hosted thousands of varieties of grasses supporting birds and butterflies, bees and other wildlife.

In Figure 3.3 the way trade rules impact on developing countries' biodiversity is schematically shown. In this instance, the impact of the EU-AEC Economic Partnership Agreement on Uganda's Biodiversity was the specific example, but the diagram reflects a general pattern of competitive pressure leading to pressure on biodiversity from obligations under international trade agreements. In general, as the world's economies become ever more closely linked through international trade and investment, planners at the (inter)-national level need to understand and take into account the local effects of powerful macroeconomic forces. This is particularly true in the case of biodiversity, where new investment or increased international demand in particular sectors are so often linked to increased habitat destruction, resource depletion and industrial pollution.

Figure 3.3 Possible policy effects of trade on biodiversity in developing countries



Source: adapted from The National Environment Management Authority of Uganda's Economic Policy Research Centre presentation "An Integrated Assessment of the potential impacts of the EU-AEC Economic Partnership Agreement on Uganda's Biodiversity: a case-study of the horticultural sub-sector"

Figure 3.3 basically outlines the way that international competitive pressure to pursue free trade agreements, which increases in the face of globalisation, has negative implications for biodiversity. This occurs either directly as development of intensive sectors of economic activity resulting from new domestic policy leads to pollution and land-use change (conversion of habitat to other forms); or occurs indirectly as trade rules-based restrictions lead to domestic policy changes themselves with the resultant negative impact on biodiversity.

3.2.6 Technology

Science and technology may be seen as helpful tools to solve the problem of biodiversity loss. However, often scientific and technological developments may seriously negatively affect biodiversity. Especially within the field of agriculture, it is not certain whether technological and scientific innovations are beneficial or not. One rather recent development will be discussed in detail: genetic engineering.

Genetic engineering has been cited as a driver of biodiversity loss. In India, for example, peasant producers cultivate some 50,000 varieties of rice, developed through traditional practices over hundreds of years. This huge variety came about from subtle differences in soil and climatic conditions through mutation, evolution, and the deliberate application of cultural preferences. The GATT-TRIPs rules make it harder for farmers to harvest and reuse the seed of any rice variety that has been patented. Unlike hybrid species cultivated by plant breeders, genetically engineered plants do produce viable seed. Lack of access to seed stocks will cause the abandonment of much of India's biologically diverse agriculture, which in turn sustains healthy diversity in surrounding ecosystems.

Other technological developments
The high levels of science and technology in most industrialized countries influence innovative power, which may cause new potential environmental dangers. Well-known and relevant examples are radioactive waste, dangerous new chemicals, and nanoparticles. However, technological development in agriculture, fishery and mining may also affect biodiversity.

At the same time, ecological and environmental sciences and sustainable technology have rapidly developed in the last decades, making it easier to formulate ecological standards and to stimulate environmentally friendly production modes. In many regions in the world, however, there is little development of ecological practices, environmental sciences or sustainable technology. Furthermore, in these regions, most citizens, bureaucrats, managers, local NGOs and industries are not well informed about scientific aspects of sustainable modes of management.

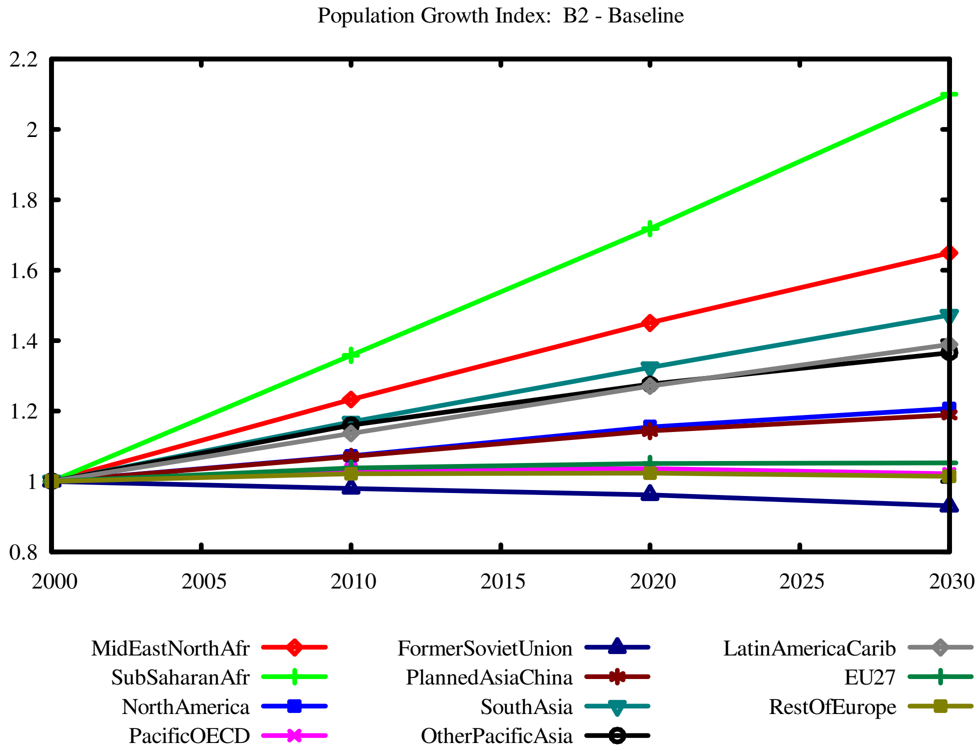
3.3 Demographic drivers

3.3.1 Population size

The globe has experienced a rapid population growth throughout the last century. According to the US Census Bureau the world population increased from 3 billion in 1959 to 6 billion by 1999, a doubling that occurred over 40 years. Population projections imply that the global population will continue to grow throughout the first half of the 21st century, although at lower growth rates than seen throughout the second half of the 20th century. A growing global population consequentially implies a growing demand for agricultural products (food) and forest products (building) material.

Figure 3.4 displays a region-specific scenario development with regard to population growth. The first observation which can be easily made is a decreasing population within the region of the former Soviet Union until 2030. In the EU-27, the remaining Europe and the Pacific OECD region, the population will remain more or less at current levels by 2030, having the potential for slight population increases. Besides these regions experiencing a declining of stagnating population, all other POLES regions will experience continuous population growth until 2030. Especially striking are the population growth projection lines for Sub-Saharan Africa, the Middle East and North Africa as well as South Asia, in order of indexed population growth. All these regions, will experience a substantial population growth

Figure 3.4 Projected population growth 2000-2030



[Source: IIASA]

Although population growth is certainly a driver of biodiversity loss and current projections of human population growth as described here will further increase the pressure on biodiversity, this picture still needs to be refined. A study by Holland et al.[60] for example has demonstrated that it is not simply population growth, but rather the size and structure of the economy that can provide a better explanation of the impact on biodiversity. Increasing human populations can and do place direct demands and pressures on existing natural resources. This can often lead to the harvesting of natural resources at unsustainable rates.

Although urban populations are directly dependent on rural food and fibres production for their survival and as such have the higher consumption intensity per person than that of rural populations, it is nevertheless the case that increased population pressures will lead to people looking to move to unoccupied or less densely occupied areas and in so doing may turn to protected sites to provide these livelihood opportunities. In many cases, such encroachment leads to environmental deterioration at these sites, which has adverse effects on habitat suitability and ultimately on the number of different species that can

[60] Ibid

locate in that area. In other studies, it has been found that economic migrants may bring with them new techniques for utilizing resources that prove environmentally destructive in these new settings.[61]

3.3.2 Public attitudes and individual behaviour

The arrangements and functioning of human institutions and of the attitudes of individuals is a major underlying cause of biodiversity-loss. A key element is the failure of most societies to exercise adequate controls over land, water, and other resources. Effective means for controlling land use do not exist in most countries; laws and regulations that permit governments to exercise such control, when existent, often cannot be enforced because of the danger of strong public resentment and resistance. Although it is necessary that resources be used with a view to preserving their future productivity, this view all too often conflicts with the present needs or demands of the resource-users. The solution to this conflict is not within the scope of science or technology; instead, it is a question of attitudes and values and these are less open to change than laws or regulations. Although attitudes towards nature and technological risks have shifted in a more sustainable direction, at least in some European countries, this may vary from place to place and time to time. In addition, in many developing countries, nature conservation is associated with colonial history or corrupt post-colonial regimes. Although there are non-Western conservation approaches that sometimes have a long history, they are rarely taken into account.[62] Also in the Arctic region, the Inuit have a different attitude towards nature than inhabitants of the neighbouring industrialized countries.

Furthermore, environmental programmes usually receive lower priorities in many developing countries, and tend to suffer considerably from budget restraints, leading to understandable environmental consequences. Budget cuts in social services often increases poverty for the poorest populations who then rely increasingly on natural resources, such as fuel wood for example, which has a detrimental effect on biodiversity.

3.4 Institutional drivers

The underlying causes of biodiversity loss that have been identified thus far have been set out to provide an overview of the economic, social and technological drivers of biodiversity loss. However, it is clear that although these underlying mechanisms can explain why biodiversity loss occurs, these same causes cannot be considered to necessarily represent a "wrong" choice for a society, i.e. a society that develops in terms of population size, develops socially and economically, and applies technology is not making a wrong choice per se, it is rather the unintended negative effects of these choices on environmental properties that is not being addressed.

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[61] WWF's Socioeconomic Root Causes of Biodiversity Loss Project. (Analysis and identification of causal mechanisms based on 10 country cases)

[62] Arnscheidt, J. 'Debating' Nature, 2009, Leiden University Press. Leiden.

Institutional and governmental factors are regarded as crucial to improve biodiversity policies. Although in most western countries extensive legislative frameworks exist, biodiversity policy is far from successful. Failure of actors include, among others, a lack of political will of governments, international cooperation, and implementation of the measures and involvement of stakeholders. Especially developing countries face many challenges.

Increasing economic activity in both the developed - and the developing - world generates significant negative externalities in the form of habitat destruction and in turn, biodiversity loss. Other common externalities include noise-, soil-, air- and water pollution, and degradation of the environment in general terms. It is often the choices that are made about economic activity at both local and larger scales that do not factor in the ecological consequences of those decisions effectively enough that is the root of the cause of biodiversity loss. The main explanations for why this occurs are due to:

- a lack of effective property rights;
- and ineffective governance structures,

Running through these factors is a misunderstanding about the character of ecosystems as resources (i.e. they exhibit restricted substitutability, threshold levels, irreversible loss of renewability, non-linearity of production, interdependency across spatial scales through abiotic (water, nutrients) and biotic (species populations) exchanges).

3.4.1 Property rights

Property rights to natural resources define privileges and responsibilities in the use of environmental goods and services. They specify the way people should behave toward one another as they use environmental resources. Property rights to natural resources control both use and conservation. Their scope may be either individual species or areas of land and water in which species live. The scope of property rights also includes different types of use. At present, most systems of property rights are designed for direct uses, such as catching fish for food, but they may also include indirect uses, such as the right of the public to enjoy wildlife viewing or to protect endangered species. Property rights are almost never defined for unused species or for communities of species. The idea of using property rights for the protection of not only single species but also biodiversity is a new and broader application of their accustomed use.

The form and function of property rights in relation to biodiversity is an area of knowledge that is in development. It is generally known that that there remains considerable uncertainty with respect to the design of property rights for biodiversity protection. Managing the direct and indirect effects of activities in ecosystems in order to maintain the diversity of genetic, species, and functional components is problematic because of:

- Lack of knowledge and understanding of the social and economic relevance (benefits) of well-functioning ecosystems and associated biodiversity for owners and users of these systems
- a lack of provision of appropriate incentives so that people find it in their interest to promote and maintain the public good of biodiversity;

- problems specifying how rights, rules, and responsibilities that constrain resource use can be expanded from single species or physical areas to multiple species that may be distributed over wide areas;
- how to make the transition from traditional single-species commodity production types of use to new types of use that accommodate the protection of species diversity through the maintenance of ecosystem services;

A number of emerging issues illustrate the challenges to the use of property rights to protect biodiversity. Amongst the most challenging issues are:
- uncertainty;
- exclusivity;
- distribution of benefits;
- and the alignment of private and social goals.

Uncertainty
Protecting biodiversity requires a set of rules and responsibilities for property rights set within institutions that accommodate the attributes of the ecosystem and the people who use it[63]. How to design property rights and related institutions in order to fully capture the properties of the ecosystem remains a challenge. It is generally understood that biodiversity is crucial to the stability, function, and sustainability of ecosystems, but there is a much less understanding of specifically what to protect. For example, knowledge is incomplete of the thresholds at which biodiversity loss irreversibly changes ecosystems. In addition, the role played by individual or key-stone species in contributing to critical ecosystem functions is also inadequately known. These uncertainties create a corresponding uncertainty in the objectives and design of property rights to reflect the full range of ecosystem values involved. TEEB has shown however that the information base is developing regarding biodiversity and ecosystem services. TEEB points out that although decision makers are still relatively worse off in considering biodiversity than in considering many other issues, there are developments both at the project and meta level. The Millennium Ecosystem Assessment is one example of a pooling of scientific information and identification of gaps (and a plan to fill them).

Exclusivity
A problem with many property rights that apply to natural resources is that they do not specify claims to the full range of services provided by an ecosystem. In failing to fully specify property rights claims, they fail to protect exclusive use. If property rights were defined for all components of an ecosystem, users and decision makers would have to take all the consequences of their actions into account. This would be the first step in making biodiversity conservation profitable[64], but under current systems of property rights, this is rarely the case. The history is to apply property rights to natural resources as commodities but not to the services they provide (or alternatively to their existence value). The lack of full specification means that it is unclear who can claim and control rights of use.

[63] Hanna, S.,S. Property rights and Biodiversity, Encyclopedia of Biodiversity, Volume 4 (2001)
[64] Ibid

Distribution of Benefits
If biodiversity protection is to work in a world with multiple stakeholders and other parties all seeking to maximize their own interests, then finding a suitable mechanism for the distribution of the associated benefits of biodiversity protection is essential. However, it is difficult to distribute benefits in a way that all stakeholders will gain and there will not be any losers. Indeed, this is true for benefits from any resource as there are always (hidden) costs and thus losers to any transformation of resources in a production process. Nevertheless, biodiversity values have the potential to be protected through a number of different types of property right, but it is difficult to design an effective system of property rights without addressing the questions of (i) what the objectives are, (ii) how progress toward those objectives will be measured, and (iii) the time frame over which they will be met. To make an equitable distribution of benefits also means extending them into the international arena, where the distribution of benefits between rich and poor nations comes into play.

Effective protection also is reliant upon a legitimate system that can apply the rights, rules and procedures of participants. Biodiversity levels are difficult to monitor, and the possibilities for circumvention of rules is made easier as a consequence[65]. When people doubt the legitimacy of the system of property rights because they cannot accept its distributional outcomes, their incentives are to undermine rather than support its evolution to a new form. Scarcity compounds the erosion of legitimacy by creating greater incentives and opportunity for rent seeking that is characteristic of resource competition.

Alignment of Private and Social Goals
There is basic conflict between private preferences and public preferences for biodiversity conservation, and a system of property rights must try to bridge the gap between the private and social goals. Individuals and companies tend to set private goals for productivity of ecosystems goods that may not be compatible with social goals for biological production. In addition, biodiversity on public lands is a public good, so it is subject to the potential for free riders to enjoy the benefits without paying the related costs of use.[66] Furthermore, it will be necessary to develop property rights that can still allocate existing rights and rules that favour direct uses of ecosystem goods. It is the realignment of private and social incentives to conserve biodiversity that is receiving attention in nature conservation programmes, but this task is still to a large extent unresolved. Most current systems of rights, because they are still unspecified for ecosystem services, favour the conversion of ecosystems into goods. Options for change include the expansion of the scope of property rights, payment of compensation to owners for conserving rather than using resources, or developing prohibitions against certain uses.

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[65] The difficulties can be overcome by agreeing on a selection of representative species or indicator species, which is actually being developed in various countries, e.g. work in the Netherlands by the Central Bureau of Statistics and the Central Planning Bureau on the so-called "Network Ecological Monitoring" takes this approach.

[66] A complicating factor is that some of the ecosystem services are trans-boundary (e.g. climate regulation) and some are dependent on trans-boundary inputs (nutrients, water). Moreover, biodiversity is related to physical habitats on land, lakes, rivers and seas etc., which are often privately owned.

3.4.2 Governance

Biodiversity has declined over the years partly due to the lack of adequate governance that is required to make informed choices in connection to decision-making processes at different levels. Specifically, the failure to create institutions that can internalise the values of biodiversity within the decision-making of countries and individuals making conversion decisions is at the heart of the governance issue. Good governance includes problems and solutions at different scales:

- governance at the international level;
- governance at the national level;
- governance at the regional level;
- and governance at the local level, including the cooperation with local stakeholders.

International levels

The ineffectiveness of the international governance of biodiversity is often cited as one of the most significant obstacles to achieving the 2010 target. Due to its fragmented nature, lack of strength, and the weak political clout of biodiversity conservation compared to other issues such as trade and development, which are often in conflict with biodiversity goals, it is indeed a major hurdle to effective biodiversity conservation. At the upper level of international governance, implementation and control are hard to realise. Despite the existence of several legislative frameworks directly or indirectly concerning biodiversity loss, there are hardly possibilities to force stakeholders or nations take these frameworks seriously. Some, among them the US, are not willing to sign these kinds of international agreements. Sometimes agreements between countries in a certain region of the world exist, but only in a few cases these includes common frameworks of aims, monitoring, control and evaluation.

It is generally recognized that the current governance mechanisms at international level such as the CBD, the WTO (which regulated 97% of trade in the world) and other fora include provisions for biodiversity conservation, but that the major difficulty lies in establishing the rights of indigenous people and communities who are the local custodians of biodiversity. Of particular concern is their right to participate in decision-making, to access the biological resources on which they depend, and to receive an equitable share of the benefits and costs of using and protecting these resources. Although the CBD's Articles 8(j) and 10(c) for example recognise the special role of indigenous and local communities in conservation and sustainable use, and provisions clearly recognise the importance of community knowledge for biodiversity decision-making and the need to respect community rights to customary use of biodiversity resources, the implementation of such principles in practice is another matter.

National levels

At national levels, problems of adequate governance may be encountered concerning the quality of legislation, political will and appropriate policy instruments, people, money or organization. In many developing countries the national governments have not much power compared to multinational companies and institutions. Some have inappropriate legal frameworks which have contributed to serious degradation of natural resources. In most cases there is a lack of clear environmental and biodiversity policy aims, several independent governmental levels, severe weaknesses in law enforcement of natural resources, the lack of involvement of stakeholders and a general lack of commitment to sustainable management and development of natural resources.

A potential solution to this is to mainstream biodiversity in national economic sectors. Mainstreaming biodiversity is a central goal of the CBD's Strategic Plan for achieving the 2010 target on halting biodiversity loss. To date, the discussion surrounding mainstreaming has largely focused on biodiversity per se, without considering the components of biodiversity that are most important for local livelihoods. Given that the rural poor are often heavily dependent on biodiversity, it is important to focus on reducing development impacts on both biodiversity and related livelihoods, particularly in some developing countries with high levels of poverty. Similarly, mainstreaming or integrating attempts have sometimes focused on conservation through protected areas, which remain separate to development processes and can negatively affect the poor.

Regional levels

The importance and nature of political and institutional varies considerably from region to region. At the regional level more or less the same problems can be found, lack of money, regulations, political will, stakeholder involvement, policy instruments, equipment, power and so on. The share of responsibilities is not clear and corruption may flourish in many countries. In some regions international cooperation has a long history, for instance in the North Sea region in Europe. Most abide by EU legislation and all respect international legislation concerning environmental and biodiversity protection. However, the implementation of international legislation may differ from country to country. Due to common agreements, improvements have been reported with respect to the discharge of nutrients and some contaminants from rivers. In most cases, control in the sea area itself is poorly organized, although this is improving.

In other regions, the implementation of international legislation is very poor and responsibilities are not clearly assigned. In South-East Asia for instance, very few protective measures have been taken and control remains poorly organized. For instance, most of the marine protected areas are so-called paper parks, that is, they do not exist in practice. Due to the powerful interests involved and the lack of legislation, political will or control, fisheries regulation, for example, is far from optimal. A real problem in most countries is the limited involvement of local stakeholders and poor collaboration between governmental levels.

Local levels

Ideally, local institutions should be democratic, transparent and accountable to the local community as some of the most important functions for representative local institutions include:

- equitable benefit-sharing of revenues that communities receive (for example from ecotourism);
- sustainable resource management, i.e. developing and enforcing rules, penalties and incentives for resource conservation and rational use;
- negotiation with outsiders in order to claim and defend community resource rights and regulate/exclude outside access.

Institutions at the local level that could take up the role of governance include local authorities/elders, traditional resource management practices and tenure arrangements, and related customary laws and values. Strengthening culture and identity can also be as important as the economic aspects of maintaining sustainable livelihoods and can serve to strengthen cohesion between actors at the local level and in turn can mean that collective enforcement of biodiversity protection measures is enhanced. Traditional institutions often centre on collective management of land and common property resources and social relations.

3.4.3 Formal policies and their effects on biodiversity

Policy frameworks in which biodiversity are assessed usually take the form of an impact assessment, with the main tools used in policy assessment in regard to biodiversity including:
- Environmental Impact Assessment carried out for individual projects (EIA);
- Strategic Environmental Assessment of policies plans and programmes (SEA).
- Regulatory Impact Analysis (RIA) or the European Commission's Impact Assessment, which is a Policy Assessment Framework frequently used to examine and measures the likely benefits, costs and effects of new or changed policies and regulations.
- Trade impact assessment (sometimes referred to as Integrated Assessments (IA) or Sustainability Impact Assessment (SIA) cover both trade in goods that can affect biodiversity and the commodities provided by biodiversity that are then traded internationally Decision frameworks include decision making structures such as legislation and decision-making processes, such as implementation, participation, monitoring and feed back mechanisms.

There also policy frameworks that are designed to safeguard biodiversity that usually have an international scope such as the Bird Directive, the Habitat Directive, the conventions of Bonn and Bern, CBD, CITES, Ramsar etc. However even where extensive legislative frameworks exist, biodiversity policy is far from successful. One of the underlying reasons is the failure of actors at all levels to make decisions that are in the best interests of ecosystem functioning. Failure of actors include, among others, a lack of political will of governments, a lack of international cooperation on this issue, poor implementation of measures and inadequate involvement of all stakeholders.

Positive and negative effects on biodiversity
In table 4.1, a list of international, European and national policy frameworks that seek to halt the loss of biodiversity is shown; while in table 4.2, policy frameworks that may have adverse effects on biodiversity levels is listed (Source: Braat & Ten Brink, (eds.) 2008).

Table 3.1 Overview of international, EU and national policies (e.g. legislative and policy instruments) with positive contribution to the conservation and sustainable use of biodiversity

International	EU	National
International binding agreements ▪ UN Convention on Biological Diversity (CBD) ▪ Convention on the Conservation of Migratory Species of Wild Animals (CMS) ▪ Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) ▪ International Plant Protection Convention (IPPC) ▪ Convention on the Conservation of European Wildlife and Natural Habitats (the Bern convention) **International non-binding agreements** ▪ Pan-European Biological & Landscape Diversity Strategy (PEBLDS) ▪ Political resolutions on biodiversity (2004 Kyiv Resolution on Biodiversity; 2007 G8 Potsdam Initiative on Biological Diversity) ▪ Biodiversity related action plans, Codes of conduct and best practise etc. by organisations such as UNEP, IUCN etc.	**Legislative instruments** ▪ Habitats & Birds Directives (e.g. official Guidance Documents for implementation) ▪ EU Wildlife Trade Regulations **Policy instruments** ▪ EU biodiversity policy and the 2006 Biodiversity Action Plan ▪ Different non-binding Community Guidelines for the implementation of Habitats and Birds Directives and other elements of the EU biodiversity policy **Funds** ▪ EU Structural funds ▪ European Agricultural Fund for Rural Development	**Legislative instruments** ▪ National legislation for biodiversity and nature protection, e.g. in the EU national implementation of Habitats & Birds Directives **Policy instruments** ▪ National biodiversity policies, Action Plans and guidance documents
	Biodiversity elements within other policies	
International binding agreements ▪ UN Framework Convention on Climate Change (UNFCCC) **International non-binding agreements** ▪ Political resolutions with included biodiversity as species, e.g. the 2002 UN Johannesburg Plan of Implementation on sustainable development ▪ Action plans, Codes of conduct and best practise with biodiversity relevance etc. by authoritative organisations such as FAO UNEP, IUCN, International Council for the Exploration of the Sea (ICES)	**EU environmental policy** ▪ Legislative instrument: EIA and SEA Directives ▪ Policy instrument: Thematic Strategy on the Sustainable Use of Natural Resources **EU Common Agricultural Policy (CAP)** ▪ Policy instrument: EU Forest Action Plan; Rural development fund (2nd pillar of CAP) **EU Cohesion Policy and regional development** ▪ Legislative instrument: Financial support under European Structural and Cohesion Funds for conservation and sustainable use of biodiversity **EU climate change and energy policy** ▪ Policy instrument: EU policy for Climate Change adaptation (white paper 2009) **EU policies on development cooperation and external assistance** ▪ Legislative instrument: Financial support under the EU Development Cooperation Instrument (DCI), European Neighbourhood and Partnership Instrument (ENPI) and European Development Fund (EDF) for conservation & sustainable use of biodiversity ▪ Policy instrument: Thematic Programme for EU 2007-2013 External Action on Environment and Sustainable Management of Natural Resources (incl. energy)	Legislative and policy instruments for sustainable use and conservation of biodiversity integrated into national sectoral policies: ▪ environmental policies ▪ forestry policy ▪ regional development policy ▪ climate change and energy policy ▪ policies regulating land-use and land-use planning ▪ policies for development cooperation and external assistance In the EU, this includes national level implementation of relevant EU provisions – with the exception on land use planning as this falls under the full competence of the Member States.

Policy instruments not specifically addressing biodiversity but with potential to do so		
International binding agreements ▪ European Landscape Convention **International non-binding agreements** ▪ UN Millennium Development Goals (MDGs) ▪ Different regional agreements for sustainable development within river basins, mountain regions etc.	**Legislative instruments** ▪ EU Regulations for animal and plant health (re: invasive alien species) Note: Additionally, all above mentioned sector EU legislative instruments could be used to protect biodiversity in more pro-active manner	**All national legislative and policy instruments providing for environmental sustainability and sustainable development.** Environmental education, e.g. awareness rising on the value of ecosystem services, could play an important role in changing unsustainable consumption patterns.

Table 3.2 Overview of international, EU and national policies with negative effects on the conservation and sustainable use of biodiversity

International	EU	National
	High concern	
Trade: WTO and regional trade agreements ▪ trade liberalisation increases unsustainable land-use practises in areas with high production and export potential, e.g. intensification of land-use and converting unused ecosystems into human activities ▪ trade liberalisation results in increased spread of invasive alien species	**Climate change and energy policy** ▪ The EU biofuels targets require increase in a) biofuels production in the EU and b) imports outside the EU. This can cause rapid land-use changes with negative effects on biodiversity both within and outside the EU. **Common Fisheries Policy (CFP)** • Fishing Agreements with third countries continue to support exhaustion of resources by EU vessels outside the EU leading more generally to unsustainable use of natural resources in these countries, e.g. increased use of bush meat **Cohesion Policy and regional development** ▪ Regardless of increasing potential for supporting sustainable development (e.g. biodiversity conservation), the support to regional development continues, to a large extent, to be focused on development of growth, jobs, industries and infrastructure with limited biodiversity considerations.	Similar to EU, national policies / legislation contributing to unsustainable use of natural resources in the following sectors: ▪ Land-use and land-use planning ▪ Use of water resources ▪ Energy (and climate change) ▪ Agriculture, forestry and fisheries ▪ Biotechnology and GMOs ▪ Policies for industries, e.g. extractive industries ▪ Tourism Bi-lateral trade agreements between countries can cause similar effects than global trade liberalization.
	Moderate / indirect concern	
	EU budget ▪ The decline in the EU overall and Member State species budgets increases competition for financial support between different sectors. It is likely that this will decrease available resources for environment. **EU internal trade** ▪ Free intra-EU trade makes it difficult to control the spread of invasive alien species within the EU **EU Development Policy and External Assistance** ▪ EU financed activities continue to have adverse effect on biodiversity in the third countries.	

3.5 Policy assessment applied: some examples

3.5.1 A closer look at the scaling mismatch and the effects of globalisation on biodiversity in coastal ecosystems

Some of ecosystem loss and degradation problems are confined more or less to the local scale (i.e. within coastal zones). The drivers and pressures and their impacts are in the instances, at least in principle, open to local management actions. But problems such as eutrophication of estuaries and coastal waters have to be viewed at the regional scale. The drivers and pressures, agricultural intensification/expansion etc., are located in physical catchments or political designations which extend well beyond the coastal zone. Increasingly, the drivers of coastal change are very distantly located from the ecological impacts and consequent socio-economic cost effects. A combination of globalised elements, remote markets, heavily advertised goods and services which condition consumer preferences, financial markets, trade arrangements, transport networks, regulatory regimes (or the lack of regimes) and international labour cost differentials, all contribute to ecosystem loss in coastal zones.

The global economy and engine of economic growth, international trade, is characterised by a focus on short term financial returns, 'light touch' regulation of markets and trading arrangements and an underlying growth imperative measured in terms of GDP/GNP maximisation rather than qualitative development progress. The model appears to assume that economic activity can expand indefinitely without regard for either source or sink environmental limits. Critics argue that international trade results in an ecologically unequal exchange and the accumulation of ecological debt, which rich countries owe to poor countries.[67] The causes of ecosystem change are typically then beyond a nation's boundaries, or within its territory but beyond its control. The resource exploitation frontier, for example, for shrimps, palm oil etc., advances in new territories such as lateral extension along coastlines or into wider areas of coastal waters. The consequences of this expansion are often local costs borne by the poorest social groups. The prices received for exports from the frontier do not include compensation for the local or, sometimes, global environmental costs. An example in the widespread conversion of tropical mangrove forests to shrimp aquaculture. These farms supply Europe and North America with cheap shrimp, but nearby residents must pay the costs: the loss of mangrove storm services, fish nurseries and fuel and fibre sources.[68]

This process exacerbates the debt burden problem because rich countries make disproportionate use of environmental space or services without proper payment or recognition of other people's entitlements. Srinivasan et al. (2008) present some quantitative evidence at the global scale of the distribution of environmental impacts across income groups for the period 1962-2000, with important implications for ecological debts between country groups. In general terms the analysis confirms that

[67] Martinez-Alier, J. (2005). The Environmentalism of the Poor. New Delhi, Oxford University Press.

[68] Sathirathai, S., and E. B. Barbier, (2001). Valuing mangrove conservation in southern Thailand. Contemporary economic policy 19:109-122.

poorer countries are carrying more than their fair share of the costs of environmental damage around the globe.

3.5.2 Likely future effects of increased biodiversity protection efforts

The following case study on the implications of biodiversity protection in the Congo Basin aims to better illustrate the importance of the above-described underlying drivers of biodiversity loss.

Classification of current and future protection status
To assess potential impacts on deforestation and associated species loss, current protection levels are juxtaposed to those in 2030 under the policy shock of 10% additional biodiversity protection.

Current protection status: The geographic location and classifications of currently protected areas are based on the World Database on Protected Areas (UNEP-WCMC, 2009). The current classification of protected areas was then reclassified according to protection statuses: high-very high protection and middle-low protection status. The International Union for Conservation of Nature (IUCN) classes Ia, Ib, II, IV and international and national government managed protected areas (e.g. World Heritage Convention, United Nations Educational Scientific and Cultural Organisation programme on Man and the Biosphere Reserve, Ramsar Convention area, wildlife reserves) are grouped into the category of high-very high protection status. Whereas the IUCN classes III, V, VI and all other categories (e.g. forest park, wildlife management area) are classified into middle-low protection status category. The classification used in this study is based on management objectives for conserving biodiversity provided by IUCN (1994) and the Ministerial Conference on the Protection of Forests in Europe (MCPFE) (2003). Their guidelines are compared in the table below.

Table 3.3 Comparison of MCPFE and IUCN classes (MCPFE, 2003)

MCPFE Classes		EEA*	IUCN**
1. Main Management Objective 'Biodiversity'	1.1 'No Active Intervention'	A	I
	1.2 'Minimum Intervention'	A	II
	1.3 'Conservation through Active Management	A	IV
2. Main Management Objective 'Protection of Landscapes and Specific Natural Elements'		B	III, V, VI
3. Main Management Objective 'Protective Functions'		(B)	n.a.

* References as identified in the Standard Data Form of the Natura 2000 and Emerald networks and used in the same way in the framework of the Common Database on Designated Areas (CDDA), managed by the EEA on behalf of two other organizations (Council of Europe and UNEP-WCMC). The groups (A, B or C) are related to designation types and not to individual sites.

** Indicative reference:
- The equivalence of IUCN Categories may vary according to the specific management objective (of the forested part) of each individual protected area. A technical consultation process with IUCN and its World Commission on Protected Areas (WCPA) is underway to ensure full comparability between the MCPFE and IUCN systems.
- IUCN Categories III, V and VI have biodiversity conservation as their primary management objective. However, they fit more easily under MCPFE Class 2 than 1.
- The area of forest and other wooded land assigned to the classes 1 and 2 should not be summed up with the data collected under class 3 to avoid double counting.

Projected protection status: The projected protection area has originally been created for global biomass assessment by the Dutch Planbureau voor de Leefomgeving (PBL).[69] In their database there are two reference years of protected area projections (2030 and 2050), which are based on the Sustainability First Scenario designed by Lera Miles (WCMC). The WCMC Sustainability First Scenario assumes: expansion of terrestrial network to 10% of all biomes + all single-site endemics by 2025 and 20% of all biomes by 2050; new sites allocated as 30% no-change, 65% sustainable use, 5% failed.

The projected protection area is classified by the protection status (simplified from IUCN classes) in the data set:

1. Fully protected, no use is allowed;
2. Protected, but sustainable use of area is allowed; and
3. Protection failed, these areas in practice are not protected at all (not considered).

Failure indicates that there is no barrier to land use change in this protected area. In Sustainability First, the new protected areas are first allocated to priority areas for biodiversity to attain at least 10% of each biome/region combination. Additional areas are then allocated to cover single-site endemic species that have not captured, based upon the Alliance for Zero Extinction (AZE) point dataset. These additional areas are circles of equivalent size to that specified in the AZE dataset, thus giving an artificial appearance to the scenario data. The coverage of some biomes is therefore expanded to greater than 20% by 2025 within these two scenarios.

For this study, the 2050 protected area projection by PBL is assumed as the status of 2030 under the Sustainability First Scenario. In order to maintain consistency across the current and projected biodiversity scenarios, the variation of the future protection statuses shown above has been considered as one category, i.e. future protection area, rather than distinguishing between the types of future protection.

Comparison of current and projected biodiversity protection levels

The area of current and projected protection areas is summarized in the table below. The results show an overall increase in protected areas from 2009 to 2030 of approximately 433 Mha worldwide and 19 Mha in the Congo Basin.

Table 3.4 Summary table of protected area for 2009 and 2030

Year	Protection status	World area (hectares)	Congo Basin* (hectares)
2009	With High-Very High protection status	1,569,862,600	46,312,100
	With Middle-Low protection status	1,118,212,000	26,063,100
	Current protection area total	2,688,074,700	72,375,200
2030	Projected protected area in 2030	3,121,463,600	91,390,200
	Assumed real increase 2009-2030	433,388,900	19,015,000

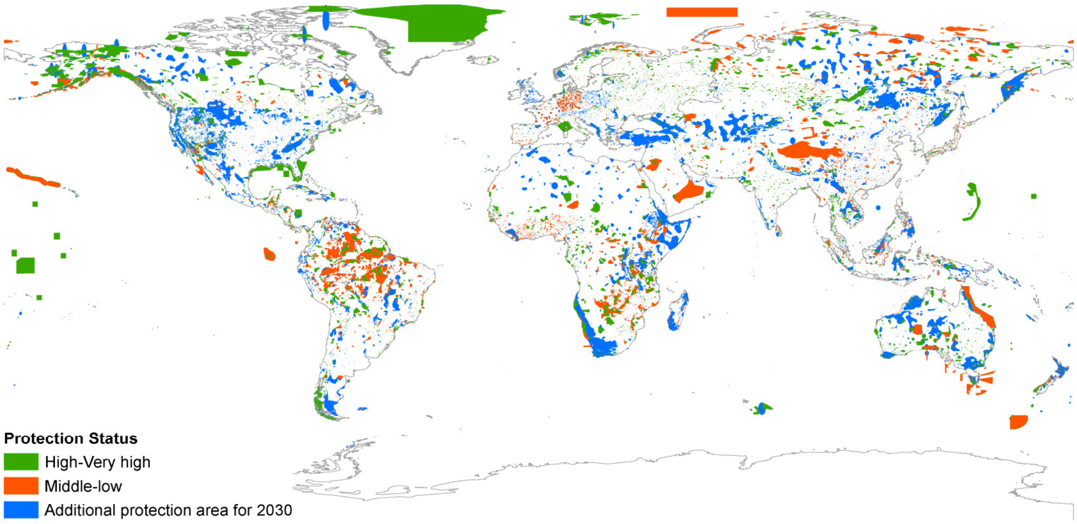
* Cameroon, Central African Republic, Democratic Republic of the Congo, Equatorial Guinea, Gabon, and Republic of Congo.

[69] Lysen et al (2008). Global biomass assessment. Dutch Planbureau voor de Leefomgeving (PBL).

[Note: High – Very high protection status for the IUCN classes Ia, Ib, II, IV and internationally and national government managed protected areas (e.g. World Heritage Convention, Ramsar Convention area). Middle-Low protection status for the IUCN classes III, V, VI and all other categories (e.g. forest park, wildlife management area)]

The following figure depicts this change in protected areas from 2009 to 2030 geographically on a worldwide scale. The protection status of the currently protected areas is classified by management objectives as mentioned above.

Figure 3.5 Worldwide protected area for 2009 and additional protected area according to biodiversity scenario for 2030

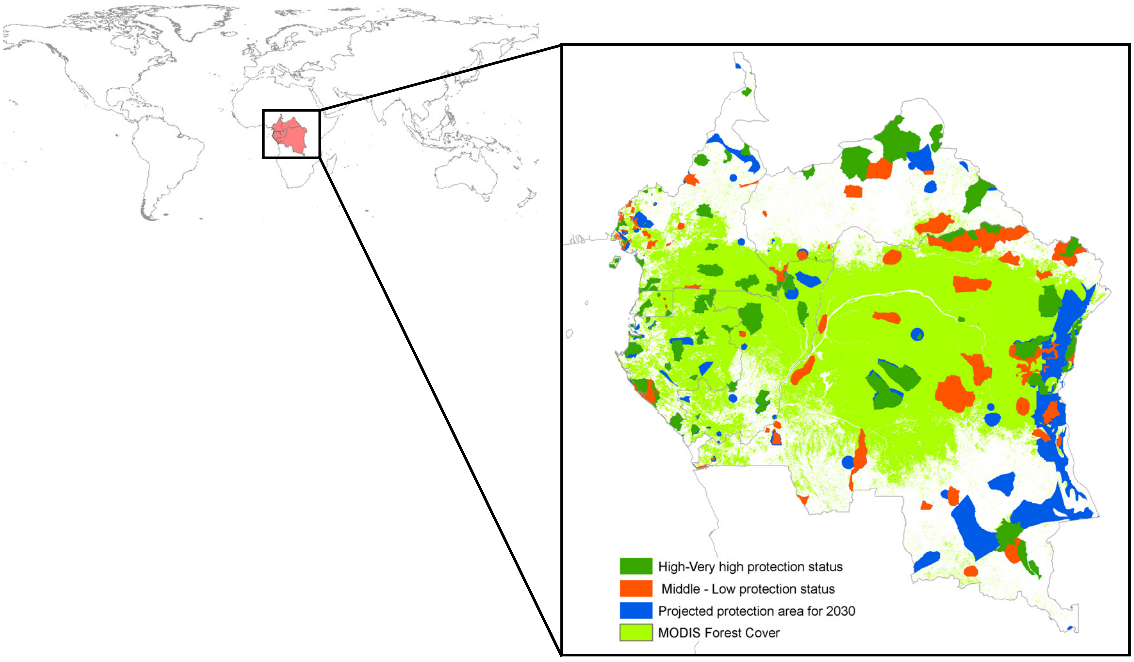


[Source: WCMC]

When projected into the future (until 2030), the policy shock in form of a 20% increase in the total amount of protected areas on a worldwide scale shows that additional protected areas are introduced in particular across east and south Africa, along the west coast of the United States of America, across Russia, in south east Europe, across Southern America (especially Brazil and Argentina), and in South East Asia and Australia.

The next figure zooms in on the Congo Basin countries: Cameroon, Central African Republic, The Democratic Republic of the Congo, Equatorial Guinea, Gabon, and Republic of Congo. This geographic-explicit analysis of the results for a specific case study region allows for a more detailed review of the projections. Once again the figure shows the currently protected areas in 2009 (both high-very high protection and medium-low protection levels) as well as the projected additional protected areas in 2030.

Figure 3.6 Congo basin countries: current protected area (2009) and additional protected area according to biodiversity scenario for 2030 with MODIS forest cover (2004)



[Source: WCMC]

Under the biodiversity policy shock scenario, the additional protected areas in 2030 will primarily have been established along the eastern and southern area of the Democratic Republic of Congo. The other Congo Basin countries also show some geographically dispersed additional protected areas.

Comparison of biodiversity scenario effects

Table 3.5 summarises avoided deforestation under the given biodiversity scenarios. In the Democratic Republic of the Congo, for example, a large forested area (about 250,000 hectares in 2030) could be maintained if additional biodiversity protection areas are implemented.

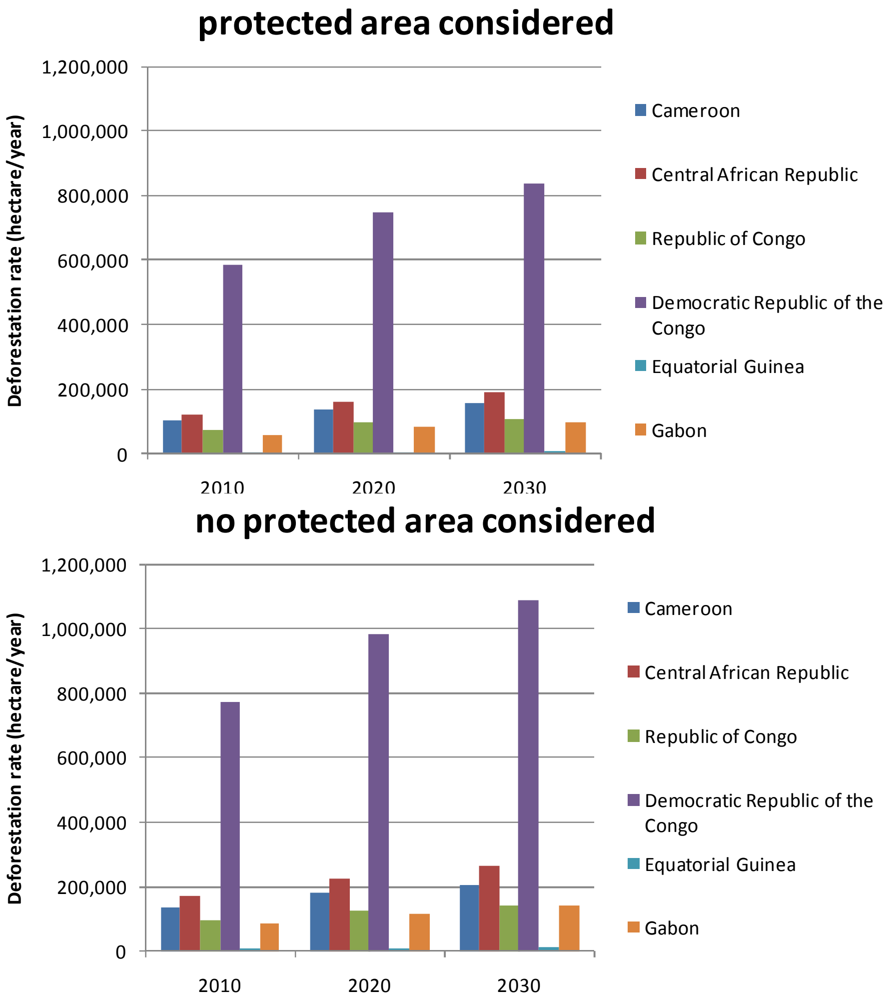
Table 3.5 Avoided deforestation (hectares / year) under increased biodiversity protection scenario (BAU1 scenario without incentive payment) in the Congo Basin

Avoided Deforestation (hectares / year)	2010	2020	2030
Cameroon	32,536	42,768	47,034
Central African Republic	47,836	63,403	74,113
Republic of Congo	22,334	29,589	33,721
Democratic Republic of the Congo	187,282	231,235	249,370
Equatorial Guinea	3,409	4,514	5,275
Gabon	27,027	36,964	44,034

[Source: IIASA]

In order to now gain a clearer picture on the difference protected areas can make in terms of avoiding deforestation, the following graphs depict deforestation rates in the Congo Basin with and without protected areas taken into account. The results show particularly significant differences in deforestation rates in the Democratic Republic of the Congo, the Central African Republic and Cameroon.

Figure 3.7 Effects of biodiversity scenarios under BAU1 scenario without incentive payments on deforestation rates in the 6 Congo Basin countries considering versus not considering projected protection areas, 2010, 2020 and 2030

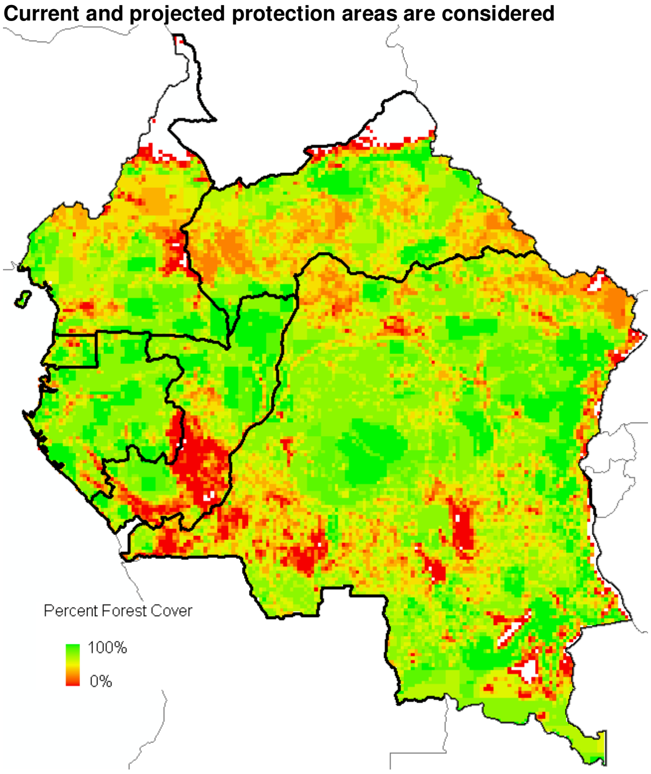


[Source: IIASA]

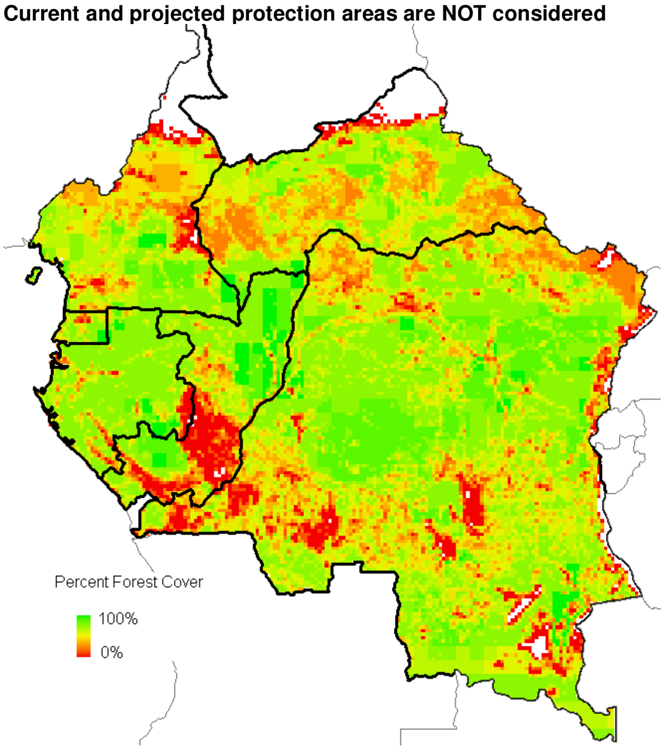
Similar to this quantified difference of deforestation rates when accounting for protected areas, the following figure maps out this avoided deforestation effect in a geographically explicit manner.

Figure 3.8 Effects of protected area on avoided deforestation (forest cover loss in percent) in the Congo Basin for 2030

Current and projected protection areas are considered



Current and projected protection areas are NOT considered



[Source: IIASA]

Conclusions on the impacts of increased protection areas on biodiversity loss

Baseline deforestation is significantly different in the biodiversity protection scenario as compared to the baseline scenario without biodiversity protection. Biodiversity protection is implemented by assuming full conservation of the respective forests according to the WCMC scenario. Deforestation of large areas can be avoided with increased protection areas as they are currently not protected in those countries where forest cover dominates, such as the Democratic Republic of the Congo. Although the positive effects of conservation on deforestation are substantial, even higher biodiversity conservation effects can be expected outside the forest domain in the Congo Basin. This is due to the fact that the majority of the additional projected protection areas (for 2030) are actually located outside the forest cover within the Congo Basin (see Figure 3.5).

The wide expansion of protection areas in 2030 within forested areas is projected to be located in the less accessible mountainous parts of the Congo Basin - the Eastern border to Uganda and Rwanda. Therefore, the positive effects of newly protected areas on future deforestation levels could be further enhanced via parallel policies. The results thus suggest that well-established conservation schemes for existing protection areas (e.g. avoiding illegal logging) and further establishment of protection areas in forest ecosystems will increase the potential for avoided deforestation in the Congo Basin.

The protection scenarios were calculated using the G4M model which assumes exogenous prices and does not account for regional or global leakage. Thus, the baseline emissions in the scenario including protection are most likely underestimated in the sense that one can argue that the difference between the baseline without protection is the true baseline and protection is already an additional REDD measure with specific geographic targeting to conserve biodiversity.

3.5.3 A case study of biodiversity implications of biofuels policies

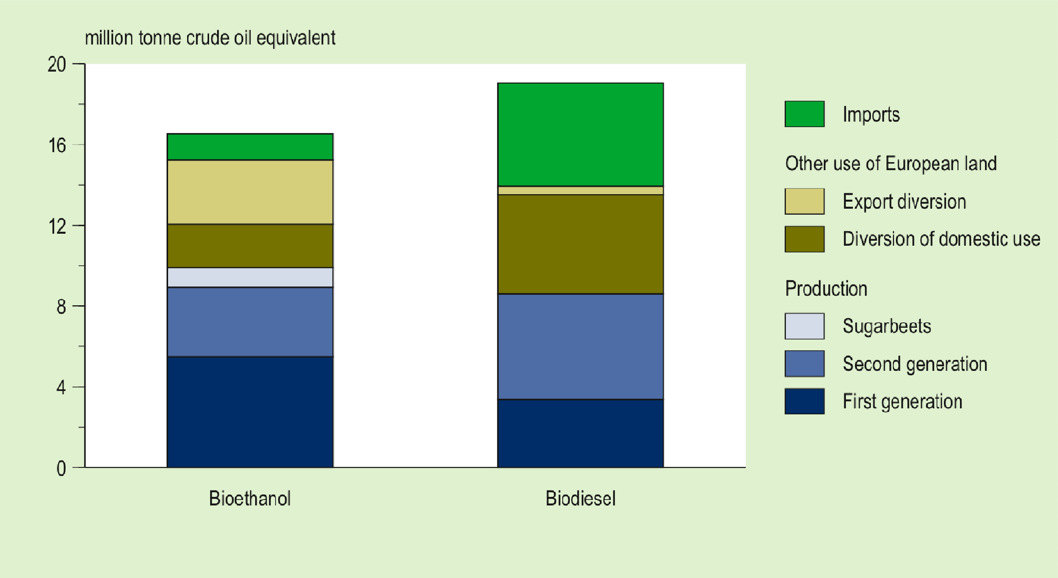
The role of public policy in pushing forward global biofuel production is a key factor in understanding the incentives that underlie biodiversity losses caused by biofuels production. Indeed, in all but a few cases today, biofuels are not economically competitive without explicit public support. Brazil, the European Union and the United States are the world's largest biofuel producers and all three have made use of a strong regulatory framework to promote biofuels. As such, global biofuel production is largely driven by public policy initiatives and documented biodiversity loss caused by biofuel production is thus causally related to public policy. Today, the global regulatory framework is catching up with the potential downsides (social, environmental and economic) of biofuel production. Indeed, sustainable development criteria (e.g the EU Renewable Energy Directive) aim at mitigating negative impacts of biofuel production. Below are some examples of public initiatives encouraging biofuel production globally.

European Biofuels Policies
The following are the main underlying policy drivers of biofuel production in Europe:

- The European Biofuels Technology Platform (EBTP) is a Community initiative that was launched in June 2006, and is the centralized policy platform through which a coherent EU biofuel policy is discussed The EBTP "aims to help in the development of cost-competitive, world class biofuel technology, contribute to the creation of a European biofuels industry and to identify the research needs to achieve this."[70]

- The 2003 Directive (2003/30/EC) on biofuels committed EU member states to include biofuels in transport at the rates of 5.75 percent by 2010 and 10 percent by 2020. Member states are given leeway for implementation of this directive since only the targets are specified in the directive. The target for 2005 of 2 percent was missed by 0.6 points and the 2010 target does not appear to be in reach for the EU as a whole.
- The energy taxation directive (2003/96/EC) allows member states to grant reductions and exemptions to biofuels in transport in order to promote their integration into the market for vehicle transport.
- Some member states are introducing mandatory biofuel blending levels. These oblige suppliers to use a percentage of biofuels (either ethanol or diesel) on the market.
- Introduced during the CAP reform of 2003, the energy crop scheme (ECS) is an aid supporting the development of energy crops. The ECS replaced the non-food-set-aside scheme (NFSA) which was a CAP transfer scheme paying farmers producing non food crops or leaving a parcel of arable land in fallow. However, the Covering a fixed area of two million hectares including the new member states (it was 1.5 million before 2007), an aid of €45 per hectare is available under the new ECS. If fully implemented, this program will cost the EU €90 million.

Figure 3.9 Sources for bioethanol and biodiesel production in Europe by 2020



Source: MNP Local and Global Consequence of the EU directive for biofuels

Global land demand for wheat, maize, oilseeds and sugar cane is set to increase by 10 percent by 2020, even in a baseline where no explicit biofuel policies are assumed and yield improvements are assumed. The Netherlands Environmental Assessment Agency (MNP) notes that "with additional biofuels policies in the United States and the EU, an

[70] http://www.biofuelstp.eu/overview.html

additional growth of 5 percent may be expected [by 2020][71]. Such a claim is based on and supported by the OECD/FAO Agricultural Outlook 2007 – 2016[72]. The Institute for Prospective Technological Studies estimates that between 12% and 15% of the EU's arable land would be needed to meet the EU Biofuel Directive[73].
As such, important land use challenges are set to emerge in the coming decade, an issue that may be substantially compounded by active biofuel policies in important regions such as the EU and the United States.

Biofuel policies in the United States
The United States has several federal agencies involved in the promotion of biofuels, which are the Department of Energy and the Department of Agriculture. The Biobased Products and Bioenergy Coordination Council (BBCC) was established by the Secretary of Agriculture in 1995 to create a platform through which USDA agencies can coordinate and promote research, development, transfer of technology, commercialization, and marketing of biobased products and bioenergy using renewable domestic agricultural and forestry materials. It is a similar concept to the European Biofuel Technology Platform.

The 2002 Farm Bill passed by the US Congress contains several provisions granting public aid to the agricultural sector for the purpose of pushing biofuel production in the United States. This includes support for biorefinery equipment, biofuel and biobased products.

The Energy Policy Act of 2005 is a large energy policy package which was passed by the US Congress in 2005. The Energy Policy Act contains several provisions relating to biofuels and biobased production. The following are the main drivers of public policy in the US contained in the Energy Policy Act that drive biofuel production:

- Section 932. The Bioenergy Program establishes linked between the Department of Energy's biomass and bioproducts and industrial and academic institutions to advance the development of biofuels, bioproducts, and biorefineries;
- Section 942. Production Incentives for Cellulosic Biofuels. This section establishes incentives to ensure that annual production of one billion gallons of cellulosic biofuels is achieved by 2015;
- Section 1501. Renewable Fuels Standard. This section requires that gasoline sold in the United States be blended with ethanol. In 2006, 4 billion gallons of ethanol were mixed with gasoline, and this requirement increased annually to 7.5 billion gallons by 2012. For 2013 and beyond, the required volume of renewable fuel will include a minimum of 250 million gallons of cellulosic ethanol.

[71] The Netherlands Environmental Assessment Agency: Local and global consequences of the EU renewable directive for biofuels. Testing the sustainability criteria
[72] OECD-FAO Agricultural Outlook 2007- 2016. Organisation for Economic Co-operation and Development (OECD), Paris, France and Food and Agriculture Organisation of the United Nations (FAO), Rome, Italy. http://www.oecd.org/dataoecd/6/10/38893266.pdf
[73] Kavalov, B. (2004). Biofuel Potentials in the EU, Institute for Prospective Technological Studies.

Biofuel policies in Brazil

Brazil is the world's largest bioethanol producer and exporter, with a production level standing at over 25 billion liters in 2008. Its national alcohol program (PROÁLCOOL) was launched in the 1970s and aimed at achieving energy independence and exploiting the large arable land surface of the country to produce sugar cane for ethanol and bio-ethanol purposes.

4 Bottlenecks and solutions

Policy assessment frameworks help to improve the quality and coherence of the policy development process, and better integrate biodiversity concerns. These do so by requiring the identification of the likely positive and negative impacts of different possible policy actions, enabling informed political judgements to be made about the proposal and identify trade-offs in achieving competing objectives. This allows for decision-makers to make their decisions on the basis of better information. Informed decision making should clearly lead to better decisions[74].

Procedural and organisational embedding is an important aspect of making effective use of any assessment framework or any instrument derived from it; the instrument should be embedded in, or adjusted to, an existing institutional setting. Roles and responsibilities must be clear, and preferably some sort of quality control system should be put in place to be able to evaluate and adjust procedures, norms and standards. International and inter-regional agreements should established or improvement by formulating of clear goals, principles, scientific founding procedures, involvement of local communities, an institutional basis, policy instruments, control and feed back mechanisms.

Principles of ‘the polluter pays’, ‘sharing responsibility’ and the ‘precautionary principle’ need to be firmly embedded in assessment frameworks. Voluntary cooperation has brought successes in some areas; it probably will be not enough for effective management in the future. The challenge is to find models of cooperation that respects security concerns and issues of national sovereignty. At the same time some political, economic and social principles are needed such as benefit sharing, procedures to solve disputes and co-management. The inclusion of indigenous organizations and their knowledge in decision-making and management is crucial.

At national and regional level, the solutions will be more or less the same: more money, better and more regulations, political will, stakeholder involvement, more and better policy instruments, better equipment, more power and implementation processes, including all relevant actors. But not all problems can be solved by government. Sometimes, science and technology can help to improve ecological standards and to stimulate innovations in agricultural, industrial or other sectors. Technical solutions can contribute to serious improvements, especially in some regions, such as the former Eastern Europe.

[74] The Economics of Ecosystems and Biodiversity (TEEB); TEEB for Policy Makers (D1)

However, the role of the market and the adagio of economic growth may be serious bottlenecks as well. Some kinds of market regulation, as in Europe may be encouraged. The principle of economic growth should be replaces by sustainable growth to be able to solve environmental issues. Although is it certainly not the principle driver, population growth and population density contribute to biodiversity problems, so stabilisation of population growth is advisable. For some vast areas in the world this would mean that a substantial raise of living standard is needed. Only then, population will stabilize. Cultural factors such as high standards of luxury and an attitude of exploring nature to the end should be considered, discussed and reconsidered.
In many cases sharing is the key term, sharing of costs and benefits, sharing money, sharing responsibilities and sharing policy-making, implementation and management.

The summary table overleaf provides an overview of the key bottlenecks in underlying causes of biodiversity loss for the various case study areas and lists potential solutions to better tackle these bottlenecks in the future. Further details about these causes and solutions can be found in the respective annex reports.

Case study	1a: Beach Ecosystems, Italy	1b: Mangrove ecosystems in Thailand	1c: Freshwater coastal wetlands, Norfolk & Suffolk Broads, UK	1c: Salt marsh ecosystems, Coastal Eastern England, UK	2a: Marine ecosystems, North Sea	2b: Marine ecosystems, Arctic ocean	2c: Marine ecosystems, Coral Triangle	3a: Forest ecosystems in the Congo Basin	3b: Forest ecosystems in the Amazon	3c: Forest ecosystems in Tanzania
Direct causes of ecosystem change	▪ Urbanisation ▪ Tourism ▪ Pollution ▪ Specific: Industrial plant ▪ Specific: Oil Spill 1997 ▪ Climate change	▪ Shrimp farming ▪ Clearance for housing ▪ Logging ▪ In the future: Sea level rise due to climate change	▪ Land use change ▪ Agricultural development ▪ Water based tourism growth ▪ Increased risk of saline intrusion and flooding ▪ Neglect of fen and woodland habitats ▪ Climate change	▪ Land reclamation for agriculture ▪ Industry ▪ Port development ▪ Construction of flood defences ▪ Urbanisation ▪ Untreated domestic sewage and wastewater discharges	▪ Fishing ▪ Shipping ▪ Extraction of minerals ▪ Gas and oil production ▪ Introduction of exotic species ▪ Tourism	▪ Shipping ▪ Pollution ▪ Fisheries ▪ Climate change	▪ Fishing ▪ Shipping ▪ Pollution ▪ Exploitation of energy ▪ Mineral extraction ▪ Tourism ▪ Climate change	▪ Small-scale permanent agriculture ▪ Large-scale permanent agriculture ▪ Fuel wood consumption ▪ Commercial logging and timber production ▪ Illegal logging ▪ Infrastructure ▪ Deforestation	▪ Large scale deforestation ▪ Cattle ranching ▪ Soy production ▪ Sugarcane / biofuel production ▪ Large-scale wood extraction ▪ Illegal logging ▪ Mining	▪ Large scale deforestation ▪ Agricultural expansion ▪ Wood extraction ▪ Illegal logging ▪ Mining

Underlying causes of ecosystem change	▪ Overpopulation ▪ Economic growth	▪ Population growth ▪ Changing global market preferences ▪ Market failure effects ▪ (The lack of) Policy interventions ▪ Weak governance	▪ Overpopulation ▪ Market failure ▪ Intervention failure	▪ Historical legacy from industrialisation	▪ Overpopulation ▪ Economic growth ▪ Lack of governance and control ▪ Problems with policy implementation ▪ Lack of specific innovations ▪ Potential dangerous innovations ▪ High consumption ▪ Luxury life style	▪ Economic growth ambitions in the future (oil and gas) ▪ No clear governance ▪ No legislation ▪ No involvement of stakeholders ▪ No national ambitions ▪ lack of implementation structure ▪ Potential dangerous innovations ▪ Lack of knowledge among stakeholders	▪ Population size, growth and inequality ▪ Economic growth ambitions ▪ Poverty ▪ No clear governance aims ▪ No integration with other policies ▪ Weak leadership ▪ Bad regulations ▪ No control ▪ Lack of money ▪ Poor involvement of local stakeholders ▪ Strong autonomy of market parties ▪ Lack of knowledge ▪ No ecological standards ▪ Low public awareness	▪ Inappropriate policies and regulations ▪ Poor law enforcement ▪ Poverty ▪ Low awareness ▪ Decision making - lack of community involvement ▪ Population growth ▪ Poor governance and corruption ▪ Declining capacity of public forestry agencies, including research, education, training and extension ▪ Land tenure uncertainties, weak legal frameworks ▪ Poor inter-sectoral linkages, with high-priority sectors such as agriculture, mining, energy having a greater impact on forests than forest policy	▪ Population growth ▪ Market failures ▪ Trade links with international biofuels and soy market ▪ Ill-defined property rights for indigenous peoples ▪ Lack of clear land policies, equitable and secure property rights; ▪ Policies focussing to a large extent on economic growth generated by industrial development; ▪ Counter-productive weak environmental policies; ▪ Weak and centralised regulatory systems.	▪ Population growth ▪ Lack of umbrella environmental legislation ▪ Inadequate quality control mechanisms, ▪ Improper execution of established planning processes and regulations (lack of capacity) ▪ Biodiversity hotspots remain unprotected ▪ Poor interaction between stakeholders. ▪ Slow change from centralized to community-based / local management approaches

Potential solutions and their likelihood (+/- = rather unlikely; + = somewhat probable solution; ++ very probable)	▪ Promotion of Local Agenda 21 (++) ▪ Environmental certification ISO 14001 (++) ▪ Education centre (+) ▪ Quality chart for tourists (++) ▪ Public awareness of pros and cons of nourishment (++) ▪ Integration between coastal and inland tourism (+)	▪ International payment for ecosystem services (+) ▪ Governmental community forest management (+) ▪ Financial measures for sustainable shrimp farming (+) ▪ Accreditation of mangrove friendly products (+)	▪ Flexible catchment-wide planning and management process (++) ▪ Higher boat toll charging regime (++) ▪ Discount for sailing, electric and solar boats (++) ▪ Inclusion of all stakeholders (+)	▪ (Better) valuation of ecosystem services (+) ▪ Enhanced planning law (+) ▪ Compensation issues (+/-) ▪ Inclusionary support (+) ▪ New, inclusive CBA (++)	▪ Stabilizing population size (-/+) ▪ Sustainable economic growth (+) ▪ Improving implementatio n (+) ▪ Enhance control (+) ▪ Cooperation market parties (+) ▪ Sustainable innovations, especially for fisheries and energy extraction (+) ▪ Tackling consumption level ideology and luxury life style (+/-)	▪ Turn to sustainable growth (-/+) ▪ Creating clear international legislative framework (+) ▪ Implementatio n structure (-/+) ▪ Cooperation market parties (+/-) ▪ Involvement of stakeholders (++) ▪ Standard setting for technologies (+/-)	▪ Stabilizing population size (-/+) ▪ Tackling inequality (-/+) ▪ Sustainable economic growth (-/+) ▪ Tackling poverty (-/+) ▪ Creating clear international legislative framework & implementatio n structure (+/-) ▪ Involve stakeholders (+) ▪ Covenants NGOs (+) ▪ Sustainable innovations (+) ▪ Standard setting for technologies (+) ▪ Sharing traditional and scientific knowledge (+) ▪ Creating common grounds for biodiversity conservation among public (+)	▪ Political stability (+/-) ▪ Improving governance levels & law enforcement (-/+) ▪ Stabilising population size (-/+) ▪ Tackling poverty & inequality (-/+) ▪ Creating sound legal framework + implementat-ion structure (incl. property rights) (-/+) ▪ Involve stakeholders (+) ▪ Sharing traditional & scientific knowledge (+) ▪ International payment for ecosystem services (REDD) (+) ▪ Community-based forest management (+) ▪ Improve inter-sectoral links (+)	▪ Clear international framework on biofuels production (+) ▪ International payment for ecosystem services (REDD) (+) ▪ Strengthened regulatory system (+/-) ▪ Mainstream various sectoral policies to support biodiversity protection (+) ▪ Improved property rights for indigenous peoples (+/-) ▪ Tackling poverty and inequality (+)	▪ Speed up the process of preparing the National Biodiversity Strategy and Action Plan and adopt it for immediate implementat-ion (+) ▪ Prepare guidelines for undertaking biodiversity assessment (+) ▪ Prepare simple and effective tools to planning and managing biodiversity at local and district levels (+) ▪ Integrate biodiversity conservation in national and local economic planning (+/-) ▪ Develop national research programme on biodiversity monitoring (+) Incorporate biodiversity considerations into EIAs on a national scale (+)

4.1.1 A closer look at possible marine ecosystem specific bottlenecks and solutions

The oceans include vast areas of marine ecosystems, which represent 64% of the total surface of seas and oceans. Furthermore, the oceans include special environments such as deep seas.[75] Some of these parts are only just beginning to be explored (discovery of hydrothermal vents, seamounts, cold-water coral reefs, gas hydrates etc.) by the scientific community.[76] Nevertheless there is clear evidence of detrimental human impacts to cold water coral reefs, sponge reefs, seamounts and pelagic habitats. Major existing and potential anthropogenic threats to the high seas in general and to these vulnerable ecosystems in particular include fishing practices, climate change, maritime traffic, pollution, offshore activities, coastal developments, and last but certainly not least influences from land-based human activities. Some studies (SBSTTA, 2007; Halpern et al., 2007; Gray, 1997; Nevill, 2008) mention introduction of species, research, bioprospecting, carbon sequestration, ozone depletion, tourism and ocean acidification as serious threats.

On the other hand, the studies on marine ecosystems pay relatively little attention to underlying causes. Only bad implementation of international legal framework, conflicting interests at national and local levels and limited public awareness concerning marine protection are mentioned. Most studies suggest that the current international framework is incapable of providing a satisfactory response to the threats weighing on the particularly rich and vulnerable resources of the high seas.

With respect to international legislation, reinforcing the application of some main conventions, in particular UNCLOS is necessary. They may provide an appropriate legal basis for improving the protection of fragile and vulnerable ecosystems in areas beyond national jurisdiction. Some principles such as ‘the polluter pays’ and the ‘precautionary principle’ should be further elaborated. In addition, we have to look at other appropriate international levels, also beyond the fields in which environmental concerns predominate, in particular within the framework of the World Trade Organization (WTO), for instance to revise several system of subsidies granted to for instance industry, agriculture and fishery. On the international level, it is advisable to regulate pollution better by introduction of mechanisms of control and punishment. In addition, systems of marine stewardship or covenants for fishery, offshore activities and other activities could be developed in cooperation between environmental NGOs, consumer organizations, market parties and governmental institutions.

On the supranational - regional level, existing approaches and frameworks such as the Arctic Council or the North Sea Ministers conferences should be consolidated and further developed. For instance, regional fisheries management institutions potentially have the capacities needed to overcome the shortcomings of international governance, by

[75] SBSTTA, 2007, Synthesis and review of the best available scientific studies on priority areas for biodiversity conservation in marine areas beyond the limits of national jurisdiction, UNEP.

[76] Rochette, J. & R. Billé, 2008, Governance of marine biodiversity beyond national jurisdictions: Issues and perspectives: Report of the international seminar “Towards a new governance of high seas biodiversity” (Principality of Monaco, March 20–21, 2008), Ocean & Coastal Management, 51 (12), 779-781.

developing more specific sustainable management policies, by controlling destructive fishing practices , by combating unregulated fishing, and by introducing systems of sustainability certification and eco-labelling. The further development of supranational institutions could be helpful to develop a common responsibility for certain areas, too. Within these areas innovative networks can be developed to come to integrated and adaptive co-management of oceans and seas. For fragile ecosystems additional measurements are needed such as Marine Protected Areas, no-take areas or recovery areas.

Because implementation of regulation on the national and regional levels turned out to be a crucial success factor, much attention should be paid to factors related to implementation. Involvement of all relevant parties is one factor, improvement of policy another. This means: clear aims, political will, horizontal and vertical integration, sufficient tools for governmental institutions and service, biological and policy monitoring. To be able to establish appropriate monitoring systems, ecological quality standards should be developed, in close cooperation with scientists and representatives of local people to ensure the inclusion of traditional ecological knowledge.

For specific direct causes of biodiversity loss, specific measures are needed. With respect to fishery, it is unavoidable to enforce the existing systems of fish quota, control, no-take areas, eco-labelling and maritime zoning. For pollution enforcement of international agreements and regional implementation strategies will be needed. For several direct causes, technological innovations can be helpful, for instance to improve fishery and mining techniques and to make coastal development more sustainable. Also to prevent the introduction of alien organisms, techniques can be developed to assess and clean ballast water. Problem-oriented innovative networks should be created including scientists and people from the different sectors. Because climate change is seen as a major threat for marine biodiversity, biodiversity and environmental policy for marine and terrestrial areas have to be integrated.

In most cases, political and scientific or technological solutions will not be enough. To tackle marine biodiversity loss seriously, problems of poverty, high consumption levels, unemployment, market economy and culture have to be taken into account. For instance population density is a serious problem but is even a more serious problem if it is goes hand in hand with high consumption levels. Without solving these problems, political solution concerning biodiversity will fail. This is also the case with problems of poverty and unemployment. Alternative employment should be created somehow to tackle the problem of over-fishery in many regions. Probably the main challenge is to make free market ideology consistent with biodiversity governance. Without involvement of market parties, and without some reform of classical entrepreneurship, deterioration of the marine environment will not come to an end.

There is no clear solution, there all only search directions. One search direction concerns the sharing of problem definitions, benefits, knowledge, awareness and management will probably contribute to mutual commitment. Sharing of problem definitions implies that parties look for common grounds, such as a combination of biodiversity and food security and different aspects of sustainability. Sharing of benefits means that indigenous or local people are allowed to use natural resources if they accept principles of sustainable use. It also means that large fishery companies are allowed to fish the oceans, if they accept the principle of optimal yield and they pay local fishermen. Sharing of knowledge means that it is tried to bring traditional knowledge and experiences and modern scientific insights together. Sharing of awareness implies that parties accept different opinions on nature, and natural resources and are willing to discuss these differences. Sharing of management stands for common responsibility of governments, environmental NGOs and users for management. A second search direction is learning. Only through adaptive co-management successes are possible.

4.1.2 A closer look at the role of governance as a potential bottleneck

Using the example of forest biodiversity, it is possible to explore the role of governance as a potential bottleneck for successful biodiversity conservation. Does good or improved governance always equate sound biodiversity conservation? Do other institutional factors need to improve as well to really make a difference for better biodiversity conservation?

European biodiversity levels and policy efforts

The share of forest and other wooded land of the total land area in EU-27 countries ranges from around 77% in Finland and 75% in Sweden to 1% in Malta.[77] The latest FAO figures indicate an average annual increase in European forested area of 877,000 hectares, or 0.9%, between 1990 and 2000 and a slightly slower expansion of total forested area between 2000 and 2005 of 661,000 hectares/year, or 0.7%. This forest area increase occurs in practically all EU-27 Member States, according to the most recent *State of Europe's Forests Report* (MCPFE 2007[78]). Changes in forest area are mainly caused by afforestation of former agricultural lands aiming to increase long-term timber supply, to increase the level of non-wood goods and services, and to provide alternatives for agricultural use of land. In general, afforestation activities have slowed down somewhat since 1980.

No comprehensive assessment currently exists on the status change of forest biodiversity in the EU-27. According to the most recent and authoritative MCPFE 2007 report, forest management practices have changed in ways that promote the conservation and enhancement of biological diversity, notably through the increased use of natural regeneration and more mixed species stands. Measures are also being taken to encourage deadwood accumulation. The same assessment reports that the area of mixed forests in Europe has increased annually during the last 15-year period by over 1%. Nearly 50% of the forests in Europe are regenerated by natural means (natural regeneration, natural regeneration enhanced by planting, and coppicing). The share of natural regeneration is increasing while the share of planting and seeding is decreasing. Over 85% of forests in Europe are semi-natural. Plantations cover about 8% of the forest area, located mainly in North West Europe.

[77] FAO, Forest Resources Assessment 2005 and Eurostat News release STAT/08/146.

[78] MCPFE 2007: Köhl M. and Rametsteiner E. eds. (2007) The State of Europe's Forests 2007. Ministerial Conference for the Protection of Forests in Europe, Liaison Unit Warsaw, Poland

According to the European Environmental Agency (EEA[79]), which is mainly based on the same data as the MCPFE 2007 report, more forests are now allowed to grow into older development stages, which have positive effects on forest biological diversity. Afforestation programmes as well as decreasing grazing pressure lead to large-scale conversion of former agricultural land. Nevertheless, afforestation may also threaten existing biodiversity values in some localities, such as peatland when it is combined with draining.

According to the same report, so far, Europe's efforts in halting biodiversity loss in forests has had mixed results. According to IUCN, 11 mammal species depending on forest in some stage of their life cycle should be considered as threatened. In the case of forest birds, common populations show a decline in north and south Europe, while they are largely stable in the West and East.

The EEA assessment 2008 suggests that the 2010 target of halting the loss of biodiversity will not be met for all aspects of European forest biodiversity. This is a consequence of a range of factors, whereby the status of a limited number of threatened species, invasive species and nitrogen deposits are the three main areas of concern, according to EEA.

In sum, although existing data does not allow a comprehensive judgment, the trends measured in a number of main indicators for the development of forest biodiversity are actually indicating improvements in the conditions for forest biodiversity, contrary to public perception. However, especially with regard to some threatened species, such as forest birds, the trend seems actually to be a slowdown in their decline, rather than a stabilisation or a reversal towards greater numbers.

This relative success across Europe, when compared to other regions of the world, can likely be attributed to the sound governance and institutional structures as well as the high level of socio-economic development across European countries. As mentioned in the introduction to this study, a sufficiently high level of development tends to imply improved means for protecting biodiversity. In particular, common efforts on a European level over recent years may have lead to the relatively positive trends in forest biodiversity developments over recent years; these include:

- The Birds and Habitats Directives provide a solid legislative basis for protecting important species and habitats, especially through Natura 2000. This EU-wide network of protected areas covers 17% of EU land and is being extended to our seas.
- Furthermore, successive reforms of the Common Agricultural and Common Fisheries Policies have increasingly provided opportunities to preserve biodiversity.
- In the LIFE+ Financial Programme at least 50% of funds are for EU biodiversity conservation projects. The EU Biodiversity Action Plan provides a strategic framework.
- The Water Framework Directive (WFD) requires lakes, streams, rivers, estuaries, and coastal waters to be in a good ecological state by 2015.

[79] EEA (2008): European forests — ecosystem conditions and sustainable use; EEA Report No 3/2008; European Environmental Agency, Copenhagen, Denmark

- In 2008 about 115 000 sq. km were added to the Natura 2000 network, including sites in Bulgaria and Romania.
- Additionally, the Commission put forward options to deal with harmful invasive species – a growing problem facing European forests-, including a Europe-wide early warning system to report new and spreading species.[80]

Europe furthermore also pays close attention to the international situation of biodiversity, playing a leading role in negotiations for international policy measures for better conserving global biodiversity. In 2008 the Commission presented two initiatives to protect global forests: a Regulation[81] obliging timber and timber product traders to seek guarantees that the timber was cut legally in the country of origin; and a Communication[82] proposing to halve gross tropical deforestation by 2020 and halt global forest loss by 2030. Furthermore, bilateral action, such as the EU's move in 2008 to reach and agreement with Ghana under the framework of the EU Forest Law Enforcement Governance and Trade (FLEGT) initiative[83], which aims at stopping illegal logging, demonstrates how international bilateral or also multi-lateral actions could strengthen the current policy framework for biodiversity.

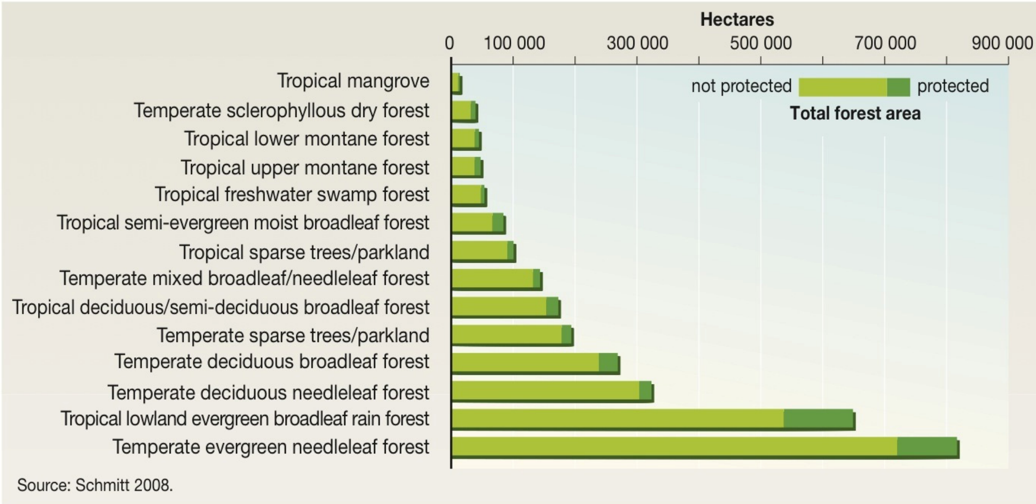
Governance and biodiversity in the Congo Basin

Annex 3, case study 3a provides a case study on the role of governance in avoiding deforestation in the Congo Basin, highlighting the importance of improving not only governance levels but also other institutional factors for any effective biodiversity conservation. Results are taken from the ongoing ECORYS/IIASA study using GLOBIOM and G4M modelling scenarios. These modelling results seem to show that given the overall large size of deforestation happening under the business as usual scenario, even improving governance cannot make a big difference in terms of decreasing the rate of deforestation in the Congo Basin. Nevertheless, better governance in combination with other policy successes, for example an increase in protected areas, could make a larger difference since better governance is assumed to allow for better implementation and reinforcement of more direct policy measures for protection.

As can be seen in the following figure, there is potential on a worldwide scale for much greater protection of all types of forests.

[80] COM(2008) 789
[81] COM(2008) 644
[82] COM(2008) 645
[83] This agreement will only allow EU sales of Ghanaian timber products with a licence attesting their legality. Talks continue with other African and Asian tropical timber exporting states.

Figure 4.1 Worldwide percentage of protected versus non-protected forest area by forest type

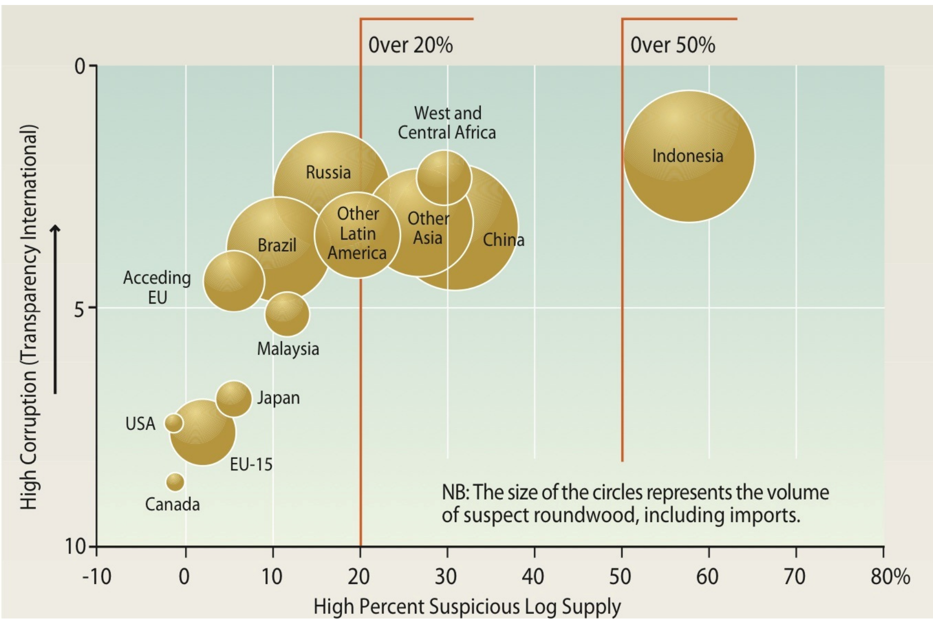


Source: UNEP-GRID

However, any type of protection status needs to be backed up by a functioning governance and institutional system that has the power to enforce the protection status. Without such governance and institutional backing, protective areas will likely not lead to the intended result of protecting forest biodiversity.

The following figure indicates that good governance (represented here by lower levels of corruption) is clearly connected with levels of illegal logging worldwide. Countries with high corruption levels, such as Indonesia or West and Central Africa also recorded a higher percentage of observed illegal logging activities. Countries with relatively low corruption levels, such as Canada, the USA and the EU-15, on the other hand, also report much lower levels of illegal logging activities.

Figure 4.2 Illegal logging and corruption linkage worldwide



Source: UNEP-GRID

As the Congo Basin case study suggests, however, better governance can certainly contribute to reducing illegal logging, for example, but will in most cases not be sufficient for significantly decreasing deforestation.

Transition to local and community-based biodiversity management in Tanzania
Annex 3, case study 3c demonstrates how a favourable legal and policy environment are most of the time necessary ingredients for successful policy assessment and change towards improved biodiversity governance. In the case of Tanzanian forestry policy, the surrounding political environment was favourable and ripe for a major reform away from failing centralised management policies towards participatory forestry management handing over the responsibility for forest management to the district and community levels.

4.2 Conclusions and recommendations

The direct threats to biodiversity are numerous and well known, encompassing inter alia land-use change and habitat fragmentation and destruction, pollution, climate change and invasive alien species. As is highlighted by the case studies, there is however an underlying complex interplay of factors (causes) that lead to certain choices being made at all political, social, and economic levels that are certainly less-than-optimal from a biological conservation and sustainable-use point of view.

This is not surprising if one assumes, as the TEEB review does, that decisions made regarding local, regional and wider development amount to a choice between the uncertainty of the long-term uncertain non-market value of biodiversity and ecosystem services and the relative certainty of a short-term marketed alternative land use or revenue stream from exploiting a natural resource. It is almost always the case that the alternative land use or revenue stream will be chosen, and hence biodiversity may be put at risk.

Development of an international market for ecosystem services in which the benefits of ecosystems are captured, valued and paid for to mitigate the negative effects on biodiversity from development projects is one method of capturing and allocating the benefits of biodiversity conservation. This requires close cooperation between ecologists and economists in order to obtain acceptable valuations of these services, and moreover requires strong institutions to implement regulatory control. To develop an international payment system of ecosystem services will require payment for example through the World Bank or through regional development banks to those parties affected, and will require suitable methods for host countries to apply for compensation, control and enforcement. Adequate enforcement of current biodiversity policy is also highly recommended, and will make it possible to implement conservation strategies and agenda's more effectively. Protection of conservation areas (with financial or land compensation for the local/ regional/ national human populations) requires adequate enforcement (somewhat like blue helmet UN interventions against poaching).

Addressing the underlying causes of biodiversity loss can be done using currently available knowledge and by following a process similar to the framework that has developed out of the need to address climate change, i.e. learning from a world-wide “neutral” IPCC-like initiative. The process of raising awareness of the economic, social and environmental value of biodiversity is underway in Europe with the TEEB process being an important example. Making sure the value of nature, ecosystems and biodiversity is profiled as highly as climate change has been in recent years will create a global platform from which further development of solutions can be pursued.

Long-term education of the importance of biodiversity is another option that should be pursued by the international community. Teaching the next generation (including school children and students) about the complexities of the world economy, ecosystem services, ecological footprints and inequality etc. is required to make sure the actions required to stop the halt in biodiversity are met now and in the future. Educational material is plentiful, expertise is available and current staff at schools and universities can easily be trained. However, this approach also requires adequate financing of education in developing countries.

In terms of global market failures, the evidence presented points to certain economic solutions for the problem of international biodiversity loss. By using trade interventions or by creating new international markets and institutions for the global environmental benefits generated by the biodiversity conserved by host countries, the international community should come to an agreement on the setting up of markets that help pay for ecosystem services and help mitigate against biodiversity loss. However, this approach requires a huge investment in international cooperation, while the establishment of markets for biodiversity is a long road indeed, with a number of hurdles to be overcome to be able to make it work.

There are positive developments as well that are happening as current initiatives in the market place such as green banking and green investment seem to be sensitive to the “image” of environmental awareness etc. As with the climate policy framework, awareness is only one step. Enlightenment and recognition of the social and economic value of conservation and sustainable use of resources are the next necessary steps. This must be done by engaging consumers directly and influencing citizen and consumption behaviour in order for the positive effect to be felt in the market place and hence to make a difference on the ground where biodiversity is lost. To influence consumers, there is a world of advertising psychology available which is more frequently being used in retail products, but could be exploited much more by societal actors.

Hence, the notion of addressing the underlying causes of biodiversity loss is to operate at all levels of society, and at global, national and local levels. Policy makers, administrators, businesses and consumers have to employ the best available means to disseminate knowledge and create awareness of the biodiversity issue. It seems there are no clear cut solutions to the on-going decline of the diversity of life on the planet, only directions to develop solutions.

5 Annex 1: Case studies on coastal ecosystems and biodiversity loss

5.1 Introduction

Depending on the precise definition used, coastal zones occupy around 20% of the earth's surface but host more than 45% of the global population and 75% of the world's largest urban agglomerations. The functioning of coastal and related marine areas is maintained through a diversity of ecosystems – coral reefs, mangroves, salt marshes and other wetlands, sea grasses and sea weeds beds, beaches and sand dunes, estuaries and lagoons, forests and grasslands. This natural capital stock provides a range of services, such as nutrient and sediment storage, water flow regulation and quality control and storm and erosion buffering (see Figure 5.1).[84]

[84] Crossland, C. J., et al (eds), (2005). Coastal Fluxes in the Anthropocene, IGBP series, Springer, Berlin.

Figure 5.1 Classification of coastal and marine ecosystem services

ECOSYSTEM CLASSES	INTERMEDIATE SERVICES	FINAL SERVICES	BENEFITS
Specific characteristics of coastal-marine ecosystem as determined by location factors	A service that comes from other factors than the ecosystem itself (ecosystem processes)	The result of the ecosystem process (ecosystem functions)	The benefits of the ecosystem for humans
Open sea	- Primary production - Climate mitigation	- Regulation of water flow and quality - Habitat for many aquatic species	- Carbon control - Biodiversity maintenance - Amenity / recreation - Waterways/ transport
Coastal areas / estuaries and salt marshes	- Geodynamics: sediment and nutrient cycling and transport - Primary production - Water cycling - Climate mitigation	- Creation of beaches, dunes etc. for recreation - Sediments, nutrients, contaminants retention/storage - Biomass export - Regulation of water flow and quality - Carbon sequestration - Maintenance of fish nurseries and refuges - Habitat for migratory and other species - Biodiversity	- Flood/storm buffering - Shoreline stabilisation / erosion control - Carbon storage - Fish production - Ecosystem stability/resilience - Amenity and recreation provision - Cultural / heritage conservation

Coastal zone ecosystems are impacted by dynamic environmental change that occurs both ways across the land-ocean boundary. The natural and anthropogenic drivers of change (including climate change) cause impacts ranging from erosion, siltation, eutrophication and over-fishing to expansion of the built environment and inundation due to sea level rise. All coastal zone natural capital assets have suffered significant loss over the last three decades (e.g. 50% of marshes lost or degraded, 35% of mangroves and 30% of reefs).[85] The consequences for services and economic benefits value of this loss at the margin is considerable, but has yet to be properly recognised and more precisely quantified and evaluated.[86]

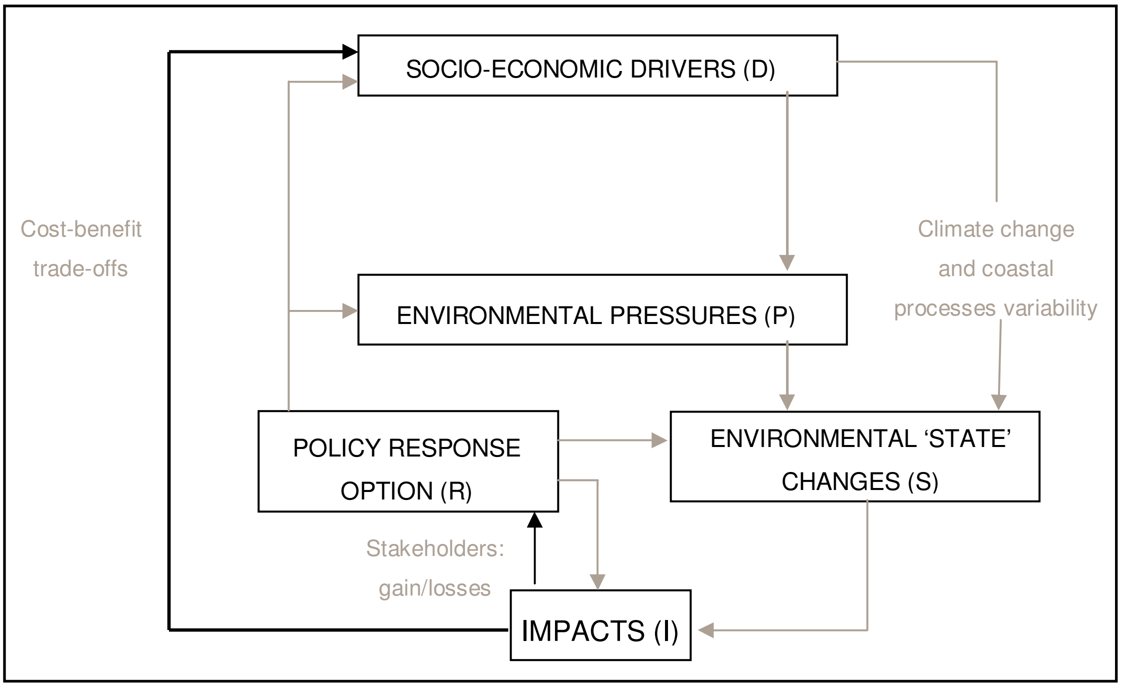
[85] Millennium Ecosystem Assessment, (2005). Chapter 19 – Coastal Systems. World Resources Institute, Washington, DC, Island Press.

[86] Daily, 1997; Turner et al., 2003; Maler et al 2008; Barbier et al. 2008.

5.1.1 The DPSIR framework applied to coastal ecosystems

The so-called DPSIR framework (see Figure 5.2) is a useful device for clarifying the role that socio-economic drivers play in inducing pressures on the environment (over varying timescales and across a range of spatial scales). These pressures result in state changes (often ecosystems degradation or loss) and consequent impacts of the welfare of people and communities locally, regionally and sometime globally. Efforts to modify the impacts (policy responses) these produce feedback effects within the drivers/pressures systems.[87]

Figure 5.2 DPSIR for coastal ecosystems



Source: adapted from Turner et al (1998).

Coastal zone management is hindered by, among other factors, the scale mismatch problem which has intensified as the process of globalisation has itself accelerated. Coastal zone issues are often conditioned by an historical legacy e.g. the build up of contaminants in estuarine and coastal sediments from past industrial/urban development; or chronic eutrophication from intensive agriculture and/or inadequate sewage treatment facilities etc. This (negative) legacy impact on ecosystem services provision can be difficult and costly to ameliorate e.g. improving social productivity, cleaning aquifers or modifying coastal defence structures.

The socio-economic drivers of environmental change in coastal zones are increasingly regional and global in scale and the local population may have little leverage over them. The vulnerability of coastal ecosystems is increasing because of a combination of exposure to natural (often weather and climate change related) events, storms etc. and the

[87] Turner, R. K., I. Lorenzoni, N. Beaumont, I. J. Bateman, I. H. Langford, and A. L. McDonald, (1998) Coastal Management for Sustainable Development: Analysing Environmental and Socio-Economic Changes on the UK Coast. The Geographical Journal 164:269-281.

workings of the global economy and its deregulated components (industrial production/location, trade, advertising etc.). A further element in the increased vulnerability equation is the growth in world population and the fact that the more hospitable coastal zones are already densely populated with little future margin for out-migration.

5.2 Case study 1a: Beach ecosystems in Italy

Sand, or mixed sand and rock, beach ecosystems constitute some 75% of the world's ice-free coastlines.[88] Beaches are dynamic, harsh environments, which the action of wave and tides largely determine species diversity, biomass and community structure.[89] When the smaller forms of invertebrate species are included in diversity surveys, in a single beach several hundred species of invertebrates can be found.[90] Unique ecological services, not covered by any other ecosystem, such as filtration of large volumes of seawater, are provided by beaches.[91] Beaches also recycle nutrients, support coastal fisheries, and provide critical habitats (nesting and foraging sites) for endangered species such as turtles and birds.[92] Nevertheless, the intrinsic value of processes and functions of beach ecosystems are often perceived as secondary to the economic value associated to beach tourism.

The natural dynamic resilience (changing shape and extension) of unconstrained beaches in response to storms and variations in wave climate and currents is opposite to the 'coastal squeeze' currently faced by most beaches globally, which are trapped between urbanisation on the terrestrial side and manifestation of climate change at sea.[93] The traditional management response to the global trend of beach erosion driven by sea level rise and increased storminess was the use of 'hard' armouring (groynes, breakwater, pier, jetties). Over the last two decades, coastal authorities implemented 'soft' engineering solutions, such as nourishment, as opposite to coastal engineering constructions.[94] At the local scale, engineering activities on beaches can have serious ecological consequences including loss of biodiversity and destruction of critical habitats for endangered species, as well as modifications of the subtidal zone which is important for many sandy beach animals.[95] Although more sustainable, also nourishment should be implement with care to avoid negative indirect effects such as water turbidity and damage to benthonic biocoenoses.[96]

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[88] Brown, A. C. (2001) Biology of sandy beaches. In:Encyclopedia of Ocean Sciences, Volume 5, ed. J.H. Steele, S. A. Thorpe &K.K. > Turekian, pp. 2496-2504. London, UK: Academic Press.

[89] Brown, A.C. and McLachlan, A. 'Sandy shore ecosystems and the threats facing them: some predictions for the year 2025' Environmental Conservation (2002), 29:1:62-77 Cambridge University Press.

[90] Armonies, W. & Reise, K. (2000) Faunal diversity across a sandy shore. Marine Ecology Progress Series 196, 49–57.

[91] McLachlan, A. & Brown, A.C. (2006) The ecology of sandy shores. Academic Press, Burlington, Massachusetts.

[92] Schlacher, T. A., Dugan, J., Schoeman, D. S., Lastra, M., Jones, A., Scapini, F., McLachlan A., Defeo, O. Sandy beaches at the brink. Diversity and Distributions, (Diversity Distrib.) (2007) 13, 556–560 DOI: 10.1111/j.1472-4642.2007.00363.x

[93] Nordstrom, K.F. (2000) Beaches and dunes on developed coasts. Cambridge University Press, Cambridge, UK.

[94] Schlacher, T. A., Dugan, J., Schoeman, D. S., Lastra, M., Jones, A., Scapini, F., McLachlan A., Defeo, O. Sandy beaches at the brink. Diversity and Distributions, (Diversity Distrib.) (2007) 13, 556–560 DOI: 10.1111/j.1472-4642.2007.00363.x

[95] Ibid.

[96] Marin, V., F. Palmisani, R. Ivaldi, R. Dursi, and M. Fabiano. 2009. Users' perception analysis for sustainable beach management in Italy. Ocean & Coastal Management 52:268-277.

Pressures causing beach erosion are primarily due to direct or indirect anthropogenic factors (see Figure 5.3) - structures (urbanisation) or activities (tourism and ecotourism) that impede natural sand transport, pollution, mining, overfishing, off-road vehicles use, trampling, bait collection, beach cleaning etc.; increased ultraviolet (UV) radiation and changes related to global warming - as well as natural causes. However, although serious because of the rising pressure on the shore, coastal erosion due to population growth in coastal areas and tourism may be largely offset in developed and developing countries by better beach management. On the contrary, the expected sea level rise and the increase in the frequency and or intensity of storms are likely to escalating erosion and consequent loss of habitat.[97]

Figure 5.3 Key anthropogenic pressures on sandy beaches

Key pressure	Reference(s)
Climate change and sea level rise	Feagin *et al.* (2005); Cowell *et al.* (2006); Harley *et al.* (2006)
Coastal infrastructure and development	Nordstrom (2000); Scapini (2002)
Shoreline armouring and erosion	Beentjes *et al.* (2006); Dugan & Hubbard (2006)
Beach nourishment	Peterson *et al.* (2000, 2006); Speybroeck *et al.* (2006)
Resource exploitation	
Fisheries	Defeo & de Alava (1995); McLachlan *et al.* (1996); Schoeman *et al.* (2000)
Mining/sand extraction	McLachlan (1996); Simmons (2005)
Pollution	
Chemical (oil spills)	de la Huz *et al.* (2005); Junoy *et al.* (2005)
Litter	Derraik (2002)
Freshwater discharge (quality and quantity)	Lercari & Defeo (1999); Lercari *et al.* (2002)
Grooming and cleaning	Llewellyn & Shackley (1996); Dugan *et al.* (2003)
Recreation and tourism	de Ruyck *et al.* (1997); Davenport & Davenport (2006)
Human trampling	Rickard *et al.* (1994); Fanini *et al.* (2005); Gheskiere *et al.* (2005)
Off-road vehicles (ORVs)	Godfrey & Godfrey (1980); Williams *et al.* (2004); Schlacher & Thompson (in press)
Beach and dune camping	Hockings & Twyford (1997)
Wildlife disturbance	Burger (1991); Parris *et al.* (2002); Thomas *et al.* (2003)
Light pollution	Salmon (2003); Bird *et al.* (2004)

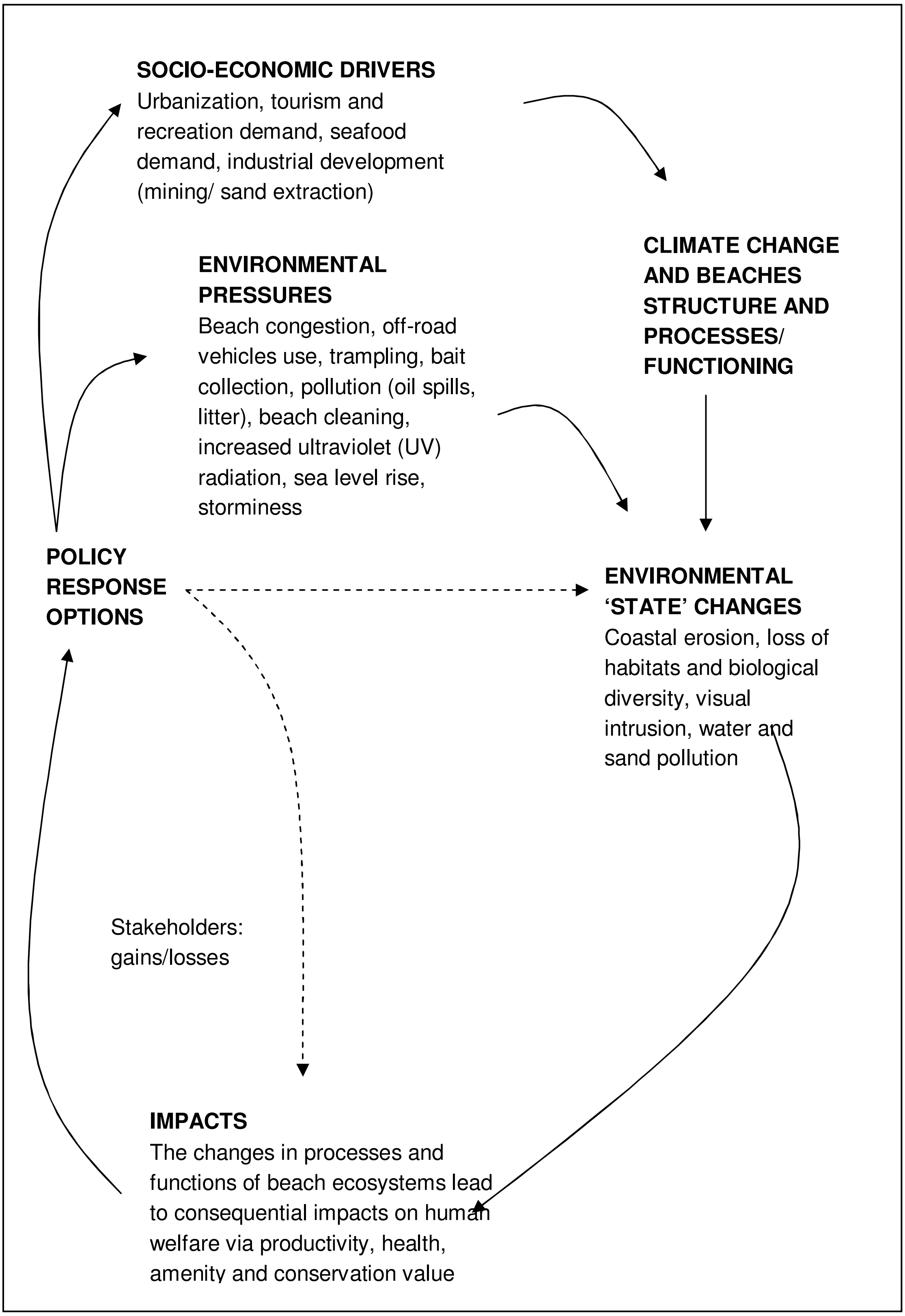
Source: Schlacher et al., 2007.

Main anthropogenic and natural drivers and pressures, and their consequences for the beach ecosystems are shown in Figure 5.4 in which the DPSIR (socio-economic Drivers - environmental Pressures - environmental State changes – Impacts – policy Response options) framework[98] is applied.

[97] Brown, A.C. and McLachlan, A. 'Sandy shore ecosystems and the threats facing them: some predictions for the year 2025' Environmental Conservation (2002), 29:1:62-77 Cambridge University Press.

[98] Turner, R. K., I. Lorenzoni, N. Beaumont, I. J. Bateman, I. H. Langford, and A. L. McDonald, (1998) Coastal Management for Sustainable Development: Analysing Environmental and Socio-Economic Changes on the UK Coast. The Geographical Journal 164:269-281.

Figure 5.4 Driver-Pressure-State-Impact-Response (DPSIR) framework applied to beach ecosystems



Source: Adapted from: Turner et al., 2003.

5.2.1 Management of beaches in Riviera del Beigua (Liguria)

It is only over the last century, especially in the past 50 years, that sunbathing and bathing activities become popular among the citizens of industrialised countries. On the one hand coastal tourism has globally become an important source of income for local economies, but on the other hand it also became one of the main pressures on the coastal environment.

In Italy, the Ligurian coast is a narrow strip of land close between the sea and the mountains subject to a heavy anthropogenic pressure mainly in the form of urbanisation and tourism activities. The case study presented focuses on the Riviera del Beigua, an area located between the cities of Genova and Savona (NW Italy), which takes its name from the close high mountains hosting the biggest regional protected area (Beigua Regional Natural Park, 815 ha). The Riviera includes six municipalities (Arenzano, Cogoleto, Varazze, Celle Ligure, Albisola Superiore and Albissola Marina). The coastline of the Riviera del Beigua is characterised by heterogeneous morphological features: cliffs are alternated with sandy and sandy-gravel beaches and gravely-cobble pocket beaches. The beaches are characterised by a limited width (50–80 m) and variable length and are often bounded by natural promontories or artificial defence works built to face erosion (Marin et al., 2009).

As many other ecosystems around the globe, the coastal and marine ecosystems of the Riviera have experienced in the last decades a process of degradation due to the high local anthropogenic pressure (coastal settlements, nourishments, industries, illegal trawling fishery etc.). For example, the Posidonia oceanica beds, which represent one of the higher ecological values among Mediterranean marine habitats, are now quite ruined and constitute the remains of a wider bed once present in the area. This is relevant for this marine area which belongs to the so-called Cetaceans' Sanctuary of the Mediterranean Sea - an area of approximately 100,000 km^2 situated within the territorial seas of France, Italy and the Principality of Monaco, where the number of cetaceans is at least twice as high as anywhere else in the Mediterranean.[99]

Direct causes of ecosystem change

Closed between the sea and the mountains, the Riviera del Beigua and the adjacent areas are characterised by land scarcity, which results in a high concentration of population and human activities along the coastline. As a result, coastal areas are almost entirely taken by urban settlements and related infrastructures (roads, highway, railways), which are built one after the other between the two major cities of Genova and Savona - both hosting important commercial harbours and industrial activities.

The main direct causes of ecosystem change seem therefore due mainly to anthropogenic factors: urbanisation, tourism (beach congestion), and related pollution – litter on beaches, sewage outfalls, landfills etc. On top of that, two specific considerable pollution sources have affected the Riviera over the last decades: the extensive and chronic

[99] Marin, V., F. Palmisani, R. Ivaldi, R. Dursi, and M. Fabiano. 2009. Users' perception analysis for sustainable beach management in Italy. Ocean & Coastal Management 52:268-277.

pollution of heavy metals (mainly Cr) provoked by a chemical industrial plant situated in Cogoleto, which effects are still visible, and the accidental worst oil spills ever occurred in the Mediterranean caused by the sinking of the tanker Haven in 1991, which released 144,000 tons of oil. That episode had immediate considerable environmental and economic impacts (on tourism), but also generated environmental long term impacts - after more than 10 years, a considerable amount of oil is still contained in the relict and, even if there are no more negative effects for the organisms in the water column, some benthonic species still show physiological alterations.[100]

Furthermore this narrow line of coast, as the whole Mediterranean area, is facing sea level rise and the increase in storminess driven by global climate change.

Underlying causes of ecosystem change

Ligurian coasts, as many other Italian coasts, are under the pressure of population and economic growth, which are the prominent indirect global causes of ecosystem change.

Actors and policy framework

Although beach users are represented both by residents and tourists, tourism in the Riviera is essentially characterised by a family-oriented domestic demand from locals owning a holiday home, and from other Italians given the proximity of holiday locations from the place of residence (the main surrounding cities in Liguria and the neighbouring regions).[101] This practice results in crowded beaches especially over the peak season (July and August).

Primary actors:

- Beach users (residents and tourists)
- Local authorities (Municipalities, Provinces and Region)

Secondary actors:

- Service industry (bathing activities)
- Industries
- Commercial shipping

Analysis and solutions

As reported by Marin et al. (2009), there are several solutions to coastal degradation that the local authorities in Liguria are implementing.

Important results have already been obtained in the Riviera: the promotion of Local Agenda 21, the environmental certification ISO 14001 for all the six municipalities, the creation of a sustainable development education centre and the adoption of a quality chart for bathing tourism activities. But a fundamental step towards a sustainable costal management is the agreement signed in 2002 by the six municipalities with the Ligurian region and the two provinces of Genova and Savona to invest a share of the refund

[100] Marin, V., F. Palmisani, R. Ivaldi, R. Dursi, and M. Fabiano. 2009. Users' perception analysis for sustainable beach management in Italy. Ocean & Coastal Management 52:268-277.

[101] Ibid.

obtained for the damages from the oil spill to promote the necessary measures to obtain the EMAS certification.

Nourishment has been used in the Riviera as an alternative solution to coastal engineering constructions. However, users' preferences too play an important role in the practice of nourishment in the area. Marin et al. (2009) results show users desire for a more soft and comfortable beach, as opposite to the natural features of the Ligurian beaches, mainly characterised by pebbles and mixed sediments, reporting that managers are often tempted to use fine sand instead of sediment with grain size adequate to local characteristics for the nourishment of the Ligurian beaches. Specific education campaign is needed in order to pursue public awareness about the pros and cons of the nourishment practice.

In their study Marin et al. investigated also the problem of beach crowding. Although mitigation policies are deemed necessary and recent studies confirm the need to define limits depending on local features, there are no recognised thresholds for the space on the beach which has to be available per person.

Given the favourable results obtained in the Marin et al. study showing a good level of interest in alternative cultural and natural activities, another suggested solution for this area is the integration between coastline and inland tourism, as it was already suggested for other Italian regions (e.g. Sardinia[102]), merging the Riviera with the close Beigua Regional Natural Park.

5.3 Case study 1b: Mangrove ecosystems in Thailand

Mangroves are under severe threat (in terms of habitat loss and/or quality degradation) across all tropical countries, where historically they were extensively present. Global mangrove forest cover is currently estimated to be between 16 and 18 million hectares. For countries with available data (54% of total existing mangrove area) an estimated 35% of mangrove forests have disappeared in the last two decades, at a rate of 2.1% per year or 2,834 km2 per annum. In some countries, more than 80% of the original mangrove cover has been lost due to deforestation.[103] In Thailand about half the total mangrove stock was lost between 1975 and 1993 (from 312,700 ha to 168,683 ha.[104] Although the annual loss rate has slowed it is still thought to be around 3000 ha per year.

Direct causes of ecosystem/biodiversity loss

In general terms, the direct causes of mangrove loss in Thailand is land use change leading to habitat loss, with climate change providing a growing future threat as seal level rises and storm events become potentially more intense.

[102] Rooy, P. T. J. C. V., and A. H. P. Stumpel. Ecological Impact of Economic Development on Sardinian Herpetofauna. Conservation Biology 9:263-269.

[103] Millennium Ecosystem Assessment, (2006). "Marine and Coastal Ecosystems and Human Well-Being: Synthesis," UNEP, Nairobi, Kenya.

[104] Sathirthai, S. (1998). 'Economic Valuation of Mangroves and the Roles of local communities in the conservation of the resources: Case study of Surat Thani, South of Thailand'. Final Report submitted to the Economy and Environment Program for Southeast Asia (EEP-SEA), Singapore.

Mangrove forests have been converted to allow for coastal zone urban development, mining, agricultural and aquacultural expansion and logging for fuelwood and construction material. The largest single factor in the loss of mangroves in recent years has been the expansion of aquaculture ponds into forests for shrimp production.[105] But it is important to recognise that the ecosystem conversion/degradation process is not a matter of a single driver/pressure. Linkage but rather the impact of an often quite complex set of interlinked factors and causal relationships spread out over time and across a range of spatial scales (from local to global). This juxtaposition of parameters and scales often translates into a complex causal mechanism. Thus the expansion of aquaculture into mangrove forest space is linked to the growing importance of shrimp farming to the export earnings of Thailand. In Thailand the total value of export earnings for frozen shrimp in the late 1990s was approximately 1 billion US dollars to 2 billion US dollars annually. Thailand has been the largest global producer of cultured shrimp since 1991.[106] This international trade is itself linked to changes in consumer preferences, diets and lifestyles in developed countries from Japan to North America and Europe. The economic model which underpins the cotemporary globalisation process relies heavily on international trade growth and product differentiation facilitated by persuasive advertising and the outsourcing of production to locations with relatively low labour costs. We return to the question of the complexity of the causal mechanisms for ecosystem/biodiversity loss in the indirect causes section of this case study.

To sum up so far, the direct cause of mangrove loss in Thailand has been the expansion of shrimp aquaculture which was the direct result of the raid rise in shrimp exports in response to change in consumer demand across the world. The causal chain was then augmented by increased demand foe land in coastal areas for urbanisation, industrial activity and agricultural expansion stimulated by an economic growth strategy implemented between 1979 and 1996. Local drivers of mangrove loss include logging to provide fuelwood and building materials within local communities and to supply charcoal to neighbouring countries (regional driver).
This is also a demand from the rayon industry in Japan (regional driver dependent on global markets). But these drivers have had only a limited spatial impact on mangrove areas, the most significant drivers, have been clearance for housing (local) and shrimp aquaculture (global forces). In the latter case, local entrepreneurs have exploited the mangroves, encouraged by national economic policy and conditioned by the rules of global market forces. Some 50% to 65% of Thailand's mangroves have been lost to shrimp farm conversion since 1975.[107]

The precise form of shrimp farming adopted in Thailand also has an important role to play. As this form of aquaculture expanded there was a shift from extensive to more small-scale, intensive and initially highly productive pond systems (averaging 2 to 3 ponds per enterprise over 3 or so hectares). While this type of aquaculture enterprise was capable of providing high short run financial returns, it fails the sustainability test. Water

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[105] World Resource Institute, 1996; Spalding, Blasco and Field, 1997.

[106] Barbier, E. and Cox, M. (2002) Economic and Demographic Factors Affecting Mangrove Loss in the Coastal Provinces of Thailand, 1979–1996 AMBIO: A Journal of the Human Environment, Vol 31, Issue 4 p.351-57

[107] Ibid.

quality and disease problems rapidly emerged as unintended externality effects causing shrimp yields to decline rapidly and production sites to be abandoned within 5 to 6 years. There is then a spillover effect as farmers move on to new tracts of mangrove in order to clear fen and establish new ponds. Areas of mangrove closest to Bangkok were denuded first and then production was expanded in the southern and eastern parts of the Gulf of Thailand and across to the Andaman Sea (Indian Ocean) Coast. So the legacy effect of unsustainable shrimp farming practices in the past is playing a part in the continuing loss process. Future prospects may also be constrained by sea level rise related to global climate change.

Underlying causes of mangrove loss

The most important underlying causes of mangrove ecosystem loss in Thailand are: population growth, changing global market preferences, market failure and policy intervention failure and governance. Most of the coastal population of the tropics and sub-tropics resides near mangroves. 64% of all world's mangroves are currently within 25 km of major urban centres (>100,000 inhabitants). Population in the coastal provinces of Thailand increased from around 8 million in 1979 to around 12 million by the end of the 1990s. Analysis undertaken by Barbier and Cox (2002) indicates that shrimp farm expansion is influenced by demographic pressures as provincial population changes. A 10% rise in population growth will cause shrimp farm area to expand by 1.4%. Mangrove clearing also increases by 0.1% (significant only at 10%). The fact that population growth has a significant effect on shrimps farm expansion rather than mangrove clearing may be evidence that most recently shrimp farms are increasingly replacing other coastal land uses as the mangrove areas suitable for shrimp farming become more scarce. More recent shrimp farming efforts have been located on coastal land previously used for rubber and palm plantations and rice paddy areas. Nevertheless, population pressure continues to play a part in mangrove conversion related to urbanisation, agriculture, tourism and mining/industrial activities.

Changing diets, lifestyles and consumer preferences as economic growth has continued in industrial countries has also played an important indirect role in mangrove loss in Thailand. Although mangrove conversion for aquaculture began in Thailand around 1974, the escalation in intensive shrimp farming through mangrove clearance began in 1985, exactly when demand for shrimps in Japan stimulated prices. Less extensive mangrove conversion can also be linked to demand for charcoal in neighbouring countries and the rayon industry in Japan.

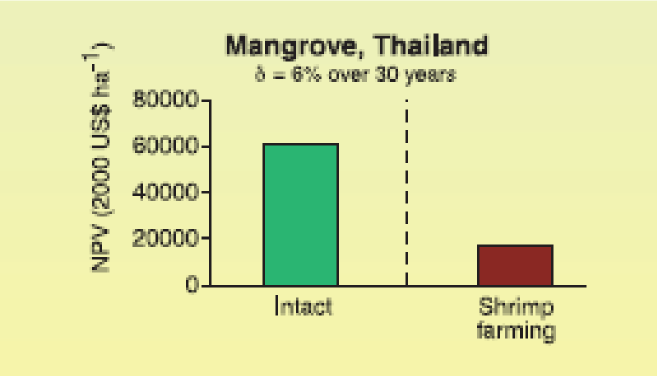
Market failure effects in terms of product prices and the lack of pricing of many mangrove ecosystem services are also evident. The particular form of intensive shrimp pond production chosen in Thailand has proven to be unsustainable (generating negative externality effects) and has exacerbated the mangrove conversion process. Loss of mangroves has deprived local people of a range of services: fisheries, storm buffering etc, which yield significant economic value. In Thailand the economic effects on coastal communities in Surat Thani Province of the lost ecosystem services due to mangrove deforestation were estimated to be US $ 27,264 – US $ 35,921 ha.[108] So while the

[108] Sathirathai, S., and E. B. Barbier, (2001). Valuing mangrove conservation in southern Thailand. Contemporary economic policy 19:109-122.

conversion of mangrove for aquaculture yields short term gains (private benefits) the net effect turns negative once external costs are factored in.[109] While the global benefits of carbon sequestration were considered to be similar in intact and degraded systems, the same was not true for other ecosystem services. The substantial social benefits associated with the original mangrove cover – from timber, charcoal, NTFPs, fisheries and storm protection – fell to almost zero following conversion. Summing all measured goods and services the total economic value of intact mangroves exceeded that of shrimp farming by around 70% (Figure 5.5).

Figure 5.5 portrays the marginal benefits of retaining and converting natural habitats, expressed as NPV (in 2000 US$ ha-1) calculated using the discount rates (delta) and time horizons presented. Values of measured good and services delivered when habitats are relatively intact and when converted are plotted as green and red columns, respectively.

Figure 5.5 Marginal benefits of retaining and converting natural habitats, expressed as Net Present Value in 2000 US$/ha



Source: Balmford et al., 2002, Science VOL 297 p. 951.

Policy interventions (or the lack of measures) have also played an important indirect role in mangrove loss. The small-scale intensive shrimp production model utilised in Thailand is not the only option. It is possible to design shrimp aquaculture systems in coastal areas that do not involve removal of vegetation and make use of tidal conditions and measures to treat discharged waste water. The financial returns from this more sustainable type of operation did not fit with the perceived need for quick financial returns as part of an accelerated national economic growth strategy. Much of the financial investments in coastal shrimp farming in Thailand come from wealthy individual investors and business enterprises not part of the local communities. Labour costs were also kept low by the hiring of foreign itinerant workers. Central government intervention could have served to help facilitate a more sustainable shrimp farm enterprise, but appropriate enabling measures were not instituted, for example, technical assistance programmes, access to credit, loans or tax easements.

In same cases, government intervention may have had unintended negative spillover effects. A ban was imposed on shrimp farming in rice an fruit growing areas. Shrimp

[109] Balmford, A., A. Bruner, P. Cooper, R. Costanza, S. Farber, R. E. Green, M. Jenkins et al. 2002. Economic Reasons for Conserving Wild Nature 10.1126/science.1073947. Science 297:950-953.

farming had been relocating away from coastal areas to these other locations because of the outbreak of shrimp disease attributed to poor water quality in coastal zones. The decline in coastal water quality in the mangrove converted areas was of course itself limited to untreated waste water discharges from the small the small-scale intensive shrimp farms. An unintended consequence of the ban could be a move by shrimp farms back to coastal zones and in particular the exploitation of remaining pristine mangroves an the Andaman coast.

More encouragingly, Barbier and Cox (2002) report some signs of policy switching in favour of the active promotion of mangrove conservation and greater participation by local communities (via new legislation an the community management of forests). The ecosystem services approach, which highlights the need to encompass all the services (local to global) provided by ecosystems such as mangroves would serve to reinforce these types of policy switching.

The mangrove conversion process has been further facilitated by the ill-defined property rights connected to mangrove areas. Although ostensibly owned by the state (via the Royal Forestry Department) mangrove areas are in practice virtually open-access areas. Historically, the 'official' view (mirrored in society in general) was that mangroves were wastelands that had little intrinsic value and therefore could properly be regarded as conversion opportunities. So tourist infrastructure, agricultural expansion and urban developments could all take precedence over coastal mangrove forests, as part of the national economic growth promotion strategy.

Actors and policy framework
Clearly a complex set o actors and forcing mechanisms are relevant to the mangrove ecosystem loss issue. It is important to distinguish complementary/conflicting goals and the type and scale of causal mechanisms influencing goals and objectives. The main actors in this case study seemed to be:

Primary actors:
- Small scale entrepreneurs and business enterprises (nationally but not locally connected); driven by short term profitability goals
- National entrepreneurs (some with international contacts) looking to exploit coastal areas for tourism or industrial ventures
- Local communities heavily dependent on intact mangroves for a range of ecosystem services

Secondary actors:
- Hired labour for shrimp farms, unlikely to be permanent settlers
- National and international NGOs promoting mangrove conservation
- Government bodies and regulatory agencies primarily geared to fulfilling economic growth targets t the national level

Global actors:
- Consumers in rich countries with changing preferences, lifestyles and diets, conditioned by advertising promoted by large international corporations
- International corporations with global-wide interests

- International agencies, World Bank, IMF, WTA etc still promoting economic growth strategies with 'light touch' regulatory regimes to promote trade and economic activity.

Analysis and solutions

Local action to protect mangroves may be insufficient to counter 'free riding' of the environment by global drivers. International payments for ecosystem services schemes may provide one answer to local mangrove loss problems. Recent national policy moves by the Thai government towards community forest management etc is also a promising option. These moves could be combined with financial measures to enable more sustainable shrimp farming methods to be adopted. Global schemes such as accreditation of 'mangrove friendly' products (in line with the 'fair trade' principles) may also be a way forward.

This package of measures (related to the appropriate scale at which causal mechanisms are operative) could serve to partially offset the negative (from a conservation perspective) effects f the market and intervention failures of the past:

- Lack of de facto property rights in mangrove forest areas
- unsustainable shrimp farming operations stimulated by short term profitability objectives, perceived to be contributing to national economic growth
- banning of shrimp farms on other agricultural land causing unintended 'rebound' effects on the remaining pristine coastal mangrove areas
- lack of credit and finance support measures for more sustainable aquaculture regimes
- lack of a polluter pays principle.

5.4 Case study 1c: Coastal wetlands in England, UK

European wetlands have been lost or are under threat, despite the existence of various international agreements (such as the Ramsar Convention) and national conservation policies. This situation has been caused by: the public nature of many wetlands products and services; user externalities imposed on other stake holders; and policy intervention failures that are due to a lack of consistency among policies being enacted across different sectors of the economy. All three causes are related to 'information' failures (e.g. a lack of appreciation of the full range of ecosystem services provided by healthy functioning wetlands), which in turn can be linked to the complexity and 'invisibility' of spatial relationships between ground and surface waters and wetland vegetation.[110]

The precise configuration of wetland pressures and consequent damage varies around Europe. Generalising, industrial development combined with agricultural intensification in N-W Europe has historically been responsible for the majority of wetland loss (around

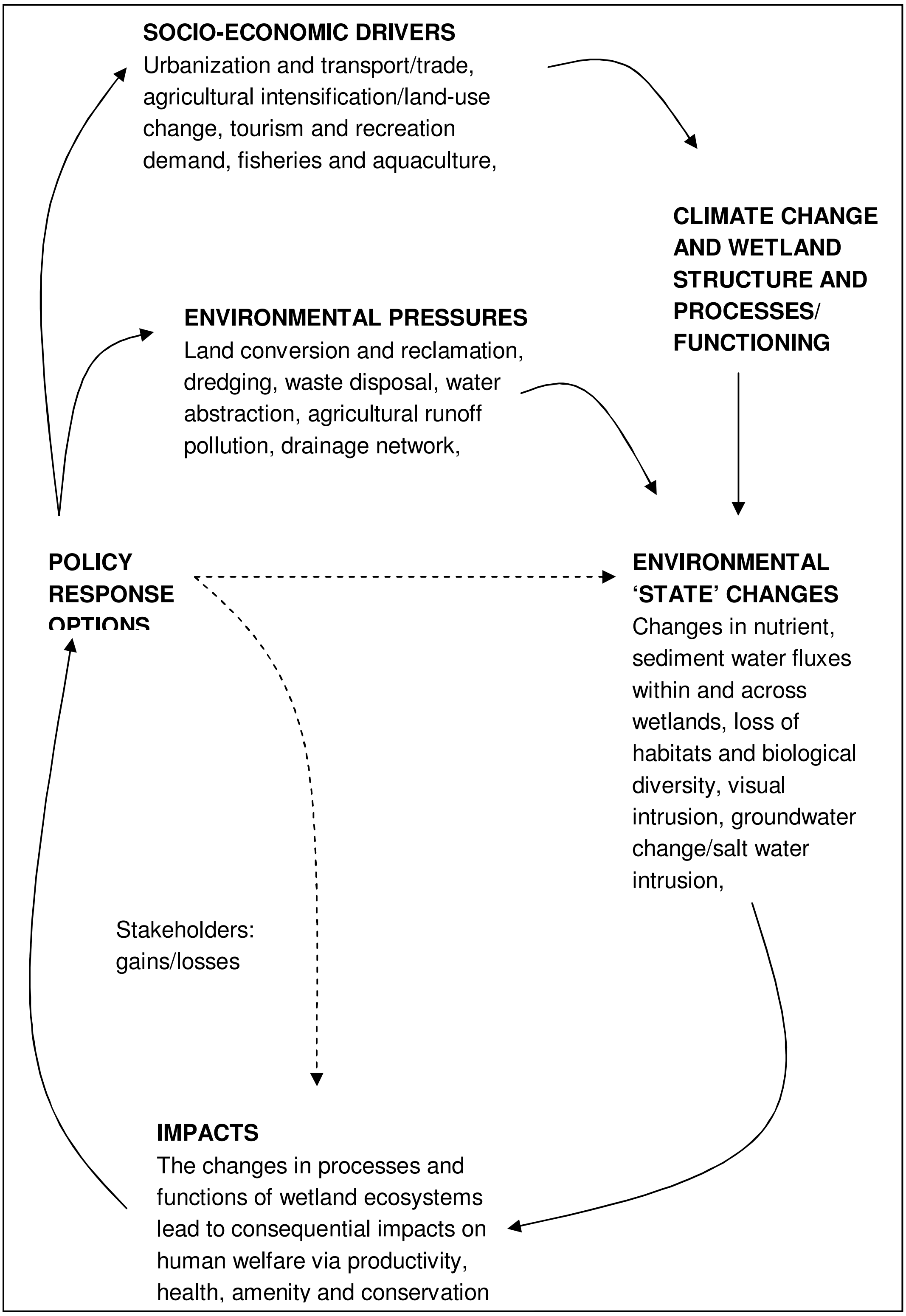
[110] Turner, R. K., J. C. J. M. van den Bergh, T. Söderqvist, A. Barendregt, J. van der Straaten, E. Maltby, and E. C. van Ierland. 2000. Ecological-economic analysis of wetlands: scientific integration for management and policy. Ecological Economics 35:7-23.

60% of total wetland area). In Southern Europe, the historical occupation and exploitation of wetland ecosystem services has caused ‘system stress’ and lowered resilience. This capacity to cope with stress and shock has been further diminished by low winter rainfall in the last decade or so. In Central and Eastern Europe, and parts of Scandinavia, the less extensive spread of industrial, urban, and high intensity agriculture has served to conserve a more extensive extent of wetland.[111]

In the figure below, a summary summarises the main drivers and pressures and their consequences for wetland ecosystems.

[111] European Environment Agency (1999), Environment in the European Union at the Turn of the Century: Environmental Assessment Report, No. 2, European Environment Agency, Copenhagen, Denmark.

Figure 5.6 Driving forces-Pressure-State-Impact-Response framework applied to wetlands



Source: Turner et al., 2003.

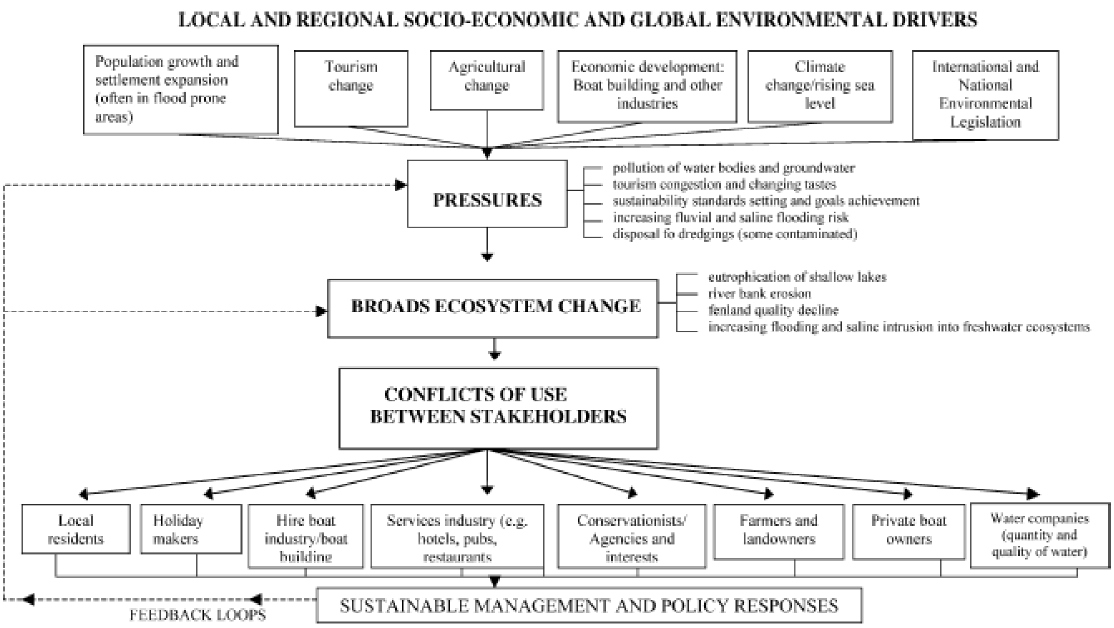
5.4.1 Freshwater coastal wetlands: The Norfolk and Suffolk Broads

The Broads comprise a complex (freshwater, brackish and saline zonal area) wetland of both national and international significance, located in the East Anglian region of England. Broadland is managed by an official agency, the Broads Authority (BA), with powers similar to other UK National Park Authorities, plus navigation duty. But the BA is not subject to the Sandford Principle, which mandates primary status for nature/biodiversity conservation in all the other UK National Park areas. The BA's statutory duties are focused around the requirements to balance navigation, biodiversity conservation and recreation/amenity interests. Its three core purposes can be summarised as: conservation of Broads wildlife; conservation of the Broads cultural heritage and promotion of understanding as well as enjoyment of the Broads; and protection of the interests of navigation.[112] The BA has to operate by making sometimes pragmatic trade-offs, subject to EU Directives and national legislation constraints.

Direct causes of ecosystem change

The direct causes of wetland degradation/loss are: land use change and agricultural development; further growth of water based tourism; increased risk of saline intrusion and flooding and neglect of fen and carr woodland habitats. Figure 5.7 sets out the full range of direct and indirect causes of wetland pressure and related use conflicts that have arisen in Broadland. Table 5.1 brings together the ecosystem services provided by the Broads, their socio economic uses and benefits, and treats to the future availability of the functions.

Figure 5.7 Direct and indirect pressures and related use conflicts in the Broads



Source: Turner et al., 2004.

[112] Turner, R. K., I. J. Bateman, S. Georgiou, A. Jones, I. H. Langford, N. G. N. Matias, and L. Subramanian. 2004. An ecological economics approach to the management of a multi-purpose coastal wetland. Regional Environmental Change 4:86-99.

Table 5.1 Ecosystem services provided by the Broads

Function	Biophysical structure or process maintaining function	Socio-economic use and benefits	Threats
Hydrological functions			
Flood water retention	Short and long-term storage of overbank flood water and retention of surface water runoff from surrounding slopes	Natural flood protection alternative, reduced damage to infrastructure (road network etc.), property and crops	Conversion, drainage, filling and reduction of storage capacity, removal of vegetation
Groundwater recharge	Infiltration of flood water in wetland surface followed by percolation to aquifer	Water supply, habitat maintenance	Reduction of recharge rates, overpumping, pollution
Groundwater discharge	Upward seepage of groundwater through wetland surface	Effluent dilution	Drainage, filling
Sediment retention and deposition	Net storage of fine sediments carried in suspension by river water during overbank flooding or by surface runoff from other wetland units or contributory area	Improved water quality downstream, soil fertility	Channelization, excess reduction of sediment throughput
Biogeochemical functions			
Nutrient retention	Uptake of nutrients by plants (n and p), storage in soil organic matter, absorption of n as ammonium, absorption of p in soil	Improved water quality	Drainage, water abstraction, removal of vegetation, pollution, dredging
Nutrient export	Flushing through water system and gaseous export of n	Improved water quality, waste disposal	Drainage, water abstraction, removal of vegetation, pollution, flow barriers
Peat accumulation	In situ retention of c	Fuel, paleo-environmental data source	Overexploitation, drainage
Ecological functions			
Habitat for (migratory) species (biodiversity)	Provision of microsites for macro-invertebrates, fish, reptiles, birds, mammals and landscape structural diversity	Fishing, wildfowl hunting, recreational amenities, tourism	Overexploitation, overcrowding and congestion, wildlife disturbance, pollution, interruption of migration routes, management neglect
Nursery for plants, animals, micro-organisms	Provision of microsites for macro-invertebrates, fish, reptiles, birds, mammals	Fishing, reed harvest	Overexploitation, overcrowding and wildlife disturbance, management neglect
Food web support	Biomass production, biomass import and export via physical and biological processes	Farming, fen biomass as alternative energy source	Conversion, extensive use of inputs (pollution), market failures

Source: Modified from Turner et al. (1997) and Burbridge (1994)

Source: Turner et al., 2004.

The impact of agricultural activities over the year has changed from land conversion (i.e. drainage schemes to convert marshland into intensive grazing or arable cultivation) to diffuse pollution affects which cause eutrophication in the shallow lake systems of the Broads. The earlier conversion threat was stimulated by the effects of the Common Agricultural Policy. Its subsequent reform and the establishment of ecosystem conservation-related payments schemes (environmentally sensitive area schemes, stewardship schemes etc.) have almost eliminated conversion activities. But the threat to wetland ecosystems has switched to a diffuse pollution (notably N and P fluxes) problem leading to eutrophication.

The Broads are the most visited lowland wetland in England. The rivers and connected broads (shallow lakes) are intensively used for recreational boating, involving around one hundred boatyard operators. The number and popularity of motor boats brings with it the problem of congestion and noise pollution at various locations in the systems (Brower et al., 2002). In the light of climate change and carbon footprint concerns, the demand for 'local' holidays seems certain to increase. This increased tourism demand will be for the strengthened in the Broadland by the growing regional population (particularly in the eastern sections of the region) who nearest 'wild' area is the Broads.

The east coast of England is at risk from saline inundation from the North Sea and the Broads area is also prone to fluvial flooding events. As a consequence a comprehensive flood defence system is in place, built largely after the 1953 flooding catastrophe. But the flood defences are expensive to maintain and will not provide an on-going uniform level of protection across Broadland in the future if climate change related sea level rise predictions prove correct. Efforts are underway to selectively maintain/improve flood defences, but saline intrusion which will transform the freshwater ecosystem of the Broads continues to slowly increase. There is a complex relationship between flood defence policy, stakeholder perceptions of flood risk and ecosystem change. In the latter decades of the 20th century, flood defence investments served to reduce the fear of flooding and this perception in the farming community encouraged land drainage and conversion schemes. The EU CAP then served to reinforce this wetland drainage process. With the growing recognition of climate change and its threats, perceptions have again begun to alter with calls for more extensive sea defence and fluvial flooding investments (including tidal barriers). Concern over national food security may once again encourage more agricultural activity with spillover effects on wetlands, water resources (groundwater depletion as irrigated cropping regimes are further developed) and flood protection investments. We return to this issue in the climate change section, for now we note that all too often the scale of flood interventions has been constrained by political and institutional considerations and has developed down to the lowest common denominator, for example, local pressures focused on short lengths of a river. The proprietorial interests shown by local people in 'their' section of the flood plain are an extremely powerful force and one which democratic systems find difficult to accommodate. Yet natural floodplain systems are driven by processes that transcend the local 'space' and the short run timescale.

Climate change (sea level rise and increased storm intensity leading to enhanced saline and fluvial flooding risk) poses a multifaceted challenge. It is clear that there is unlikely to be insufficient resources to protect all of Broadland to a uniform standard, especially if some of the more extreme predictions of future sea level rise etc. prove correct. A more flexible catchment-wide approach will have to be adopted which may prove favourable to nature conservation in some respects e.g. the increased use of 'natural' washland areas to contain peak flooding. On the other hand, an enhanced level of flood protection may stimulate renewed intensive agricultural activity, especially if food security concerns continue to rise up the political agenda. The negative spillover impacts in terms of water flows and eutrophication will then result in further pressure on the fenland and shallow lake ecosystems. At the coast, improved sea defences would lessen the risk of saline intrusion into the Broads, although an expansion of the saline zone further into the freshwater catchment is inevitable, albeit at a slow pace, via the hydrological gradient.

Management efforts by BA and other official agencies to restore and improve water quality in the Broads will have to be conditioned by the climate change risk. The threat of saline intrusion, marine inundation and fluvial flooding, biodiversity changes and losses, and increased rates of sedimentation continues to grow. The BA has therefore adopted a restoration/improvement strategy which seeks to adopt waterbody management within a more naturally functioning flood plain over a time horizon of 50 to 80 years. It is further conditioned by compliance with existing legislation such as the Water Framework Directive and the achievement of 'good ecological status' in the waterbodies. The BA strategy has twin dimensions in that it is targeted i.e. focused on the protection and enhancement of those existing good quality sites that have the greatest chance of retaining freshwater habitat over the long run, in the context of saline intrusion/inundation due to climate change. But it also seeks to uniformly prevent, as far as is feasible, any further derivation of any of the existing waterbodies. In short, it aims to combine efficiency, effectiveness and prudence principles.[113]

Underlying causes of ecosystem change

The East Anglian Region will be expected to accommodate a significant proportion of the nation's housing needs as population and the number of households continues to increase. Apart from the flood risk problem this expansion of population and housing has important consequences in terms of the water resources required for human use and improved wetland ecosystems. Surface water throughout the region is already fully committed to existing abstractions and the environment during the summer and there are no significant additional quantities of water available as back up. This has implications within the Broads where fenland is particularly susceptible to lowered water table conditions. Winter surface water is still available aver most of the region, apart from some small chalk catchments and coastal streams. Most of the region's groundwater resources are already in broad balance and, therefore, any new abstractions would be subject to rigorous local assessment before they could be granted. In some areas, abstraction rates are already judged to be excessive. Water transfer schemes have been appraised but this option also brings with it a number of ecological uncertainties as river flows are diverted into new catchments.

Market and intervention failures have been particular feature of wetland loss and degradation and the Broads are no exception. Table 5.2 below summarises in typology form the types of failure that have been prevent.

Table 5.2 Typology of main market and intervention failures in Broadland

Type of Failure	Source of Failure
Pollution Externalities	
Water pollution, on-site	Excess N & P from agricultural and sewerage sources; some industrial contamination of sediments by mercury (historical legacy problem)
Water pollution, off-site	Catchment-wide agricultural and recreational pressures
Public Goods-type Problems	
Groundwater depletion	Overexploitation (on and off site) of surface and groundwater supplies leading to diminution of wetland water supplies
Congestion costs, on-site	Recreational boating pressure an wetland carrying capacity; low toll rates on boaters counter balanced by limits on number of licences issued for hire craft
Intersectoral Policy inconsistencies	
Competing sector output prices	Agricultural subsidies (CAP, historical) / subsequent land drainage requirements
Competing sector input prices	Drainage conversion subsidies; flood protection schemes for agricultural land
Counterproductive Wetlands	

[113] Lake Restoration Strategy for the Broads, Broads Authority, Norwich, May 2008.

Policies	
Inefficient policy	Policies lacking a long term structure in line with sustainable development e.g. Habitats Directive and Hickling Broad management (see next section)

The complex political, economic and environmental trade-off process was made more difficult for the BA as a result of EU Directives (notably the Birds and Habitats Directive). This regulatory approach has at its core a rather 'static' interpretation of biodiversity conservation. Such an interpretation does not sit easily with the BA's remit of 'balancing' different interests in order to mange sustainably all the assets within its executive area. The navigation duty sometimes proves to be at odds with the provision of quite public enjoyment and the conservation of the area's natural beauty. The EU Water Framework Directive has added to the complexity of the BA's work. This has introduced management duties that extend spatially up to the catchment scale e.g. achievement of 'good ecological status' in the Broads waterbodies. But the BA has no formal pressures at the catchment scale (which is beyond its executive area) and will have to forge partnership arrangements with other government agencies and private concerns such as water companies. While at least catchment scale management is required, this objective fulfilment is constrained by insufficient scientific data (information failure) and the mismatch between the administrative boundaries and the environmental systems that are to be conserved (scaling mismatch problem).

The case of Hickling Broad serves to highlight some of the management difficulties. This waterbody has a legal navigation channel but over the years boating has become possible over a large part of the lake. More recently due to better management the water quality has been improved and aquatic plant growth has accelerated, making some sections of the water body virtually inaccessible to navigation. As part of its sustainable development commitments the BA must have regard for livelihoods and local enterprise, it also has a statutory duty to maintain navigation access. The increasingly dense bed of aquatic plant (a rare species of stonework covered by the Habitat Directive) began to obstruct boating. Non-powered boats and electric craft were particularly affected and the risk was a return to more diesel-powered craft (going against the BA's environmentally friendly boating initiative and generating pollution). A protected process of dialogue with a range of interest groups and other government agencies eventually led to a compromise partial plant cutting programme. A flexible interpretation of EC Directives and much greater stakeholder inclusion were two lessons learned.[114]

Actors and policy framework

The combination of the lack of trust/accountability felt by some stakeholders in the BA (see Hickling Broad controversy), the need for a more integrated and catchment-based management plan and strategy and the general trend towards the setting up of more inclusioning and deliberative forms of decision making, has served to galvanize efforts directed at organizational reform. The BA subsequently reorganised its committee structure and fostered the development of a so called Broads Stakeholder Forum. While this is not a decision taking body it does have an input into full BA meetings via its independent chair person. The forum contains representatives from all the local intent

[114] Turner, R.K. et al. (2003) Managing Wetlands, Edward Elgar, Cheltenham. Ch 10.

groups and bodies (>20) and debates the full BA meeting agenda items before the BA itself meets. The BA itself has a mix of locally elected politicians and other members chosen (via a competitive interview process) by the Government to represent the national interest. Most recent moves are to include local parish council members on the BA, to reinforce the local accountability of authority.

Primary actors:

- Farmers and land owners
- Boating interests: hire boat/boat building; recreational boating groups
- Conservation agencies and local NGO's
- Environmental regulation agency: wide pressures including waste disposal and flood protection

Secondary actors:

- Local residents
- Holiday makers
- Service industry, hotels, pubs, restaurants
- Tourism agencies
- Water companies

Analysis and Solutions

The complex interplay between flood protection, agriculture and wetland conservation has been made more tractable with the reform of the CAP and the reorientation towards payment schemes with a conservation objective(s). But climate change threats and food security concerns are likely to further complicate these interlinked issues. Moves towards a more flexible catchment-wide planning and management process will, in principle, help ameliorate the problems. But scale-mismatch, information failures and the rudimentary nature of the inter-agency and agency-stakeholder partnership arrangements are hindering progress. At the coast itself this is also a difficult conservation trade-off between saline and freshwater habitats rapidly emerging as climate change effects/risks increase.

Tourism congestion/pollution problems could be further eased by instituting a higher boat toll charging regime, in order to raise more revenue to address pollution and sedimentation problems. The charging regime which currently only distinguishes between rough size of craft and private hire and private owned craft could be further differentiated. The 'discount' for sailing craft and electric or solar boats could be increased to encourage more environmentally friendly boating. The overall tourist experience could be re-packaged to forms on lower volume/higher volume experiences, in order to market the 'quiet tranquillity' of wetland ecosystems.

The moves to improve trust/accountability in the Broads management process have seen a shift to more inclusionary arrangements with all the main stakeholders. It is important, however, given the downsides of localism (see flood protection on simple stretches of river/coast versus a more integrated and strategic approach at the catchment scale as a minimum) are also recognised and that the 'national intent' continues to be represented in the BA's membership.

5.4.2 Saltmarsh ecosystems in coastal Eastern England, UK

The main estuaries (Humber, Blackwater, Thames etc.) on the east coast of England host large areas of intertidal habitat, mudflats and saltmarshes. Large areas of intertidal habitat have been lost over the centuries in all of the estuaries. In the Humber estuary for example some 3000 ha of intertidal habitat was lost in the mid-outer estuary since 1850.[115] For over 300 years European management of coastal lowlands and estuaries has been dominated by land reclamation and flood protection, principally through the construction of "hard" sea walls and the drainage of wetlands. However, in the context of climate change and potential significant sea level rise, the cost of upgrading and upgrading existing sea defences has prompted policy makers to reconsider their long term cost-effectiveness. The recent flooding of New Orleans has served to highlight the vulnerability of large agglomeration of people and economic assets which have continued to expand behind engineered coastal defences.[116] But not only do hard defences provide a false sense of security and encourage development immediately behind defences; they prevent a natural geomorphic response to sea level rise. The result is the loss of intertidal habitat as its landward migration is prevented by the sea walls and flood embankments i.e. 'coastal squeeze'.[117] On the Essex coastline of England the presence of medieval to 19th century embankments has caused the loss of 40,000 ha of saltmarsh.[118]

Emphasis is now moving toward a more adaptive management approach in coastal zones. Areas of high 'economic' value (settlements of a certain size, ports/harbour facilities, nuclear power stations etc.) will continue to be protected, whilst coastal processes will be allowed to proceed relatively unhindered elsewhere. More flexible 'soft engineering' measures, such as managed realignment, are now under test. These schemes involve the deliberate breaching of engineered defences to allow the coastline to migrate to anew line of defence landward of the old one. These schemes aim to re-site defences so as to reduce the length of defence required and also to increase the area of intertidal habitat. The driver for managed realignment has usually been flood defences, as the renewed intertidal/saltmarsh zone can act as a natural sea defence by attenuating wind wave height and tidal amplitude. The recreation of intertidal/saltmarsh also has a biodiversity value and allows government compliance with the European Union Habitats Directive to follow a no-net-loss policy within designated areas. Additional ecosystem service benefits are also provided by the new saltmarsh: carbon storage, nutrient and contaminants storage leading to improved water quality and fish nursery provision.[119]

Direct causes of saltmarsh/intertidal ecosystem loss

Taking the Humber estuary as a typical example the main causes of habitat loss have been: land reclamation for agriculture, industry and port development, and the construction of flood defences.

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[115] Cave, R. R., L. Ledoux, K. Turner, T. Jickells, J. E. Andrews, and H. Davies. 2003. The Humber catchment and its coastal area: from UK to European perspectives. The Science of The Total Environment - Land Ocean Interaction: processes, functioning and environmental management: a UK perspective 314-316:31-52.

[116] Andrews, J., Burgess, D., Cave, R., Coombes, E. G., Jickells, T., Park, D., and Turner, R. K. (2006). "Biogechemical value of managed realignment, Humber Estuary, UK." Science of the Total Environment, 371, 19-30.

[117] Pethick, J. 2001. Coastal management and sea-level rise. CATENA 42:307-322.

[118] Dixon, A.M., Leggett, D.J., Weight, R.C., 1998. Habitat creation opportunities for landward coastal re-alignment: Essex case study. Journal of the Chartered Institution of Water and Environmental Management 12, 107–112.

[119] Sheperd et al., 2007; Turner et al., 2007 and Luisetti et al., 2008.

Table 5.3 The DPSIR framework for the Humber

Driver	Pressure	State	Impact	Response
Population Agriculture Industry	[1]Land use/emissions: [a]sewage [b]agricultural [c]industrial [2]Contaminated sediments [3]Oil pollution	High nutrient input to coastal waters[1a,b,c] High contaminant input to coastal waters[1a,b,c,2,3] Raised temperature of water in tidal rivers[1c] Low oxygen zone at head of estuary[1a,b,c]	Reduced water quality in the Humber Estuary[1a,b,c,2,3] Export of nutrients and contaminants to the North Sea[1a,b,c,2] Damage to aquatic ecosystems[1a,b,c,2,3,4,5]	Upgrading of STWs [1a,c] Designation of NVZs [1b] Changes to agricultural practices [1b] Remediation of contaminated land [1c,2] Cleanup of industrial effluent [1c,2]
Port development	[4]Dredging	Disturbed bed sediment[4]	Passage of migratory fish upriver blocked[1a,b,c]	Cessation of sewage dumping in N. Sea [1a]
Climate change Fisheries	[5]Coastal Squeeze	Reduced intertidal area[5]	Habitat loss[2,3,4,5]	Creation of intertidal areas by setback of coastal defences [1a,b,c,4,5]

Drivers are responsible for one or more pressures. Superscripts indicate which states/impacts/responses can be linked to individual pressures. This is by no means an exhaustive list, but serves to illustrate how the DPSIR framework operates for the Humber Estuary. Fisheries is currently a small-scale socio-economic activity in the Humber Estuary, but has been included due to its former, and potential future, importance. STW, sewage treatment works. Note these accept both domestic and industrial effluent. NVZ, nitrate-vulnerable zones.

From a population perspective there are several major urban centres with the river catchment and one on the estuary itself. Until fairly recently untreated domestic sewage and wastewaters from the city of Hull (on the estuary) was discharged directly into the estuary. Many others 'treated' discharges also enter the estuary. Agricultural activities in the catchment serve to discharge N and P into water courses.

Underlying causes of habitat loss/degradation

There is a 'historical legacy' problem in this estuary as heavy metal contaminants from past centuries of industrial activity are slowly moving via the sediments from the catchment to the estuary and its intertidal areas.

Analysis and Solutions

It can be shown that targeted management realignment schemes (deliberately located to avoid people/property, cultural and designated environmental assets sites) can pass an economic efficiency cost-benefit test. The cost-benefit appraisal must include a range of ecosystem service benefits (carbon storage, water quality enhancement, fish nursery) in addition to flood defence cost (capital and maintenance costs) savings.[120] But more extensive use of realignment will inevitably raise, among others, complex social justice, trust and accountability concerns. The 'best' candidate realignment sites have low opportunity costs (typically low grade agricultural land) but if the policy is to be more widely applied the opportunity costs will inevitably increase. If small scale communities/limited number of households or large tracts of higher quality agricultural land were to be 'sacrificed' in realignment schemes then much wider criteria than just economic efficiency would be involved. Questions of social justice and compensation would rapidly rise up the political agenda. So far in the UK, planning law, compensation issues and inclusionary decision support arrangements have yet to be properly addressed. Formal cost-benefit analysis which has traditionally underpinned flood defence/erosion

[120] Turner et al., 2007; Luisetti et al., 2008.

investment appraisal will have to be augmented by a multi-criteria assessment decision support system, embedded within new deliberative and participatory processes encompassing all the ‘relevant’ stakeholders.[121]

[121] Turner, R. K., Burgess, D., Hadley, D., Coombes, E. G., and Jackson, N. (2007). "A cost-benefit appraisal of coastal managed realignment policy." Global Environmental Change(17), 397-407.

6 Annex 2: Case studies on marine ecosystems and biodiversity loss

6.1 Introduction

This annex provides an overview of the management of marine biodiversity on the basis of three case studies: the North Sea, the Coral Triangle and the Arctic Ocean. These cases differ considerably with respect to abiotic and biotic characteristics, as well as human exploitation and governance. However, all three are important regions for reasons of biodiversity, which is threatened in each case. Together they provide an impression of the management problems, backgrounds and possible solutions to biodiversity loss in marine environments. In each case study, several general characteristics will be introduced, followed by an overview of the direct causes and underlying causes of change in biodiversity, the organization of governance, including the main stakeholders, and some directions for solutions. Following the overview of the case studies, several general issues will be discussed concerning direct causes, underlying causes, governance and improvement. Before turning to the case studies, we will list and define the direct and underlying causes of change in biodiversity and present some general characteristics of marine biodiversity governance.

As *direct, human-induced causes* of change in marine biodiversity we regard *human interventions* to include the following categories:

- interventions in the area: fishing, fisheries/fish farming, shipping, offshore activities and exploitation of minerals and energy, introduction of new species, tourism
- interventions along the border of the area: coastal works
- interventions on the mainland: water polluting activities and activities relating to atmospheric changes

In addition, natural abiotic and biotic fluctuations cause changes in marine biodiversity, such as autonomous climate change and the migration of species. All of these interventions may influence habitat size, quality and diversity, ecosystem functioning, biodiversity and species population development. In contrast to most terrestrial ecosystems, most marine systems are very open.

Underlying causes are *factors related to different aspects of human society*, which are categorized here as follows:

- social, including demographic and cultural factors
- political and institutional factors, including governance and legal factors
- economic factors
- scientific and technological factors

Because these underlying causes are interrelated, it is hard to identify the most important underlying causes responsible for loss of marine biodiversity. Compared to other biomes, one principal difference is that no particular State or authority is responsible for the management or protection of the seas, although this does not mean that this is a major underlying cause. The four different factors include the following sub-factors:

- social factors: population level, population composition and social stratification, as well as cultural factors such as religion, ethics, media, recognition and evaluation of risk, nature and biodiversity
- economic factors: national income, consumption level, production level, distribution of welfare, organization of the economy and market, character of the economy in terms of sectors and branches
- political and institutional factors: role of and cooperation between different national and international governmental institutions, quality of national and international legislation, the role of parliament and citizens, political will, organization and quality of state institutions, implementation and control of legislation and other policy instruments, involvement of local authorities and stakeholders, distribution of power, monitoring and evaluation
- scientific and technological factors: levels of science and technology, characteristics of science and technology, application of science and technology and scientific literacy

The relevant governmental aspects for all marine cases comprise a number of international institutions and legislative framework (see also section 4.1.1). The most important are conventions concerning certain species, habitats, biodiversity, fisheries and fishing, marine pollution, and environmental and water management, but also include trade and economics, relevant UN and other supranational institutions, and conservation NGOs such as WWF and The Nature Conservancy.

The United Nations Convention on the Law of the Sea (UNCLOS), which came into force in 1994, is of major significance regarding biodiversity. UNCLOS established a comprehensive framework for the use of the oceans and their resources. It enables States to use parts of the seas and oceans but it also obliges them to protect and preserve the marine environment. Protective measures include pollution prevention and preservation of ecosystems, including the preservation of the habitats of depleted, threatened or endangered species. Implicitly the convention seems to promote an Ecosystem Approach and encourage the designation and establishment of Marine Protected Areas (MPAs). Together with the ‘precautionary principle’ and ‘integrated coastal management’, the ‘ecosystem approach’ and ‘marine protected areas’ are key elements in most marine biodiversity protection regulations and plans.

6.2 Case study 2a: The North Sea

The North Sea has a surface area of 0.75 million km^2. It is a semi-enclosed shallow sea, bounded by the European countries of the UK, France, Germany, Denmark, Norway, Belgium and the Netherlands – with Sweden also being included at times. A large variety of habitats can be found along the coastlines, which are sandy, muddy or rocky. The

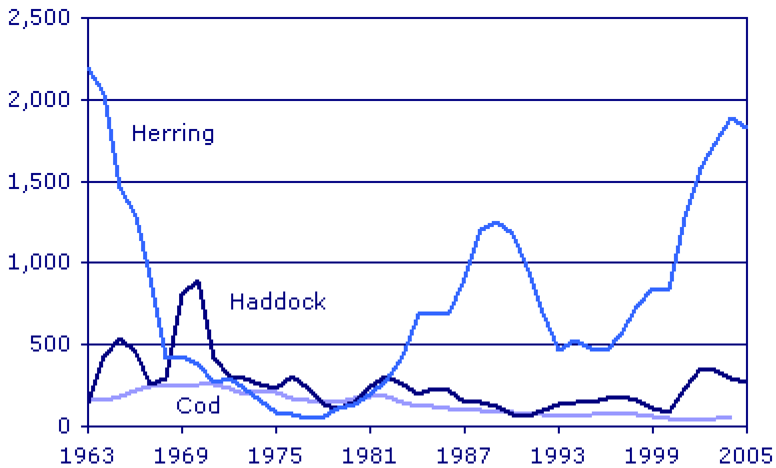
North Sea is very productive and includes the world's major fishing grounds. It is also one of the world's most important non-OPEC production sites. Although the sea is heavily used by humans for fishing, shipping and exploitation of oil and gas, it has still some areas of high biodiversity.

6.2.1 Direct causes of decrease of biodiversity

Fisheries

Fishing has a long history in most countries situated around the North Sea and is probably the major threat to biodiversity.[122] At present, fish catches are equivalent to more than 2 million tonnes annually. The ecological effects of fisheries include the mortality of target and non-target species, leading to the overfishing of some commercial fish species and to changes in species composition (Figure 6.1 and Figure 6.2). Discarding practices increase organic pollution and affect the ecology of several bird species. Some fishing techniques, especially the beam trawl, cause serious damage to the sea floor and benthic organisms. Fish farming may influence benthic communities because of the emission of nutrients and organic matter from fish cages and may also influence wild fish stocks.

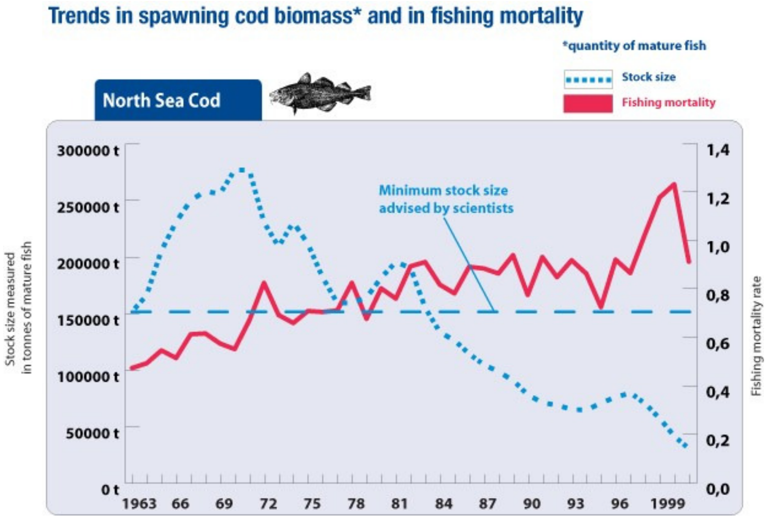
Figure 6.1 North Sea fish stocks, UK, spawning stock biomass for three fish species (thousand tonnes)



Source: www.statistics.gov.uk

[122] Ducrotoy & Elliot, 2008; Walday & Kroglund, 2002.

Figure 6.2 Trends in spawning cod biomass and in fishing mortality



Source www.ec.europa.eu/fisheries

Shipping

The North Sea is one of the busiest seas in the world[123], with almost 300,000 ships entering the main ports each year. Shipping may cause pollution and increase the risk of accidents. Major oil spills from tankers pose serious threats to sea birds.

Offshore activities and exploitation of minerals and energy

Several oil and gas companies extract huge quantities of gas and oil from the North Sea.[124] This causes the discharge of oil and the disturbance of animals due to noise and light. Huge wind farms are planned, which may also cause disturbance.[125]

Coastal works

Land reclamation activities are common along the coasts of North Sea countries, as well as coastal defence works.[126] These activities greatly influence marine habitats, affecting aspects such as the occurrence and the quality of estuaries.

Water polluting from main land activities

Many large cities and industrial areas can be found along the North Sea coast, actually and potentially causing pollution of several kinds, such as litter and chemical and radioactive waste.[127] The ecological effects of organotin compounds, as well as PAHs, PCBs and some metals are well known. Major rivers such as the Rhine, Elbe and Thames discharge large quantities of chemicals, nutrients and organic material, including nitrogen, which originates from agricultural fertilization, and phosphorus from urban waste water and soil erosion. In some areas low oxygen levels may occur. Eutrophication affects algae and invertebrates.

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[123] Walday, M. & Kroglund, T., 2002, Europe's biodiversity, The North Sea, European Environmental Agency.
[124] Ibid.
[125] Ducrotoy J.-P. & Elliot, M., 2008, The science and management of the North Sea and the Baltic Sea: natural history, present threats and future challenges, Marine Pollution Bulletin 57 (1-5), 8-21.
[126] Walday, M. & Kroglund, T., 2002, Europe's biodiversity, The North Sea, European Environmental Agency.
[127] Ibid.

Human activities with regard to changes in the atmosphere
Although climate change cannot be related to activities in one specific area, it is true that industry, agriculture and traffic in European countries situated around the North Sea contribute significantly to climate change. It is probable that climate change already affects the habitat quality and population dynamics of several species in the North Sea, for example in the Wadden Sea.[128]

Tourism
Many tourist centres can be found, particularly in the coastal areas.[129]

Introduction of new species
Non-indigenous species have arrived in the North Sea as a result of natural and human-induced processes.[130] Best known is the introduction of species by ship ballast water. More than 80 species have been introduced to the North Sea. These species have an impact on other species and sometimes reduce the numbers of indigenous species.

6.2.2 Underlying causes

Social factors
Population density is very high around the North Sea, contributing to high production and consumption levels and many activities associated with transportation and trade. Although attitudes towards nature and technological risks have shifted in a more sustainable direction, this may vary from place to place and time to time. In most North Sea countries, biodiversity and North Sea pollution are public issues and the media reports on such problems.

Economic factors
Several countries around the North Sea belong to the most powerful countries in the world, which means a very high level of industrial production and international trade. The North Sea region contains some of the most important harbours and industrial centres in Europe. It also produces 3.7 million barrels of oil per day, which is equivalent to nine percent of global production. For some North Sea countries, for example the UK and Norway, the exploitation of oil and gas from the North Sea significantly contributes to the country's welfare. Norway is highly dependent on its oil production, with oil and gas accounting for one-third of exports, while the UK is also one of Europe's most important oil producing countries.

The North Sea is a highly productive sea, supporting average annual landings of 2.5 million tonnes of fish and shellfish, with some 51,800 people employed in the North Sea fisheries sector.[131] Apart from Norway, all of the North Sea countries belong to the EU, which has adopted the free market ideal. Regulation of production for reasons of

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[128] Walday, M. & Kroglund, T., 2002, Europe's biodiversity, The North Sea, European Environmental Agency.
[129] Ibid.
[130] Ibid.
[131] Salz, P., Buisman, E., Smit, J. & B. de Vos, 2006, Employment in the fisheries sector: current situation, LEI BV, Framian BV, Den Haag.

environmental protection may interfere with free trade and must be negotiated in each case.

Political and institutional factors
All North Sea countries can be regarded as stable Western democracies with elected parliaments. Furthermore, stakeholders, including market parties and environmental NGOs, are involved in and influence political decision-making. North Sea countries have a long tradition of economic and political cooperation. Most abide by EU legislation and all respect international legislation concerning environmental and biodiversity protection. However, the implementation of international legislation may differ from country to country. Furthermore, responsibilities are not always clearly determined, and in most cases the source of pollution and disturbance is not situated in the North Sea itself but elsewhere, for example, European rivers. This openness of the system to various influences makes it even more difficult to manage. Due to common agreements, improvements have been reported with respect to the discharge of nutrients and some contaminants from rivers. In most cases, control in the sea area itself is poorly organized, although this is improving. For example, due to institutional problems and the powerful interests involved, the exploitation of gas and oil is not regulated optimally. Pollution by industry and agriculture on the mainland is regulated to some extent, but this differs from country to country.

Scientific and technological factors
The levels of science and technology are high in all of the North Sea countries. This influences innovative power, which may cause new potential environmental dangers. Well-known and relevant examples are radioactive waste, dangerous new chemicals, genetically modified organisms and nanoparticles. However, ecological and environmental sciences and sustainable technology have rapidly developed in the last decades, making it easier to formulate ecological standards and to stimulate environmentally friendly production modes. NGOs and industry are well informed about scientific aspects of management and are integrated into innovative networks.

Governmental framework and stakeholders
The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) is an important framework for North Sea management. It was developed from earlier conventions (of OSlo and PARis) on dumping waste at sea and land-based sources of marine pollution and entered into force in 1998. It includes all human activities that might adversely affect the marine environment of the North East Atlantic, except fishing. The OSPAR Commission is the forum through which 15 countries cooperate and it is made up of representatives of each government and the European Commission. There is usually one general meeting each year, but representatives of various parties meet regularly to provide advice in relation to management decisions and to monitor the development and implementation of any agreements. So-called observer organizations also participate. The effectiveness of the measures is evaluated in Quality Status Reports.

More specific to the North Sea are the international ministerial Conferences on the Protection of the North Sea. At these conferences, ministers responsible for the environment meet to assess the measures required to protect the North Sea and to provide a political framework to achieve this. All of the North Sea countries as well as international observer organizations participate in these conferences.[132] The first ministerial conference was organized in 1984, the latest in 2006, with many of the commitments being adopted in national regulations. The adoption of the precautionary principle at the conference in London in 1987 is perhaps one of the most important agreements. Another important outcome was the agreement on the integration of fisheries and environmental issues, with the aim of developing and applying an ecosystem-based approach to the management of human activities and the protection of the North Sea in 2002. An ecosystem approach, according to the conferences, means the integrated management of the sea, the formulation of clear general and operational objectives (ecological quality standards), optimal use of existing scientific knowledge, focused research on North Sea ecosystems, including climatic, biological and human driving forces of ecosystem variability, integrated monitoring, integrated assessments prepared by experts, and the involvement of stakeholders, scientists, managers and politicians at different stages of the decision-making process.[133] After 2006 OSPAR became responsible for the fulfilment of the commitments from the various North Sea conferences.

The Common Fisheries Policy (CFP) is the European Union's instrument for the management of fisheries and aquaculture.[134] Fisheries policy was seen as an EU policy problem in the early 1970s. In 1976, when the EU members extended their rights to marine resources from 12 to 200 miles off their coasts, they also decided that the European Union was best placed to manage fisheries in the waters under their jurisdiction. In 2002, the Common Fisheries Policy adopted the aim of ensuring the sustainable development of fishing activities in terms of the environmental, economic and social aspects. It also intended to improve the decision-making process by incorporating sound and transparent scientific advice and encouraging stakeholders to participate by attuning environmental and development policies and by increasing accountability and effectiveness. The policy includes measures such as annual total allowable catches, limitations on fishing effort, technical measures and the obligation to record and report catches and landings. Several measures have been adopted to limit the environmental impact of fishing, for example, the protection of non-target species such as marine mammals, birds and turtles, juvenile fish and vulnerable fish stocks, the prevention of by-catch and elimination of discarding practices, and the protection of sensitive habitats. It is the responsibility of the EU member states to ensure that the rules agreed upon under the CFP are respected. Fisheries controls play a central role in encouraging compliance, deterring fraud and ensuring sustainable fishing. To ensure that all national enforcement authorities apply the same standards of quality and fairness in their enforcement, there is also an EU Inspectorate. In the 2002 the decision was taken to establish an EU fisheries agency which could strengthen controls, and the Community Fisheries Control Agency came into operation in 2007.

Several EU directives have been formulated for environmental protection and nature conservation, such as the birds, habitat and water framework directives, and more

[132] (www.ospar.org)
[133] Ministry of Environment, 1999, The North Sea, an Integrated Ecosystem Approach.
[134] (ec.europa.eu/fisheries)

specifically for the marine environment, Recommendations for Integrated Coastal Zone Management and the European Marine Strategy Directive. As a consequence, the entire North Sea area will be better managed and new measures will be proposed such as Marine Protected Areas, which will establish science-based and participatory policy frameworks regarding European environments.[135]

Based on this governmental framework, some successes can be reported, such as the reduction of nutrients by 50 percent, the ban on offshore dumping and the ban on the application of tributyltin (TBT).

According to the EU, these successes are due to the establishment of cooperation on a regional level between States which have a common interest in protecting common resources, frequent meetings at the political level, political commitments without legally binding enforcement, a broad and comprehensive approach, a willingness on the part of ministers to commit themselves to ambitious targets, transparency and the active participation of all stakeholders, including industry and NGOs, as well as comprehensive reviews of progress.[136] Critics have said that although the new EU marine strategy may lead to the improved management of the North Sea, it will probably have the same implementation problems as previous policies, such as a lack of an integrated vision, and difficulties with the integration of management and control.[137] It is uncertain whether new measures will be taken in relation to fisheries and climate change. Often, EU proposals for more sustainable fishing are often not accepted by the member states, an example being the control of fleet capacity and initiatives to establish marine protected areas on a national scale, which are still a matter of debate.

The main parties in the North Sea region are the seven countries bordering the North Sea as well as the EU. In addition, some large market parties are active in the area, especially oil and gas exploitation companies and fisheries companies. Small and large-scale fishers and their organizations are the main stakeholders. International conservation organizations, notably WWF and Greenpeace, also attempt to influence North Sea policy. Numerous stakeholders can be found in the coastal zones, such as representatives of the tourist industry, chemical industry, construction companies, agriculture, local authorities, and conservation groups. There are several frameworks for stakeholder participation, such as the Wadden Sea Forum and the Common European Fisheries Policy and the European Marine Strategy Directive, but it is not always clear why, how and which stakeholders should be included.[138]

6.2.3 Possible solutions

Several plans have been proposed to better protect biodiversity in the North Sea. Without doubt, in theory the governmental framework is well considered and includes many

[135] Fletcher, S., 2007, Converting science to policy through stakeholder involvement: an analysis of the European Marine Strategy Directive, Marine Pollution Bulletin 54, 1881-1886.
[136] Ministry of Environment, 1999, The North Sea, an Integrated Ecosystem Approach.
[137] Nevill, 2008; www.noordzee.nl
[138] Fletcher, S., 2007, Converting science to policy through stakeholder involvement: an analysis of the European Marine Strategy Directive, Marine Pollution Bulletin 54, 1881-1886.

relevant elements for good governance, such as clear goals, scientific foundations, stakeholder involvement, process orientation, policy instruments and evaluation mechanisms.

The main bottleneck seems to lie in the implementation of such measures. Better integration is necessary, both horizontally – between governmental institutions – and vertically – between OSPAR, the EU and North Sea countries. The lack of such integration has made it impossible to establish an ecosystem approach. While the system of politically non-binding agreements may have its advantages, it certainly also has disadvantages. Furthermore, control mechanisms are poorly developed. A real dilemma is the management of the North Sea, which is divided into sectors that are in fact seen as belonging to the different countries. This division means that countries feel responsible for their part of the sea and this diminishes the need to formulate a common policy and practise common management. Furthermore, the involvement of stakeholders, both environmental NGOs and market parties, could be improved to assist in developing a common framework.

Thus, improvements are possible with respect to these issues. Better horizontal and vertical integration, more binding agreements with respect to management of the North Sea, better control and permanent stakeholder involvement are required. In addition, some specific improvements can be formulated. As fishing is the main direct cause of biodiversity loss, the key challenge is to tackle this problem and its underlying causes. Better policymaking and control regarding fishing is perhaps the most important and most achievable solution. Policy should focus on at least five issues: regulating fishing fleets, regulating the catch of commercial fish, regulating by-catch, improving fishing techniques and creating recovery areas or marine protected areas. The growing urgency to save fish stocks makes each of these measures realistic. The last three options, regulating by-catch, improving fishing techniques and creating recovery areas are the simplest. Covenants between stakeholders should be considered to enhance the involvement of the fishing industry, such as those between NGOs, fishing companies and the EU concerning sustainable fishing practices. In addition, technological solutions to improve fishing techniques and to reduce by-catch should be found.

As offshore activities related to the exploitation of the North Sea for energy purposes is the second main threat, solutions should be found to improve safety and reduce the environmental effects of these activities. At least two types of strategy should be considered: governmental regulation or covenants with market parties, and better exploitation techniques. However, as mentioned, many threats to marine biodiversity are related to activities in coastal zones or the mainland. Thus, a viable marine strategy should incorporate a mainland strategy that includes the regulation of agricultural and industrial activity.

With respect to underlying causes, we have mentioned political and institutional factors. Science and technology can help to improve ecological standards, to determine the marine protected areas and to stimulate innovation in fishing and offshore activity. However, both factors are strongly interconnected with social and economic factors. The combination of densely populated areas, high consumption levels, economic growth goals, the free market and the relative autonomy of operating companies, makes it difficult to achieve sustainability goals. With respect to each of these aspects, new approaches must be considered. Although high population levels as such do not necessarily lead to environmental degradation, it may be helpful to stabilize population levels in these countries. In addition, the tendency in most North Sea countries to combine a certain level of free market activity with state regulation should be encouraged to tackle the ongoing exploitation of the North Sea. Better regulation of international companies should be considered in particular. Thus, effective protection of the North Sea calls for better regulation of the nature of production and its technologies, and the control of products originating from neighbouring countries. This in turn demands new sustainability coalitions consisting of scientists, NGOs, governmental institutions and market parties. A shift in economic activity, priorities and sectors should perhaps also occur, as well as the creation of new financial systems or means to establish new priorities. If the nature and organization of consumption and production and the related value systems in the North Sea countries do not change, governmental and technological solutions will fail.

Therefore, several of the arrangements between the parties in these fields must be restructured, based on a common 'culture' of sustainability, in order to rethink Europe's economic enterprise.

6.3 Case study 2b: the Coral Triangle

The Coral Triangle has a surface area of 5.7 million km^2. It is part of the Indian and Pacific oceans, spanning Eastern Indonesia, parts of Malaysia, the Philippines, Papua New Guinea, East Timor and the Solomon Islands. Although it includes other habitats, coral reefs are by far the most important. The area is used heavily by humans for fishing. Because of its hundreds of coral building species and its thousands of species of reef fish, it is regarded as the global epicentre of marine biodiversity. Worldwide, less than five percent of reefs occur in areas managed under the strictest IUCN categories and 41 percent are under management categories which allow for some kind of sustainable use. Almost 50 percent of the world's coral reefs are in the Indian Ocean and South East Asia, but less than 15 percent of these are officially protected. In Southeast Asia 40 percent has already been lost (Table 6.1).

Table 6.1 Coral reef regions in Southeast and East Asia, by percent lost

Geographic Area	Total Coral Reefs (km^2)	Lost (%)	Low Risk (%)
Southeast Asia	91,700	40	15
South Asia	19,210	25	30
World Total	284,803	19	46

Source: Wilkinson et al., 2008.

6.3.1 Direct causes of decrease of biodiversity

Fisheries

Fishing has a long history in most countries located around the Coral Triangle. At present there are perhaps more than 2 million fishers active in this area.[139] Fishing is regarded the most pervasive threat to coral reef biodiversity.[140] Both the intensity of and the techniques used in fishing have very serious effects. Overfishing leads to increases in the number of fish species harvested commercially, and as levels of these stocks decrease fishers may shift to less valuable species. Consequently, the stocks of these species also decrease. In this region, by-catch seriously endangers sea turtles.[141] At least 50 percent of the area is threatened by destructive fishing, including poisoning with cyanide and blast fishing with dynamite, forms of fishing which contribute to the overfishing of commercial and non-commercial fish species, as well as the fundamental destruction of the habitat. About 75 percent of the aquaculture industry is centred in this region, which may also have an influence on specific ecosystems.[142]

Shipping

The Southeast Asian region is a major hub for shipping traffic.[143] The region has several large harbours and an extensive network of shipping lanes. Coral reefs can be threatened by oil spills, ballast and bilge discharge, and waste dumping from ships. On a smaller scale, anchors can cause local physical damage to coral.

Offshore activities and exploitation of minerals and energy

Several oil companies extract oil from or in the vicinity of the Coral Triangle marine area[144], which may cause the discharge of oil.

Coastal works

Land reclamation activities are common along the coasts of several Coral Triangle countries, for example, for the building of airports and urban areas.[145] These activities may have a strong adverse effect on coral reefs.

Water polluting main land activities

Several coastal zones of the Coral Triangle have developed rapidly, resulting in new industrial and urban developments. This may cause pollution of several kinds, such as chemical waste, eutrophication and sedimentation.[146] Normally, coral reefs in tropical waters have low nutrient levels. Agriculture, river modification, road construction and deforestation in many surrounding countries contribute significantly to increasing sedimentation. In addition, nutrients from agriculture enter rivers and flow into the sea. Because many coastal communities in this region lack adequate sewage treatment systems, population growth results in the release of high levels of nitrogen and phosphorus. More sediment and nutrients reduces coral growth, directly or indirectly.

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[139] (www.coraltrianglecenter.org)
[140] Burke, L. Selig, E. & M. Spalding (ed.), 2002, Reefs at Risk in Southeast Asia, WRI/UNEP/WCMC/WFC/ICRAN.
[141] (www.panda.org/coraltriangle)
[142] Ibid.
[143] Burke, L. Selig, E. & M. Spalding (ed.), 2002, Reefs at Risk in Southeast Asia, WRI/UNEP/WCMC/WFC/ICRAN.
[144] Ibid.
[145] Ibid.
[146] Ibid.

Human activities with regard to changes in the atmosphere
In the Coral Triangle area, activities such as deforestation contribute to the emission of gases which stimulate climate change. Climate change is perhaps one of the main threats to biodiversity in the Coral Triangle.[147] Although other factors have been mentioned, such as sedimentation, pollution and changes in salinity, climate change is most widely reported as the cause of coral bleaching. This process occurs when corals become stressed and they eject their zooxanthella, becoming pale or white. It is also possible that the increase in atmospheric CO_2 levels will reduce the alkalinity of surface waters and adversely affect the skeletal strength of corals.

Tourism
Because of the emerging tourist markets in this region, along the coastal areas many tourist centres are founded.[148]

Introduction of new species
Although non-indigenous species may arrive in the Coral Triangle area as a result of natural and human-induced processes, it is not well known how many of these species occur in this region.[149]

6.3.2 Underlying causes

Social factors
Population density is very high on some of the islands in the Coral Triangle and on many of them, marine and coastal areas provide the foundation for traditional cultures. In addition, in many countries of the region, nature conservation is associated with colonial history or corrupt post-colonial regimes. Although there are non-Western conservation approaches that sometimes have a long history, they are rarely taken into account.[150] Public awareness and media attention differs from that common to most Western countries.

Economic factors
Most countries around the Coral Triangle belong to the developing countries, but some do develop rapidly. Nevertheless poverty is a main problem for many people (Table 6.2). Substantial numbers of people live below national poverty line. Although agriculture and fishery are important sectors, the industrial sector is growing. The marine resources directly sustain the lives of over 120 million people. The primary benefits include major spawning and nursery ground for tuna species, coastal protection and nature-based tourism.[151]

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[147] Burke, L. Selig, E. & M. Spalding (ed.), 2002, Reefs at Risk in Southeast Asia, WRI/UNEP/WCMC/WFC/ICRAN.
[148] Ibid.
[149] Ibid.
[150] Arnscheidt, J. 'Debating' Nature, 2009, Leiden University Press. Leiden.
[151] (www.cti-secretariat.net)

Indonesia, in particular, should be mentioned as an important supplier of petroleum and natural gas.[152] It produces about 1 million barrels of oil and 190 billion cubic feet of natural gas per day. Exports of oil, oil products and natural gas earn Indonesia more than USD 10 billion per year, with oil and gas being the country's second and third most important income earners respectively.

All of the Coral Triangle countries have adopted the free market ideal. Regulation of production for reasons of environmental protection may interfere with free trade and must be negotiated in each case.

Table 6.2 Coral reef and poverty in the main countries of the Coral Triangle

	Coral reef area (km2)	Population (millions)	Population living below national poverty line (%)	GDP per capita (US $)	Number employees in fisheries and aquaculture
Indonesia	51020	209	27	2857	5118571
Philippines	25060	74	37	3805	990872
Malaysia	3600	22	16	8209	100666

Source: www.reefbase.org

Political and institutional factors

All of the Coral Triangle countries have a colonial history and have now more or less adopted a Western parliamentary democracy system. In addition, stakeholders, including market parties and environmental NGOs, are involved in and influence political decision-making. International nature conservation NGOs should be mentioned in particular. In practice, they initiate, finance and even manage many nature reserves.[153]

Most of the countries respect international legislation concerning environmental and biodiversity protection. However, the implementation of international legislation is poor. Furthermore, a marine area such as the Coral Triangle does not belong to any one national territory and is much more difficult to manage than areas belonging to specific countries. For example, responsibilities are not always clearly assigned. In addition, in some cases the source of pollution and disturbance is not situated in the marine area itself but elsewhere, for example, in deforested parts of the mainland. In most cases, very few protective measures have been taken and control within the marine area itself remains poorly organized. For example, most of the marine protected areas are so-called paper parks, that is, they do not exist in practice. Due to the powerful interests involved and the lack of legislation, political will or control, fisheries regulation, for example, is far from optimal. A real problem in most countries is the limited involvement of local stakeholders and poor collaboration between governmental levels.

Scientific and technological factors

The levels of science and technology are not high in most Coral Triangle countries. This influences innovative power and may inhibit environmentally friendly solutions. In this

[152] (www.aasianst.org).
[153] Miclat, Ingles & Dumaup, 2006; Arnscheidt, 2009.

region, there is little development of ecological practices, environmental sciences or sustainable technology. This makes it difficult to formulate ecological standards. Most citizens, bureaucrats, managers, local NGOs and industries are not well informed about scientific aspects of management.

Governmental framework and stakeholders

In 2007, at the Asia-Pacific Economic Cooperation Summit and the UN Conference on Climate Change in Bali, the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security was launched.[154] In addition, in 2009 a Plan of Action was presented at the World Oceans Conference. The leaders of Indonesia, Malaysia, the Philippines, Papua New Guinea, Timor Leste and the Solomon Islands recognized the ongoing degradation of the unique biodiversity of the region, the importance of this biodiversity for the livelihood and food security of their people, and the need for sustainability as a guiding principle. The Plan of Action announced the designation and effective management of 'priority seascapes', applying an ecosystem approach in the management of fisheries and other marine resources, establishing networks of marine protected areas, implementing measures to strengthen resilience and adaptation to climate change, and strengthening measures to protect threatened marine species. Within the broad framework of the Plan of Action, the six countries are now developing national strategies and action plans. In 2009, the six leaders of the Coral Triangle countries formally signed an agreement to enhance cooperation in relation to rescuing the coral reefs in the area.[155] A secretariat has been established to assist in the implementation of the initiative, which will be supported financially and otherwise by about 15 other countries. In the agreement, the six countries explicitly state that the initiative involves voluntary cooperation. Also, further steps regarding action to achieve targets, coordination, monitoring and evaluation have been announced. Implementation of the initiative must also respect sovereignty and national integrity, giving the main role to the national governments concerned, although in the agreement the countries expressed the need for transboundary management and multi-stakeholder participation.[156] The six countries have already agreed to set up a mechanism to combat coral bleaching and establish a Coral Bleaching Alert Network supported by satellite surveillance by the US.

Thus, governmental frameworks at the national level are of crucial importance for appropriate implementation. Here we only consider the situation in Indonesia, the most important country. Unfortunately, Indonesia is not well known for the quality of its legislative framework.[157] In fact, it has been argued that the complicated and inappropriate legal framework in Indonesia has contributed to the serious degradation of coastal and marine resources. Some major problems are the lack of a national marine policy, the many levels of government, severe weaknesses in law enforcement with respect to natural resources, including the control of fisheries, the lack of involvement of stakeholders and a general lack of commitment to the sustainable management and development of natural resources.[158] Fundamental terms such as 'conservation', 'marine

[154] (www.usaid.gov).
[155] (www.woc2009.org; www.cti-secretariat.net)
[156] (www.cti-secretariat.net).
[157] Arnscheidt, 2009; Dirhamsyah, 2006.
[158] Dirhamsyah, D. 2006, Indonesian legislative framework for coastal resources management: A critical review and recommendation, Ocean & Coastal Management, 49 (1-2), 68-92.

protected area' and 'marine species' are interpreted differently by politicians and bureaucrats, while the interpretation of legal rules and jurisdiction may also be in conflict.

The important parties in the Coral Triangle are the six countries in the region, as well as NGOs, industry and fishers who are the main stakeholders, and local authorities. External parties also play an important role, including the Asian Development Bank, the Global Environment Facility, which is a funding organization, the governments of Australia and the United States, scientists and three international NGOs – Conservation International, The Nature Conservancy and WWF.

6.3.3 Possible solutions

The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security possibly constitutes a major step towards improving biodiversity protection. Nevertheless the governmental framework is in a state of infancy and critics consider that it is far from certain that it will be successful.[159] Many relevant elements necessary for good governance are yet to be elaborated, such as the establishment of clear goals at all relevant governmental levels, the inclusion of scientific advice, stakeholder participation, and evaluation mechanisms.

A main challenge will be to develop the political will among the key players and the sharing of authority between the six countries and other parties. At the same time improvements with respect to legislation on threatened species and MPAs are needed. However, this is definitely not enough, with environmental policy also required, along with additional policy concerning, for example, forestry and fresh water.[160] The scientific sector should also be involved to establish an integrated ecosystem approach, including adaptive management, assessment and biological monitoring. Improvement in cooperation between local governments, NGOs and market parties is crucial to creating a governmental process that includes the sharing of priorities, management and evaluation.[161] The strengthening of local coastal governance capacity should improve proactive responses micro and macro development of interactive synergy and in this way help reduce the impact of development on reefs.[162] Closer cooperation between NGOs and governmental organizations may lead to government-led planning processes, rather than the present NGO-facilitated processes, ensuring the coordination of sustainable development of the marine conservation areas.[163] One successful way to involve the private sector is Marine Stewardship Council (MSC) labelling, which takes into account the views of the World Trade Organization (WTO).[164] Studies on stakeholder

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159 (www.panda.org/coraltriangle).

160 Richmond, R.H. et al, 2007, Watersheds and coral reefs: conservation science, policy , and implementation, BioScience 57 (7), 598-607.

161 Mascia, 2003; Sale, 2008.

162 Cruz-Trinidad, A., 'Geronimo, R.C. and P.M. Aliño, 2009, Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines, Ocean & Coastal Management, 52 (3-4), 173-180.

163 Miclat, E.F.B., Ingles, J.A. and J.N.B. Dumaup, 2006, Planning across boundaries for the conservation of the Sulu-Sulawesi Marine Ecoregion, Ocean & Coastal Management, 49 (9-10), 597-609.

164 Leadbitter, D. Gomez, G. & F. McGilvray, 2006, Sustainable fisheries and the East Asian seas: Can the private sector play a role? Ocean & Coastal Management, 49 (9-10), 662-675.

participation in integrated coastal management projects at the local level in the Philippines and Indonesia reveal that their involvement depends on a number of factors. These include the acceptance of project activities, the levels of participation in project design and implementation, compliance with regulations, the level of economic benefit received and how equitably the economic benefits are distributed within the community. Clearly, if locals believe that these kinds of projects do not address local concerns or have no positive impact on their wellbeing, they are unlikely to support or become involved in project activities.[165]

In addition, some specific improvements can be formulated. As fishing is one of the major direct causes of biodiversity loss, the key challenge is to find solutions in this regard. Better policymaking and control with respect to fishing may be important, but implementation will be difficult. Improving fishing techniques and creating recovery areas or marine protected areas may be the most promising measures. The establishment of agreements between fishers, NGOs and governments should be considered as a means of giving the former a greater role in the decision-making process.

Offshore activities related to exploitation of the Coral Triangle will probably be difficult to regulate. Special agreements at the regional level could be helpful if there is enough international pressure and financial support. However, many threats to marine biodiversity in this area are related to activities on the mainland. Thus, a viable marine strategy must incorporate a mainland strategy that includes the regulation of forestry, agriculture and industrial activities.

With respect to underlying causes, we have mentioned political and institutional factors. Science and technology can help to improve ecological standards, to determine the marine protected areas and to stimulate innovations in fishing and other offshore activities. However, both factors are strongly interconnected with social and economic factors. The combination of densely populated areas, poverty, economic growth goals, the free market and the relative autonomy of operating companies makes it difficult to achieve sustainable goals. It may be helpful to stabilize population levels in these countries, but this will only work if social welfare improves. Better regulation of international companies should be considered, but without international agreements this will be a mission impossible. Another challenge is to realize alternative employment opportunities. Studies from the Philippines reveal that retraining fishers in tourism-based and other low-capital mariculture is more realistic than absorbing them into current aquaculture businesses.[166]

6.4 Case study 2c: the Arctic Ocean

The Arctic Ocean has a surface area of 14 million km^2. It is a small ocean bounded by the Pacific and Atlantic oceans and five countries: two European countries (Denmark and

[165] Pollnac, R.B. & R.S. Pomeroy, 2005, Factors influencing the sustainability of integrated coastal management projects in the Philippines and Indonesia, Ocean & Coastal Management, 48 (3-6), 233-251.

[166] Cruz-Trinidad, A., Geronimo, R.C. and P.M. Aliño, 2009, Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines, Ocean & Coastal Management, 52 (3-4), 173-180.

Norway), the US, Canada and Russia. Habitats are unique due to a specific temperature and seasonal regime and include low productive waters, tundra and above all ice. Parts of the area are used by humans for fishing, the exploitation of oil and gas and military purposes. There are some areas with a unique biodiversity, which includes the impressive polar bear.

6.4.1 Direct causes of decrease of biodiversity

Fisheries

The Arctic Ocean has a history of relatively small-scale fishing. However, in the final decades of the twentieth century, reports revealed that increasing proportions of fish stocks were being exploited beyond maximum sustainable yield levels in the northern parts of the Atlantic and Pacific oceans close to the Arctic.[167] Due to climate change, the intensity and range of commercial fishing may increase in areas previously protected from fishing by ice cover.[168]

Shipping

At present there are no international main maritime traffic routes through the Arctic Ocean, but this could change if the icecap disappears. An increase in shipping traffic could lead to the disturbance of wildlife, including whale species, and to oil pollution.[169]

Offshore industry and exploitation of minerals and energy

Several oil and gas companies from Russia, Canada and the US are exploring northern offshore regions.[170] Russia is presently developing plans for the exploitation of a huge gas field in the northern Barents Sea. In the US, the Bush administration attempted to begin exploration for oil and gas in the Alaska Arctic National Wildlife Refuge. Finally, Canada has expressed interest in gas and oil exploration in the Arctic region. Accidents with oil tankers or pipelines may have a devastating and lasting impact on the Arctic wildlife and environment.

Water polluting main land activities

Some small cities can be found along the Arctic coasts, actually and potentially causing pollution of several kinds. The harbour at Murmansk in particular produces large quantities of radioactive waste due to the dumping of nuclear material from ships.[171]

Human activities with regard to changes in the atmosphere

Obviously, climate change poses a major threat to the Arctic Ocean because it will dramatically affect its specific characteristics (Figure 6.3 and Figure 6.4), in turn affecting

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[167] Nowlan, L, 2001, Arctic Legal Regime for environmental Protection, IUCN, Gland.

[168] Huebert, R. & B.B.Yeager, 2008, A new Sea, the need for a regional agreement on management and conservation of the arctic marine environment, WWF, Oslo.

[169] Ibid.

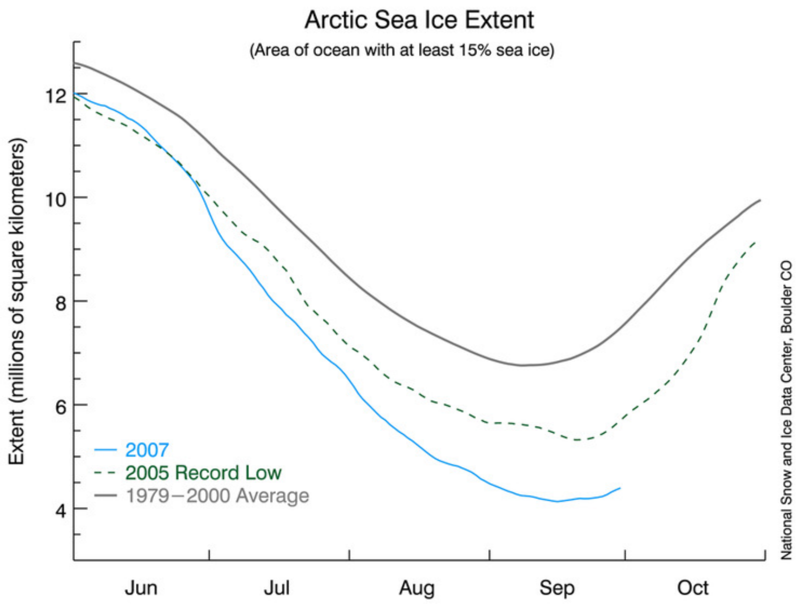
[170] Ibid.

[171] Ibid.

its fauna.[172] In addition, changes in the ozone layer are also likely to affect ecological conditions in the Arctic Ocean.

Figure 6.3 shows that the Arctic Sea ice extent in 2007 is far below the previous record year of 2005 (shown as a dashed line). September 2007 was 36% below where we would expect to be in an average year, shown in solid gray

Figure 6.3 Arctic Sea ice extent (2007)

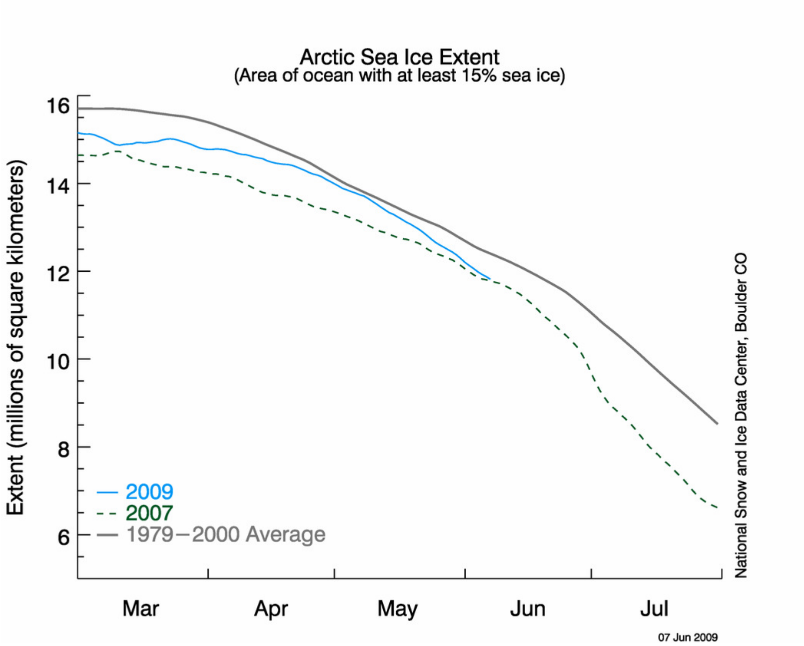


Source: National Snow and Ice Data Centre, www.nsidc.org

The following figure shows the Arctic Sea ice extent in 2009 compared to previous years.

[172] Huebert, R. & B.B.Yeager, 2008, A new Sea, the need for a regional agreement on management and conservation of the arctic marine environment, WWF, Oslo.

Figure 6.4 Arctic Sea ice extent (2009)



Source: National Snow and Ice Data Centre, www.nsidc.org

Tourism

Although relatively few tourists visit the Arctic region, the tourist industry is growing. At the moment more than one million tourists visit the Arctic annually.[173] This will probably increase as the icecap melts.[174]

Introduction of new species

No reports are available on the introduction of new species into the Arctic region. Nevertheless, there are indications that some species migrate north from subarctic regions.[175]

6.4.2 Underlying causes

Social factors

Population density is very low. Nevertheless, different approaches and interests can be found among the inhabitants. For example, the Inuit have a different attitude towards nature than inhabitants of industrialized countries.

Economic factors

Several Arctic countries are among the most powerful countries in the world and have a very high level of industrial production. Nuclear radiation in particular affects the Arctic region. The role of the Russian Arctic coastal zone in Russia's national economy has been stimulated by the active use of the Northern Sea Route for 60 years as a mainstream

[173] Nowlan, L, 2001, Arctic Legal Regime for environmental Protection, IUCN, Gland.

[174] Huebert, R. & B.B.Yeager, 2008, A new Sea, the need for a regional agreement on management and conservation of the arctic marine environment, WWF, Oslo.

[175] Ibid.

Arctic transport line. It can be expected that in future its role as a transport link may intensify because of the need for energy, not only in Russia but also the US and other Arctic countries. The Arctic region may also contain some of the world's largest oil reserves. The combination of energy needs and the estimated quantities of oil in the Arctic region will make it tempting to exploit the Arctic Ocean. Apart from Russia, all of the Arctic countries have adopted the free market ideal. Regulation of production for reasons of environmental protection may interfere with free trade and must be negotiated in each case.

Political and institutional factors

All of the Arctic countries other than Russia can be regarded as stable Western democracies with elected parliaments. In addition, stakeholders, including market parties and environmental NGOs, are involved in and influence political decision-making, while NGOs also demand better regulation and protection. Most Arctic countries have a tradition of economic and political cooperation, but the Cold War placed Russia in a unique position. In periods of financial or energy crisis, all of the Arctic countries tend to consider the exploitation of the Arctic region and the safeguarding of national sovereignty. Most countries respect international legislation in relation to environmental and biodiversity protection. However, implementation of international legislation may differ from country to country. Furthermore, the Arctic Ocean does not belong to the national territories concerned, and for this reason is difficult to manage. Responsibilities are not clearly assigned and in most cases sources of pollution and disturbance are not situated in the Arctic itself but outside the region.

Control in the sea area itself is poorly organized, although it is improving, for example, with respect to oil exploitation. Nevertheless, due to the major economic and political interests involved, the exploitation of gas and oil is not regulated optimally. With respect to the dumping of nuclear military material, regulation is also poor.

Scientific and technological factors

The levels of science and technology are high in all of the Arctic countries. This influences innovative power, which may potentially lead to new environmental dangers. Well-known examples are radioactive waste and new chemicals as well as new fishing and oil and gas extraction techniques. Although ecological and environmental sciences and sustainable technology have rapidly developed over the last decades, very limited ecological standards and environmentally friendly production modes have been applied. NGOs and industries are well informed about scientific aspects of management.

Governmental framework and stakeholders

International cooperative initiatives and agreements with respect to the Arctic Ocean include the Arctic Environmental Protection Strategy (AEPS), the Arctic Council and its guidelines for environmental protection, and the Arctic Ocean conference.[176]

In 1991 the Arctic Environmental Protection Strategy (AEPS) was created by eight Arctic countries. It was to provide a forum for discussion and cooperation for the Arctic states

[176] Nowlan, 2001; Huebert & Yeager, 2008; www.arctic-council.org.

and to provide a means of identifying different environmental problems faced by these countries in their respective northern territories. Several northern indigenous organizations were invited to join the AEPS, including the Inuit Circumpolar Conference, the Saami Council and the Russian Association of Indigenous Peoples of the North. This was the first time that representatives of indigenous Arctic communities had been given such a standing in an international body. Several working groups were established, such as the working groups for Monitoring and Assessment, the protection of the Arctic Marine Environment, the Conservation of Arctic Flora and Fauna (CAFF) and Sustainable Development. Due to the limited remedies offered by the AEPS, the Arctic Council was founded in 1996. In practice, the situation did not really change. For example, the Council did not have its own source of funding and, as with the AEPS, depended on resources volunteered by its member states.

Worth noting is the release of a study in 2004 which assessed the impact of climate change in the Arctic in partnership with the International Arctic Science Committee. This Arctic Climate Impact Assessment (ACIA) represents the most comprehensive study of its kind. Furthermore, several action plans and guidelines were launched, including offshore oil development guidelines and the protection of the Arctic marine environment from land-based activities and ship-generated waste. The guidelines with respect to oil spills provide each member state with information on how to respond to a spill, but it is left to each of the individual states to actually respond.

Overall, the AEPS and the Arctic Council are seen as important steps in the development of international cooperation in the Arctic. The Council has been reasonably effective in mobilizing interest and expertise and taking action to address pollution issues, but less effective in species and habitat protection. The Council has a limited mandate to deal with Arctic-wide maritime environmental issues.

At the Arctic Ocean Conference in 2008, the five Arctic boundary countries, Canada, Denmark, Norway, Russia and the United States, discussed plans – for the first time at the ministerial level – for environmental regulation, maritime security, mineral exploration, the overseeing of polar oil exploitation, and transportation in the Arctic Ocean[177]. One of the reasons the discussion was at this level was the possibility of extending territorial claims according to the United Nations Convention on the Law of the Sea. Another reason was the possible consequences of climate change for shipping and exploitation in the Arctic region. This conference excluded some members of the Arctic Council – indigenous peoples, Finland, Iceland and Sweden, which caused controversy. Despite the intentions of these international initiatives, implementation remains a problem. For example, Russia, the largest Arctic country, has serious problems with priority-setting, legislation and cooperation between governmental levels, as well as poor control and implementation.[178]

The main parties in this region are those participating in the Arctic Council, that is, the five countries bordering the Arctic Ocean, as well as Finland, Sweden and Iceland and the indigenous peoples of the region. The important stakeholders are large oil companies,

[177] (www. arctic-council.org)
[178] Andreeva, 1998; www.cbd.int/doc/world/ru.

fishing companies and tourist organizations, each of them actively exploring the area, as well as large nature conservation organizations promoting protection.

6.4.3 Possible solutions

Thus far, several necessary steps have been taken to protect Arctic biodiversity, such as the establishment of the AEPS and the Arctic Council. The governmental framework is well considered and includes some relevant elements necessary for good governance, such as clear goals, a scientific foundation, the involvement of local communities, process orientation, policy instruments and evaluation mechanisms. However, there are some major problems. Firstly, the framework is relatively young and can be considered a set of 'soft law' agreements.[179] Secondly, the main challenges regarding biodiversity conservation in the Arctic Ocean concern potential problems rather than actual. The development of an adaptive strategy to deal with these problems is crucial. Critics are concerned that the existing framework of the AEPS and the Arctic Council is not sufficiently robust to deal effectively with the impact of climate change or with the likely near-term expansion of fishing and industrial activity along with other human impact factors.[180] A stronger framework for cooperative management will most likely be needed. Although the present voluntary cooperative effort has brought successes with respect to understanding the problem, as well as scientific dialogue and management guidelines, this is not likely to provide a satisfactory basis for effective management in the future. The challenge is to find a new model of cooperation that respects security concerns and the issue of national sovereignty. A comprehensive approach to the management of the Arctic will ultimately require a regional treaty in one form or another, based on an ecosystem approach.[181] Adaptive management is the keyword, adapting to new threats and accompanied by a growing willingness to share responsibilities among the Arctic countries. A first step could be to formulate several environmental aims and principles, such as the 'precautionary principle' and the 'polluter pays' principle. At the same time, some political, economic and social principles are needed, such as benefit sharing, procedures to resolve disputes and co-management. In fact some of these principles are already being considered. The inclusion of indigenous organizations and their knowledge in decision-making and management is seen as crucial. A second step may include specific management arrangements for fisheries, the fishing industry, oil and gas extraction and wildlife protection, including monitoring programmes and feedback mechanisms.

With respect to underlying causes, thus far we have only mentioned political and institutional factors. Science and technology can help to improve ecological standards and to stimulate innovations in offshore activities. All of the Arctic countries are hungry for energy and most likely willing to allow oil companies to explore the bottom of the Arctic Ocean. This makes it difficult to achieve sustainability goals. Better regulation of international companies should be considered within a framework of shared interests.

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[179] Huebert, R. & B.B.Yeager, 2008, A new Sea, the need for a regional agreement on management and conservation of the arctic marine environment, WWF, Oslo.

[180] Ibid.

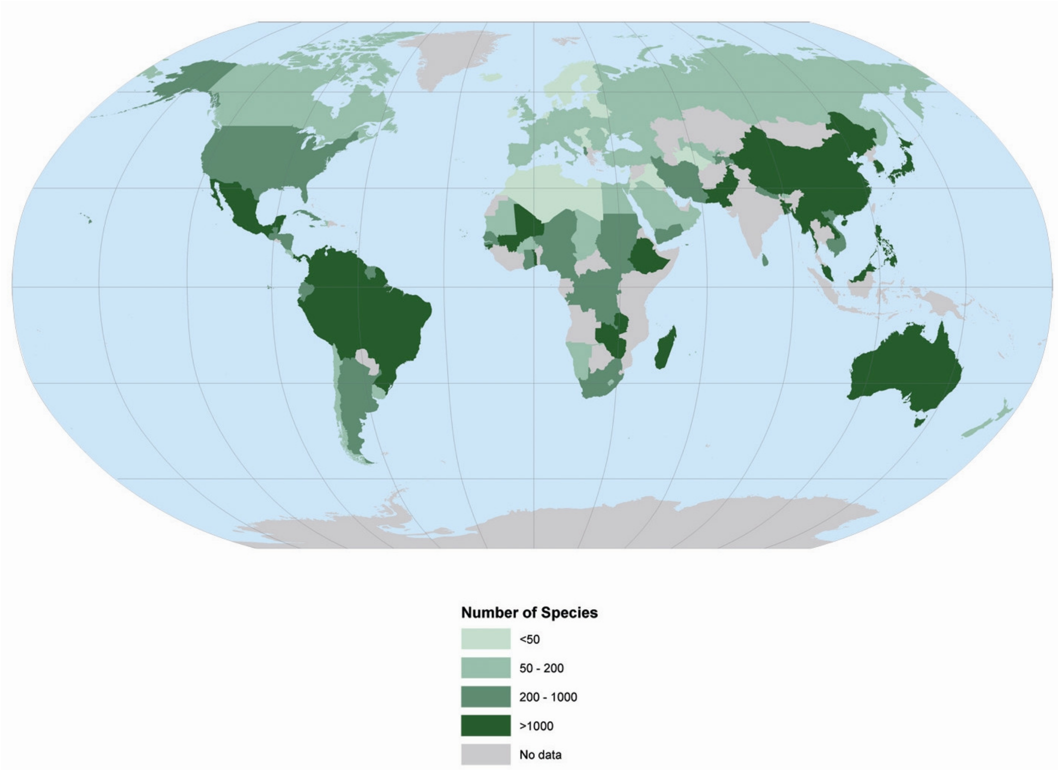
[181] Ibid.

7 Annex 3: Case studies on forest ecosystems and biodiversity loss

This annex provides further insights into forest ecosystems and biodiversity loss. Three in-depth case studies are assessed: the Congo Basin, the Amazon and Tanzanian forest ecosystems. Each case study highlights a different aspect of biodiversity and the policy assessment framework. While the Congo Basin case demonstrates the importance of simultaneous improvements in various institutional factors in order to really impact biodiversity conservation, the Amazon case focuses on highlighting the globalised world of today and how not only national factors but also international factors impact local biodiversity loss. Finally, the Tanzanian case pays close attention to showcasing successful forest management efforts and the importance of engaging local communities as well as an enabling policy environment for enabling such success.

Forests contain the greatest assemblage of species found in any terrestrial ecosystem. Forest biological diversity can be defined to cover all the life forms found within forested areas and the ecological roles they perform. Therefore, forest biological diversity encompasses not just trees, but a multitude of plants, animals and micro-organisms that inhabit forest areas.

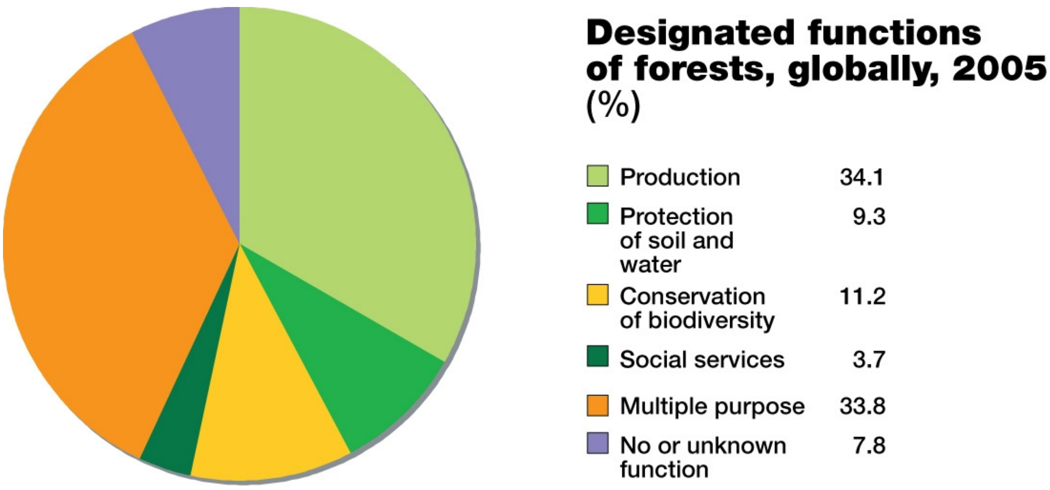
Figure 7.1 Number of native tree species per country



Source: FAO (2005), Global Forest Resources Assessment 2005.

Additionally, forest biodiversity is closely linked to a web of other socio-economic factors because forests provide an array of goods and services that range from timber and non-timber forest resources to other forest functions, such as recreation, health, and the mitigation of climate change. Furthermore, forests provide livelihoods for people around the globe and thus play important economic, social, and cultural roles in the lives of indigenous peoples. Thus, forests and their biological diversity are intricately linked to larger ecosystem and human well-being.

Figure 7.2 Designated forest functions, globally, 2005 (%)



Source: FAO (2005), Global Forest Resources Assessment 2005.

Trends in forest biodiversity

Over the course of the last 8000 years about 45% of the world's original forest cover has disappeared, most of which was deforested during the past century. The Food and Agriculture Organization of the United Nations (FAO) recently estimated that about 13 million hectares of the world's forests are lost due to deforestation each year. The annual net loss of forest area between 2000 and 2005 was 7.3 million hectares (equivalent to the net loss of 0.18 percent of the world's forests).

It is important to differentiate this overall forest loss between regions and countries. The table below presents the ten countries with the largest annual net negative change rate and the largest net loss in forest area for the period from 2000 to 2005.[182]

Table 7.1 Highest deforestation rate and highest annual area change per country globally

Deforestation rate 2000-2005		Annual loss 2000-2005	
Country	Annual change rate in % (in 1000 ha/year)	Country	Annual change in 1000 ha/year (in % negative change)
Comoros	-7,4 *(-1)*	Brazil	-3.103 (*-0,6%)*
Burundi	-5,2 *(-9)*	Indonesia	-1.871 *(-2,0)*
Togo	-4,5 *(-20)*	Sudan	-589 *(-0,8%)*
Mauritania	-3,4 *(-10)*	Myanmar	-466 *(-1,4%)*
Nigeria	-3,3 *(-410)*	Zambia	-445 *(-1,0%)*
Afghanistan	-3,1 *(-30)*	Tanzania	-412 *(-1,1%)*
Honduras	-3,1 *(-156)*	Nigeria	-410 *(-3,3%)*
Benin	-2,5 *(-65)*	DR Congo	-319 *(-0,2)*
Uganda	-2,2 *(-86)*	Zimbabwe	-313 *(-1,7)*
Phillipines	-2,1 *(-157)*	Venezuela	-288 *(-0,6)*
World	-0,18 *(-7.317)*	World	-7.317 *(-0,18%)*

Source: FAO 2006.

The following regional close-ups highlight the extreme level of forest loss in Latin America and the Congo Basin.

Latin America – accounted for the largest loss of forest losing 4.3 million hectares per annum and an average annual negative change rate of approx. -0,50% from 2000-2005. The table below presents the five Latin American countries with the largest annual net negative change rate and the largest net loss in forest area for the period from 2000 to 2005.

[182] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38. Rome (also available at www.fao.org/forestry/site/10368/en).

Table 7.2 Highest deforestation rate and highest annual area change per country for Latin America

Deforestation rate 2000-2005		Annual nett loss 2000-2005	
Country	Annual negative change rate in % (in 1000 ha/year)	Country	Annual change in 1000 ha/year (in % net negative change)
Honduras	-3,0 *(-156)*	Brazil	-3 103 *(-0,6%)*
El Salvador	-1,7 *(-5)*	Venezuela	-288 *(-0,6%)*
Ecuador	-1,7 *(-198)*	Bolivia	-270 *(-0,5%)*
Guatemala	-1,3 *(-54)*	Mexico	-260 *(-0,4%)*
Nicaragua	-1,3 *(-70)*	Ecuador	-198 *(-1,7%)*

Source: FAO 2006.

Brazil, where 60 percent of Amazon rainforests are located, accounted by far for the largest annual net loses, followed by Venezuela, Bolivia, Mexico and Ecuador. Regions with high annual net negative change deforestation rates in between the years 2000 and 2005 include Honduras, El Salvador, Ecuador, Guatemala and Nicaragua. For comparative reasons Brazil only faced an annual net negative deforestation rate of -0,6%.

Africa – accounted for a net loss of 4.0 million hectares per year and an average annual negative change rate of -0,62% in the mentioned period of time. The table below presents the five African countries with the largest annual net negative change rate and the largest net loss in forest area for the period from 2000 to 2005.

Table 7.3 Highest deforestation rate and highest annual area change per country for Africa

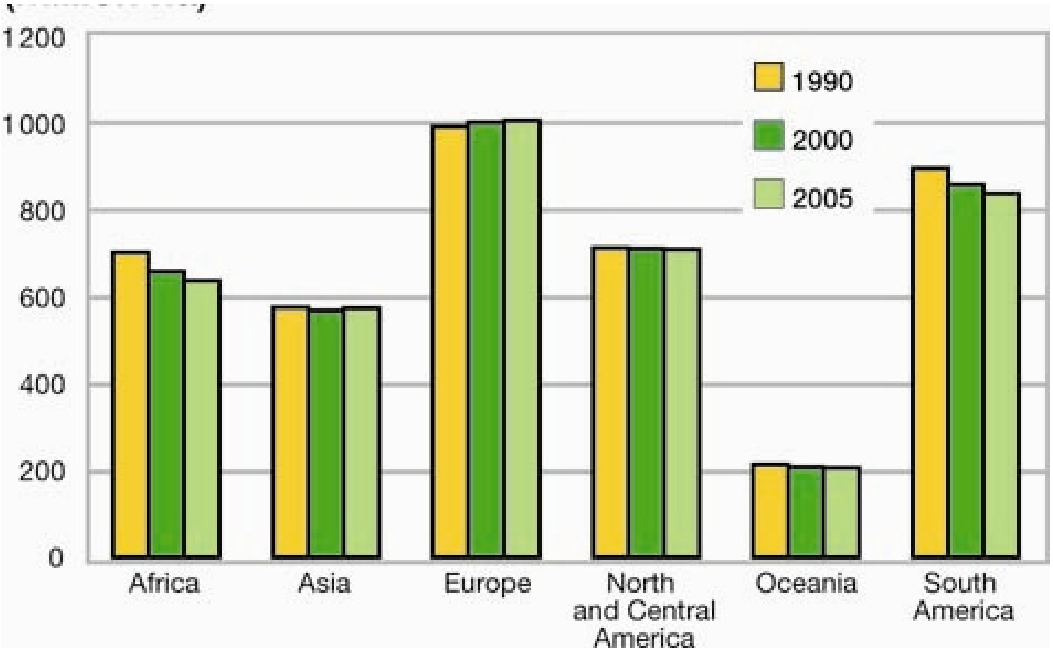
Deforestation rate 2000-2005		Annual net loss 2000-2005	
Country	Annual change rate in % (in 1000 ha/year)	Country	Annual change in 1 000 ha/year (in % negative change)
Burundi	-5,2 *(-9)*	Sudan	-589 *(-0,8%)*
Togo	-4,5 *(-20)*	Zambia	-445 *(-1,0%)*
Mauritania	-3,4 *(-10)*	Tanzania	-412 *(-1,1%)*
Nigeria	-3,3 *(-410*	Nigeria	-410 *(-3,3%)*
Benin	-2,5 *(-65)*	DR Congo	-319 *(-0,2)*

Source: FAO 2006.

Africa suffered the second largest net loss in forests per annum with Burundi having the second largest deforestation rate in the world, followed by Togo and Mauritania. As far as annual net loss is concerned, hotspots include Sudan, Zambia, Tanzania, Nigeria and DR Congo.

These forest area trends can also be seen in the following figure.

Figure 7.3 Trends in forest area by region, 1990-2005 (million hectares)



Source: UNEP-GRID

Deforestation – biodiversity loss linkage

In general, extinction rates over the past few centuries have undoubtedly been far higher than predicted based on historic trends. Analysis of the available historic data has shown that the most important reason for population extinctions, especially on small spatial scales, is habitat destruction. Actual extinctions of known forest species to date are very hard to document. Many forests are surveyed only rarely, and baseline data are lacking. Yet, there is widespread evidence of extinctions of distinct populations of species. In several parts of Europe, for example, fungal species diversity in forests has dropped by 50% or more over the past 60 years.[183] Ecologists believe that the fastest rates of extinction in the world, however, are occurring in the tropical forests, where deforestation rates and genetic and species diversity are highest. Most species in these regions remain undocumented, and therefore actual rates of extinction are believed to be highly conservative.

The following highlights summarise the state of biodiversity loss related to forest decline:

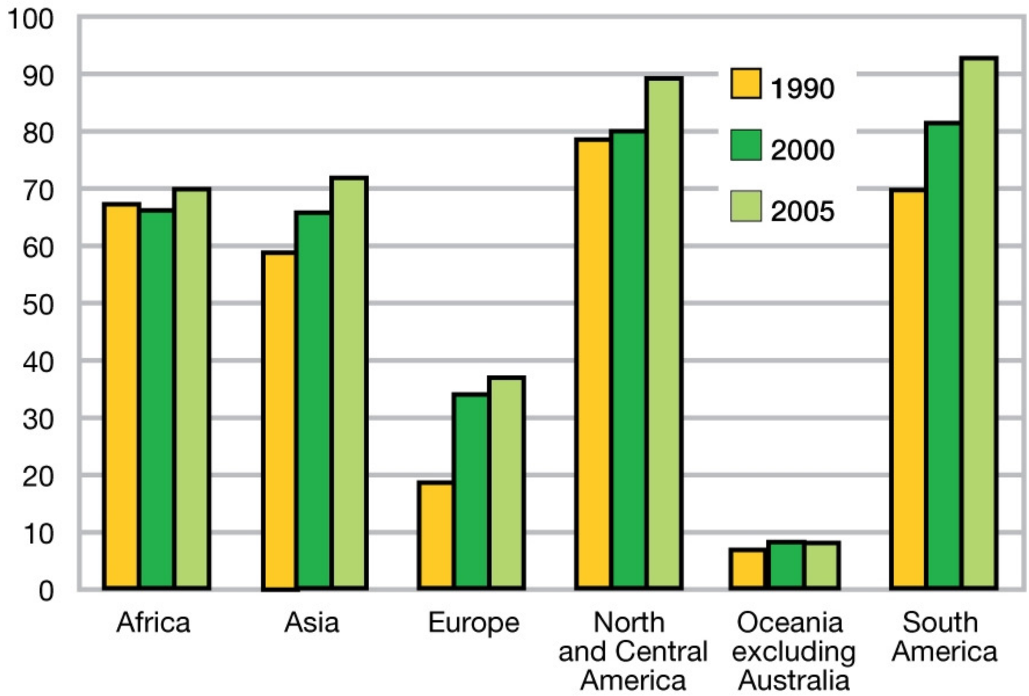
- Nearly 9 percent of trees globally are now at some risk of extinction. The leading threat is logging, followed by conversion to agriculture and expansion of human settlements.
- 11% of the world's forests are designated for the conservation of biological diversity. For the Forest Resources Assessment 2005, countries reported on the area of forest where conservation was designated as the primary function. This area has increased by an estimated 96 million hectares since 1990 and now accounts for 11 percent of the total forest area. These forests are mainly, but not exclusively, located inside protected areas. Conservation of biological

[183] WRI. November, 2000 . Pilot analysis of global ecosystems: Forest ecosystems. World Resources Institute.

diversity was reported as one of the management objectives for more than 25 percent of the total forest area.

- And only less than 8 percent of global forest area is legally protected. Legal safeguards appear ineffective against logging, poaching, and other forms of development in many countries.

Figure 7.4 Forests designated for conservation, 1990-2005 (million hectares)



Source: UNEP-GRID.

- Forests near human settlement or transportation routes have high concentrations of non-native species, which have been introduced deliberately or accidentally. Most are benign, but some invasive plants and insect pests have done extensive damage to both production and amenity forests.
- More than 300 million hectares of forests are designated for soil and water conservation. Protective functions of forests range from soil and water conservation and avalanche control to sand-dune stabilization, desertification control and coastal protection. As reported to the Forest Resources Assessment 2005, an estimated 348 million hectares of forests have a protective function as their primary objective. Eighteen countries reported that all their forests are designated for protective purposes, as either a primary or secondary function. The overall proportion of forest designated for protective functions has increased, from 8 percent in 1990 to 9 percent in 2005.
- Moderate estimates of future species extinction rates in tropical forests range from 1 to 5 percent per decade. However, such estimates have high and largely unknown levels of uncertainty, because of both the uncertainty of the underlying data and the assumptions on which they are based.

- Nearly three quarters of the world's threatened bird species have restricted breeding ranges and remain confined to relatively small areas. Endemic bird areas (EBAs) encompass the range of the majority of these birds and more than 80 percent of EBAs are found in forests.
- Centres of plant diversity have been identified as conservation priority areas, rich in plant diversity or endemism. Nearly three quarters of the centers are found in forests.

Causes of forest decline

The mechanisms causing deforestation, forest fragmentation and degradation are varied and can be direct or indirect. The most important factors associated with the decline of forest biological diversity, however, are of human origin: the conversion of forests to agricultural land, overgrazing, unmitigated shifting cultivation, unsustainable forest management, introduction of invasive alien species, infrastructure development (e.g. roads, urban sprawl, etc.), natural resource exploitation (e.g. mining), forest fires, pollution and climate change all have negative impacts on forest biodiversity. This degradation of forests is directly linked with the associated loss of biodiversity.

7.1 Case study 3a: the Congo Basin

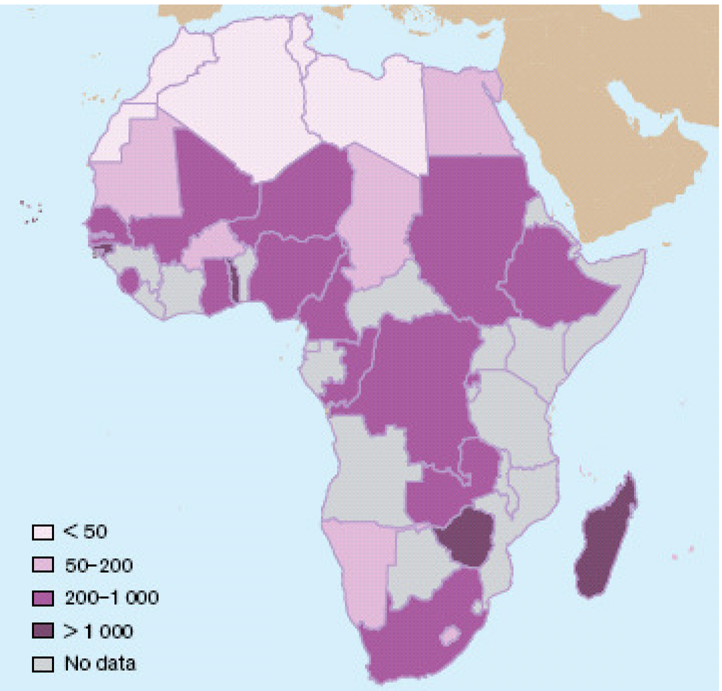
Africa's 635 million hectares of forests account for 21.4 percent of its land area, equal to 16 percent of the global forest area. In total, some 23 million hectares disappeared in the 1980s while another 20 million fell in the 1990s. FAO states that the current deforestation rate lies about 0.4 to 0.7 percent each year and is likely to continue at this rate. Many uncertainties exist regarding these estimations and figures could easily be understated. Overall, progress towards sustainable forest management in Africa appears to have been limited during the last fifteen years. Yet, there are some indications that net loss of forest area has slowed down and that area of forest designated for conservation of biological diversity has increased slightly. However, it is a fact that the permanent, rapid loss of forest area occurring in Africa is representing the highest percentage of any region during the 1980s, 1990s and early 2000s.[184]

Forest composition, the number of native forest species and the existence (or absence) of threatened and endangered species are other indicators of biodiversity. However, with only 16 countries reporting on these variables, a clear indication of the state of biodiversity is not available.

Forest composition and the preponderance of species differ widely within Africa. As would be expected, the tropical moist forests in the Congo Basin have high diversity, with native forest tree species varying from 12 to 5 000 in the reporting countries (Figure 7.5).

[184] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38. Rome (also available at www.fao.org/forestry/site/10368/en).

Figure 7.5 Number of native tree species in Africa



Source: FAO, State of the World's Forests 2007.

On average, each African country lists about 7 percent of its native tree species as critically endangered, endangered or vulnerable (*IUCN Red List of Threatened Species)*.

7.1.1 Direct causes of deforestation

The proximate causes of deforestation in Africa reflect the global pattern in order of importance with agricultural expansion as the main driver for deforestation with direct conversion of forest area to *small-scale permanent agriculture* accounting for approximately 60% of the total deforestation and direct conversion of forest area to *large-scale permanent agriculture* accounting for another 10%.[185] However, also wood extraction and infrastructure play a significant role in deforestation in Africa.[186]

The main proximate drivers of deforestation in Africa (ranked based on relative importance) are:

1. Small-scale permanent agriculture
2. Large-scale permanent agriculture
3. Fuel wood consumption
4. Commercial logging and timber production
5. Infrastructure

[185] FAO. State of the World's Forests 2009.

[186] GEIST H. and LAMBIN E.F., 2002. Proximate causes and underlying driving forces of tropical deforestation. Bioscience, Vol. 52, Nr.2, pp.143-150.

Small-scale agriculture

Small-scale agriculture is vital for livelihoods in Africa accounting for 70 percent of rural employment in 2005. The performance and productivity of African agriculture (both the subsistence sector and the commercial sector) calculated per capita has been categorised as very low in comparison with other regions and is even declining further. This decline in productivity and subsequent decline in income has increased dependence on off-farm employment, including collection of fuel wood and production of charcoal.[187] Studies point out that Africa is the only region in the world where the regional average of food production per person has been declining over the past 40 years, enhancing the demand for new agricultural land.[188]

Large-scale permanent agriculture

Deforestation for large-scale permanent agriculture is, unlike small-scale agriculture, often practised using slash-and-burn techniques. Thousands of hectares of land have been deforested this way. The converted land supports agricultural growth and delivers large harvest for 3-4 years, but then excessive use of fertilisers is necessary to yield a minimum harvest and additional land is needed for agricultural purposes. The extension of permanently cropped land in Africa is mainly aimed at subsistence farming to meet the needs of a growing (Some of the sentence is missing).[189]

Maize, millet, rice, sorghum, wheat, barley, beans, root and tuber crops are among the major crops cultivated in Africa, though representing variations in the different regions[190]. As an example, more than 4 million hectares of beans are produced every year in Africa, mainly in the highlands of East and Central African countries and in DR Congo, Ethiopia, and several countries of Southern Africa[191]. Another example is the root and tuber crops, where the African countries contribute with about 23% of the global production (primary crops), the main ones being[192]: Cassava (53% of the world production), Yams (96% of the world production); Sweet potatoes (7% of the world production); Potatoes (4% of the world production); Other root crops (70% of the world production).

During recent years, global interest in biofuels as a result of rising fossil fuel prices has increased the extension of land for biofuel production on the African continent, for example through the planting of *Jatropha* species. Biofuel production is thereby representing an emerging driver for deforestation in Africa. Uncertainties exist regarding if investments in biofuel development will provide long-term impacts for food security and a long-term solution to Africa's energy problems.[193]

[187] FAO. State of the World's Forests 2009.

[188] FAO.

[189] GEIST H. and LAMBIN E.F., 2002. Proximate causes and underlying driving forces of tropical deforestation. Bioscience, Vol. 52, Nr.2, pp.143-150.

[190] FAO 18th July 2008, Crop prospects and food situation for 2008 / 2009, http://appablog.wordpress.com/2008/07/18/fao-africa-crop-prospects-and-food-situation-for-2008-2009/

[191] Background information on Common Beans by Robin Buruchara, CIAT, Uganda, retrieved by http://www.africancrops.net/rockefeller/crops/beans/index.htm on the 28th May 2009

[192] Importance of root crops in Africa by Mr. François Ngopya, FAO Statistician/SAFR, retrieved the 28th May from http://www.fao.org/docrep/005/Y9422E/y9422e03.htm

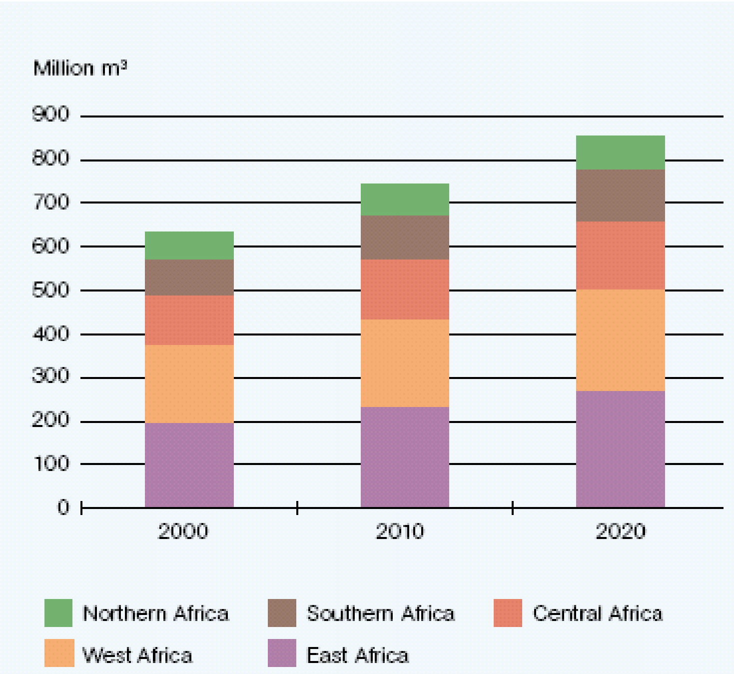
[193] FAO. State of the World's Forests 2009.

Fuel wood consumption

Wood extraction for domestic fuel wood or charcoal production remains a major issue in Africa, because most Africans use still wood and charcoal for cooking, since there are no other affordable energy sources available. Only 7.5 % of the rural population has electricity.[194] Africa has shown a steady increase in wood removals in recent years, reporting a rise from 499 million m^3 yearly (1990) to 661 million m^3 (2005). It is estimated that the majority of the removed wood is used as fuel wood, but since most of the fuel wood collection activities are not usually recorded, the actual quantity of wood removals might be understated.[195]

As seen from Figure 7.6 below, fuel wood is estimated to continue to represent an important energy source for the coming decades. Forecasts made by FAO show a 34 percent increase in fuel wood consumption from 2000 to 2020:

Figure 7.6 Woodfuel consumption in Africa



[Source: FAO, 2009]

Commercial logging and timber production

In Central Africa commercial logging has increased between 1990 and 1997 and the volume of timber exported annually from countries of the Congo basin has increased ten-fold. As a consequence of large concessions, the countries of Central Africa (Cameroon, the Democratic Republic of the Congo and Gabon) are emerging as major producers of industrial roundwood, whereas Africa produced 19 percent of global roundwood in 2006. This has been highlighted as a primary cause of deforestation in Africa's Congo basin[196] and some countries have imposed restrictions on the export of logs in order to encourage

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[194] FAO. State of the World's Forests 2009.

[195] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38. Rome (also available at www.fao.org/forestry/site/10368/en).

[196] By, among others, the Director of the World Agroforestry Centre (ICRAF) (Lobet, 2009).

domestic processing. In some cases it has resulted in investments in preliminary processing, but without results worth mentioning.[197] Table 7.4 present an overview of the African wood product output in 2006 and its share on global level. It becomes obvious that the share of woodfuel is extremely high in Africa.

Table 7.4 African wood production output (2006)

Product	Global	Africa	Share (%)
Industrial roundwood (million cubic metres)	1635	69.0	4
Sawnwood (million cubic metres)	424	8.3	2
Wood-based panels (million cubic metres)	262	2.5	1
Pulp and paper (million tonnes)	195	3.9	2
Paper and paperboard (million tonnes)	364	2.9	1
Woodfuel (million cubic metres)	1871	589.0	46

[FAO, 2008]

China plays an important role for a series of African countries, being the main destination of up to 90% of timber for some producer countries.[198]

Illegal logging

The exact amount of forests illegally cut down is subject to uncertainty due to the illegal nature of these activities. Annual losses in revenues and assets due to illegal logging on public lands worldwide are estimated to about $10 billion. In Cameroon, losses are estimated at $5.3 million; in Congo Brazzaville, it is $4.2 million; in Gabon, $10.1 million; and in Ghana, losses reach $37.5 million per year. This revenue is being lost every year due to poor regulation of timber production.[199]

Infrastructure

Commercial logging and timber production in Africa is closely connected to development of infrastructure. Logging is mostly carried out by large international companies, which normally buy or rent the land in order to harvest the timber required for infrastructure development. These companies are also responsible for creating new roads in the areas they operate in. Though transport extension was not directly aimed at promoting human settlement, road construction creates easy access for settlers, who colonise the areas around the newly implemented roads right after the logging is finished.

According to Laporte et al. (2007) industrial logging has become the most extensive land use in Central Africa, with more than 600,000 square kilometres (30%) of forest currently under concession. It is expected that industrial logging concessions will expand, with commensurate increases in the rates of logging and road building associated with foreign

[197] FAO. State of the World's Forests 2009.

[198] (IUCN, China, 29th February 2008, important to African timber producers, http://www.iucn.org/about/union/secretariat/offices/asia/asia_where_work/china/iucnch_informed/iucnch_news/?731/China-important-to-African-timber-producers)

[199] (World Bank, 2003, Combating Illegal Logging in Africa, retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:20138130~menuPK:34457~pagePK:34370~piPK:34424~theSitePK:4607,00.html, 28th May 2009)

investment.[200] In the republic of Congo the rate of road construction increased from 156 km per year in 1976-1990 to 660 km per year after 2000. In the Democratic Republic of Congo rates of logging road construction increased from 336 km per year in 1986-1990 to 456 km per year in 2000-2002.

7.1.2 Underlying causes of deforestation

The underlying causes of deforestation vary from country to country and even within a country and are often complex in nature. Although poverty is often cited as *the* underlying cause of tropical deforestation, rarely does one factor alone bear the sole responsibility for tropical deforestation. The underlying causes are often even more intractable than the proximate causes, ranging from institutional arrangements, demographic and economic issues, to ineffective technological deployment, to cultural socio-political issues.[201] In more than one third of all global cases all major underlying causes are interrelating causing the deforestation process.[202]
Due to Africa's diverse set of cultures, traditions, languages and political systems, a tendency is seen that in the majority of cases, deforestation is driven by the full interplay of institutional, demographic, economic, technological, and cultural variables rather than by single-factor causation.

Population growth
Africa's population grew from 472 million in 1980 to 943 million in 2006 and is expected to rise to 1.2 billion by 2020.[203] There are considerable variations in population size among countries, and these affect forests and forestry in a number of ways.

For example, Nigeria, with a population of more than 127 million people, is the most populous country in Africa and has the world's highest deforestation rate of primary forests. Logging, subsistence agriculture, and the collection of fuelwood are cited as the key proximate causes of deforestation between 2000 and 2005, where the country lost more than half of its primary forests. In this case the demographic situation is regarded a leading underlying cause for the high deforestation rate.[204] This also illustrates the above mentioned interrelation between multiple proximate and underlying causes.

Population density
While Central Africa as a whole has a very low population density, countries like Burundi and Rwanda on the border of the Congo basin and certain areas in Eastern Congo are very densely populated, creating enormous pressures on forests. In Burundi, for example, rates of forest clearing have risen by almost 29% since the 1990s. With an annual deforestation rate of 3.7 % in the 1990s and 5.2% in the period 2000-2005, Burundi has lost a total of 47% of its forest cover between 1990 and 2005. Today only some 152,000 hectares

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[200] LaPorte N, Stabach J, Grosch R, Lin T, Goetz S (2007) Expansion of industrial logging in Central Africa. Science 316:1451
[201] FAO (2008). State of the World's Forests 2007.
[202] GEIST H. and LAMBIN E.F., 2002. Proximate causes and underlying driving forces of tropical deforestation. Bioscience, Vol. 52, Nr.2, pp.143-150.
[203] FAO State of the World's Forests 2009.
[204] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38. Rome (also available at www.fao.org/forestry/site/10368/en).

remain forested in the country, but none of it intact. Uncontrolled cutting of trees for fuelwood coupled with agricultural clearing and livestock grazing are the main proximate causes for the nearly complete deforestation in Burundi.[205]

On the contrary, in Central Africa the low population densities do not necessarily correlate with low deforestation rates. Large land expansions and improved accessibility have been seen to favour forest clearance for commercial and subsistence agriculture.[206]

When looking at deforestation in terms of the percentage of a country's forest that was cleared over time, 10 African countries are to be found among the 13 highest ranking countries. By this metric, the island nation of Comoros (north of Madagascar) cleared nearly 60 percent of its forests between 1990 and 2005, and second came Burundi clearing 47 percent of its forests.[207]

The Kasyoha-Kitomi Forest reserve in Uganda is an example of how the pressure on the forest reserve results from inter-related demographic and socio-economic processes that influence patterns of resource use and determine local inhabitants' interest in and use of the forest. The underlying causes are land shortage, due to declining soil fertility and increasing population density; a long distance to markets and poor roads; few alternative employment opportunities apart from agriculture; and a general mistrust in local leadership and elite within the villages Because of these underlying forces it is very hard to get arable land in the area of the forest reserve. Therefore, it is a widespread practice to access agricultural land through cultivation in the forest reserve.

Market growth

Since 2000, much of Africa's economic growth has been driven by exports of primary commodities, primarily to the emerging Asian economies. FAO recently stressed that this is likely to continue.[208] Market growth is an underlying factor that is affecting forests in Africa mainly due to commercial logging and timber production. The market demand for forest resources is dominating because of commercialisation of the wood market and timber products. Globally, market growth of timber products, agricultural products and minerals account for 29%, 29%, and 15% respectively of all the cases (global) of deforestation in the study of Geist and Lambin (2002). Economic growth in Africa is generally low (under 4% per year) due to the small size of the formal economy, the low per capita income and the correspondingly low rates of savings and investment.[209]

The interrelation between the market variation and deforestation rate is exemplified through the cocoa production in Ghana. With a 2% annual deforestation rate, Ghana has one of the highest deforestation rates in Africa. Large patches of tropical forest have been cleared to support the production of the second largest producer of cocoa beans in the world and still more is being cleared to respond to increasing demand. When world cocoa

[205] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38. Rome (also available at www.fao.org/forestry/site/10368/en).

[206] FAO. State of the World's Forests Report 2009.

[207] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38. Rome (also available at www.fao.org/forestry/site/10368/en).

[208] FAO. State of the World's Forests Report 2009.

[209] African Development Bank, European Commision, FAO 2003a. Forestry Outlook Study for Africa. Regional Report - Opportunities and Challenges towards 2020. FAO Forestry Paper 141. Rome

prices are low, Ghana's foreign exchange earnings are significantly affected; which is often compensated for by increasing timber and mineral exports. Cocoa farming is thereby representing a direct as well as indirect cause of deforestation in Ghana.[210]

Income and employment factors

The FAO 2008 presentation "Contribution of the forestry sector to employment and GDP" provides a global comparison of trends in income and employment figures per region. As can be seen from the tables below, employment in forest related industries in Africa has been decreasing slightly between 2000 and 2006 and accounts for approximately 0.2% of overall employment. Similarly, the forest industry in Africa accounts for less than 2% of the total GDP.

Table 7.5 Overview of employment trends in the forestry industry, 1999 - 2006

	Millions			% of workforce		
	1990	2000	2006	1990	2000	2006
Sub-Sacharan Africa	0.5	0.5	0.5	0.2%	0.2%	0.1%
North Africa, Western and Central Asia	0.5	0.4	0.4	0.3%	0.2%	0.2%
Developed Asia-Pacific	0.7	0.6	0.5	1.0%	0.7%	0.6%
Developing Asia-Pacific	5.6	5.0	5.3	0.4%	0.3%	0.3%
Western Europe	2.3	1.9	1.7	1.3%	1.0%	0.9%
Eastern Europe	3.2	2.3	2.1	1.9%	1.3%	1.2%
North America	1.5	1.6	1.4	1.1%	1.0%	0.8%
Latin America and Caribbean	1.5	1.7	1.8	0.8%	0.8%	0.7%
All temperate countries	***12.6***	***10.5***	***10.1***	***0.9%***	***0.6%***	***0.6%***
All tropical countries	***3.1***	***3.6***	***3.6***	***0.3%***	***0.3%***	***0.2%***
World total	**15.7**	**14.1**	**13.7**	**0.6%**	**0.5%**	**0.4%**

Source: FAO 2008 presentation "Contribution of the forestry sector to employment and GDP"

Table 7.6 Overview of value added trends of the forestry sector, 1990 - 2006

	USD billion (constant 2006)			% of GDP		
	1990	2000	2006	1990	2000	2006
Sub-Sacharan Africa	9	10	12	2.2%	2.0%	1.8%
North Africa, Western and Central Asia	7	6	7	0.5%	0.4%	0.3%
Developed Asia-Pacific	52	45	41	1.2%	0.9%	0.7%
Developing Asia-Pacific	38	55	78	1.9%	1.3%	1.3%
Western Europe	131	133	119	1.4%	1.1%	0.9%
Eastern Europe	28	20	23	1.5%	1.5%	1.2%
North America	123	153	140	1.4%	1.2%	1.0%
Latin America and Caribbean	36	41	47	1.9%	1.7%	1.6%
All temperate countries	***365***	***393***	***389***	***1.4%***	***1.1%***	***0.9%***
All tropical countries	***58***	***70***	***79***	***2.0%***	***1.7%***	***1.5%***
World total	**424**	**463**	**468**	**1.4%**	**1.2%**	**1.0%**

[Source: FAO 2008 presentation "Contribution of the forestry sector to employment and GDP"]

Agrotechnological change

Technological change is a key adaptive response of a society to an increasing population. In the case of Africa, agro-technological improvements, or the lack thereof, are closely

210 UNEP - http://www.unep.org/pdf/PressReleases/Ghana_Africa_Atlas.pdf World Rainforest Movement (1999). "Background Document". Workshop on Underlying Causes of Deforestation and Forest Degradation, Cost Rica, 18-22 January, 1999.

linked to the deforestation rate through the intensification of agricultural production. Improved cropping techniques would allow for increased outcome of the existing agricultural land already cleared and reduce the pressure for expansion to new agricultural lands.

With the exception of South Africa and some countries in Northern Africa, science and technology development in the region has been relatively slow, largely because of:

- low investments in science, education and research;
- the high share of economic activities remaining in the informal domain, which curbs interest to invest in innovations;
- a failure to develop and use Africa's strong base of traditional knowledge to deal with modern problems.[211]

The slow technological development is thereby an underlying cause negatively affecting the deforestation rate. It is likely that only with agrotechnological changes of production methods the existing agricultural sector will be capable of responding to the rising food demand from a growing population. The rapidly growing human population in Africa would need continuous support to gain rapid advances in agricultural and industrial technology.[212]

Harvesting (wood) technology

With some exceptions, namely South Africa and some countries from Northern Africa, the wood technology developments in Africa have been rather slow. This development is due to a number of facts, which are listed below[213]:

- Low investments in science and R&D;
- Large shares of economic activities remain in the informal sector which does not attract investments;
- Traditional knowledge to address problems is not being applied.

Governance

Governance including institutional and policy factors are important underlying factors of deforestation and forest degradation. For Africa the main issues are the following:

- Poor governance and corruption;
- Declining capacity of public forestry agencies, including research, education, training and extension.[214]
- Land tenure uncertainties, weak legal frameworks and other hindrances to the development of a competitive private sector.
- Poor inter-sectoral linkages, with high-priority sectors such as agriculture, mining, industrial development and energy effectively having a greater impact on forests than forest policy.

The governance related issues are structured using six indicators of governance:

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[211] FAO. State of the World's Forests Report 2009.
[212] Ibid.
[213] Ibid.
[214] Ibid.

- **Voice and Accountability**: According to the World Bank's Worldwide Governance Indicators from 1996 to 2007, many African countries score very poor as far as voice and accountability is concerned. The voice and accountability ratings are reasonably high for South Africa, Ghana and Mali. Compared to international findings, South Africa's ranking reveals that ca. 75% of all countries rate worse and an estimated 25% of countries rate better on this indicator. Ghana's and Mali's rankings are lower than South Africa's, however the two countries are still ranked within a 50-75% percentile. On the lower end, DR Congo, Zimbabwe and Sudan face an extremely poor worldwide ranking regarding this indicator.[215] All three countries are ranked among the lowest decile (10%) of all countries in the world, whereas Sudan ranks lowest, followed Zimbabwe and DR Congo.

- **Political Stability**: Africa has a history of civil wars with devastating consequences for society and natural resources. The bulk of the remaining rainforest in Central Africa is found in the Congo Basin in Democratic Republic of Congo and Congo-Brazzaville, an area highly affected by internal displacement of people. Recently these forests have been increasingly threatened by large crowds of refugees fleeing rebel forces in the Democratic Republic of Congo and the movement of local militias. These large movements of people affect the forest resources in the area, which are used to provide energy to satisfy basic needs including cooking and lighting.

- **Government Effectiveness/Regulatory Quality**: Institutional weaknesses remain the most important problem in the developing countries.[216] Once again, according to the World Bank's Worldwide Governance Indicators from 1996 to 2007, many African countries score very poor as far as government effectiveness and regulatory quality are concerned. The ratings for those two indicators are reasonably high for South Africa, Ghana and Madagascar. South Africa ranks within the top 25% of worldwide countries. Ghana faces only about 25% of worldwide countries to score better on these indicators. Again the ranking reveals that DR Congo, Zimbabwe and Ivory Coast face an extremely poor worldwide ranking regarding these indicators, ranking in the lowest decile (10%) of worldwide countries. The majority of countries is ranked within the lower 10-50% among all countries worldwide. These countries include, to name just a few, Brukina Faso, Niger, Malawi, Tanzania and Uganda.

  During the past two decades Africa has witnessed significant political changes, though these changes must be characterised as slow (African Development Bank, 2003a). If government forestry agencies that have historically dominated the forestry policy scene fail to adapt to the changes, they risk losing their influence. "Adapting forestry institutions to rapid changes in the larger environment is a major challenge", says Jan Heino, Assistant Director-General of FAO's Forestry

[215] The governance indicators presented in the Report "Governance Indicators 1996-2007" present aggregated views on the quality of governance provided by a large number of enterprise, citizen and expert survey respondents in industrial and developing countries. These data are gathered from a number of survey institutes, think tanks, non-governmental organizations, and international organizations.

[216] FAO. State of the World's Forests Report 2009.

Department. “Of particular importance is the need to re-invent public sector forestry agencies that have been slow in adapting to changing customer needs”.[217] This results in poor inter-sectoral linkages where high-priority sectors, such as agriculture, mining, industrial development and energy, effectively have a greater impact on forests than forest policy itself.

Land tenure arrangements are important underlying causes for deforestation and an example of a forest related regulation influencing the deforestation rate. Insecure ownership related to uncertainties of land tenure, is a common pattern in Africa, which drives the shift from communal to private property.[218]

[217] FAO. State of the World’s Forests Report 2009.

[218] Geist, H.J., Lambin, E.F. 2002. Proximate causes and underlying driving forces of tropical deforestation. BioScience 52 (2), 143-150.

Box 7.1 The role of governance in deforestation: a scenario analysis for the Congo Basin

Governance as well as other policy factors and corresponding institutional change are crucial drivers for land use patterns. Currently these patterns are, however, poorly understand and hardly measurable. The Congo Basin lends itself as a suitable case study area as governance levels are currently rather low compared to other parts of the world and thus there is room for projecting considerable improvements in governance in the future and to assess how such changes could potentially improve biodiversity levels (i.e. measured based on deforestation rates).

To assess the impact of changing governance, two sets of scenarios were developed: one set under constant governance (no governance development over the next decades) and one set under changing governance (governance development takes place and policy factors improve over time). Within each set of scenarios, two baseline deforestation scenarios were assessed– these are based on two different reference datasets and one has a higher innate deforestation rate than the other:

- BAU 1 Scenario (A) is based on a data set, which was reported by countries to The Global Forests Resource Assessment (FRA) from FAO (FAO, 2001). According to FRA, it can be estimated that in tropical countries approximately 0.60% of forests were converted per year between 1990 and 2000 and 0.63% between 2000 and 2005. BAU 1 Scenario (A) assumes that forests in tropical regions (between 23.4 N and 23.6 S) are deforested at a rate of approximately 1 % annually. The G4M model is calibrated with the countries' net forest area change based on average FAO-FRA 2000-2005 figures. Then the model is forced to follow a deforestation rate of about 1 %/year (compared to 2000) for all tropical forests. In the model decisions on deforestation and deforestation rate in a grid cell with higher resolution (approximately 15 x 15 km at the equator) are made by taking into consideration a comparison of forestry and agriculture net present values, population and gross domestic product in the cell.

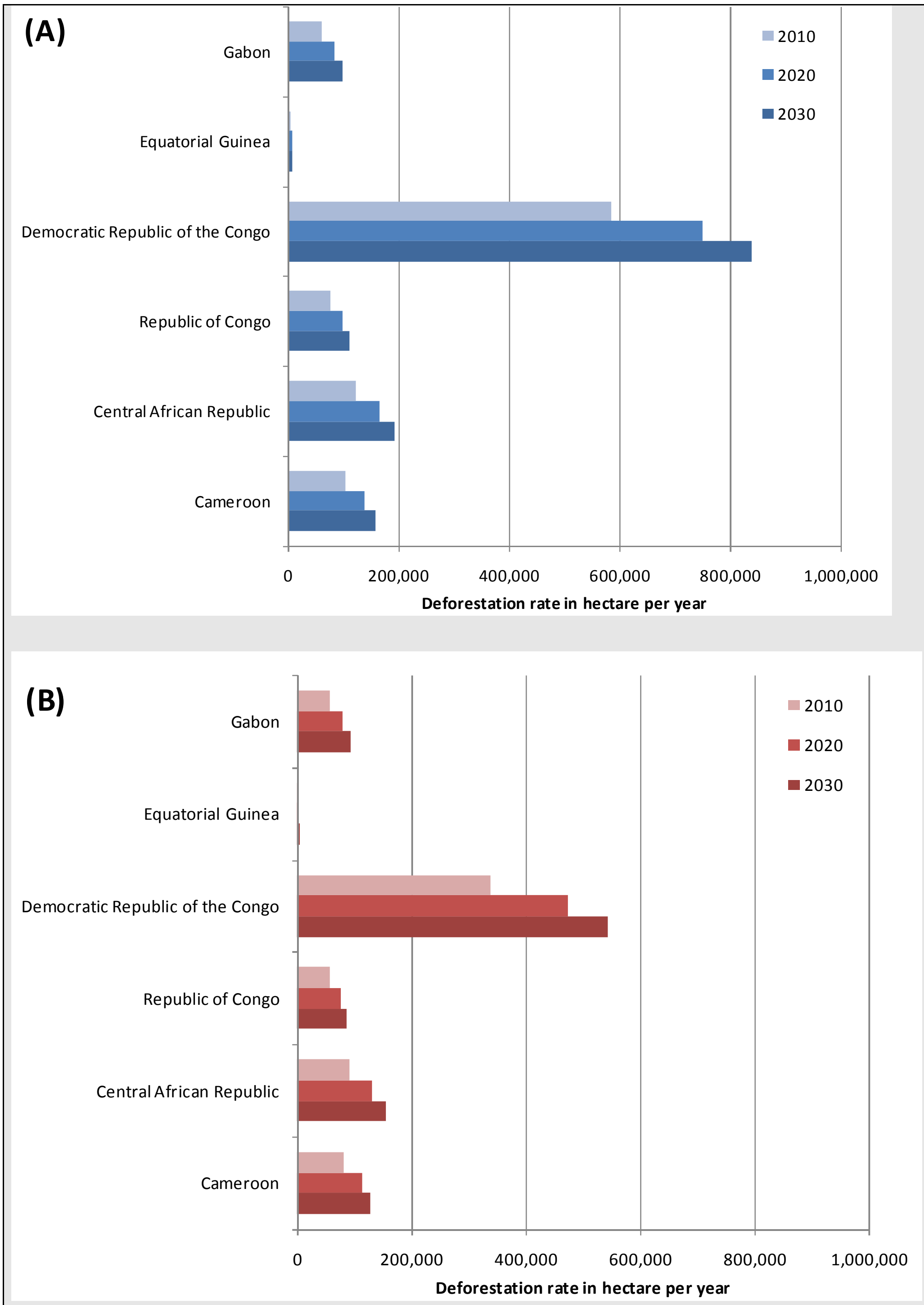
- The deforestation rate of BAU2 Scenario (B) is originated from a historical remote sensing data. This deforestation rate is slightly lower than BAU 1 Scenario (A) and the projected protection area is considered to preserve some forested area for biodiversity conservation. The deforestation rate of the current forest cover is spatially distributed in the G4M model.

In the scenario analysis -with and without changing governance-, the effects of incentive payments (Carbon price in USD/tC) on the deforestation rates were assessed. In total, 5 different prices were considered to evaluate the effects: 0 USD/tC (business-as-usual), 3 USD/tC, 10 USD/tC, and 25 USD/tC. The incentive payment is arranged every 5 years starting from 2013.

Deforestation rates (biodiversity loss) under constant governance development
The modelling results for the constant governance scenario (constant hurdle rates) show deforestation levels without REDD and with REDD at 10$/tC. Constant governance is defined as continued deforestation as to the latest FAO deforestation rates, while other drivers including governance are assumed constant.

Both BAU scenarios are calculated for 6 Congo Basin countries (Cameroon, Central African Republic, The Democratic Republic of the Congo, Equatorial Guinea, Gabon, and Republic of Congo) in 2010, 2020 and 2030.

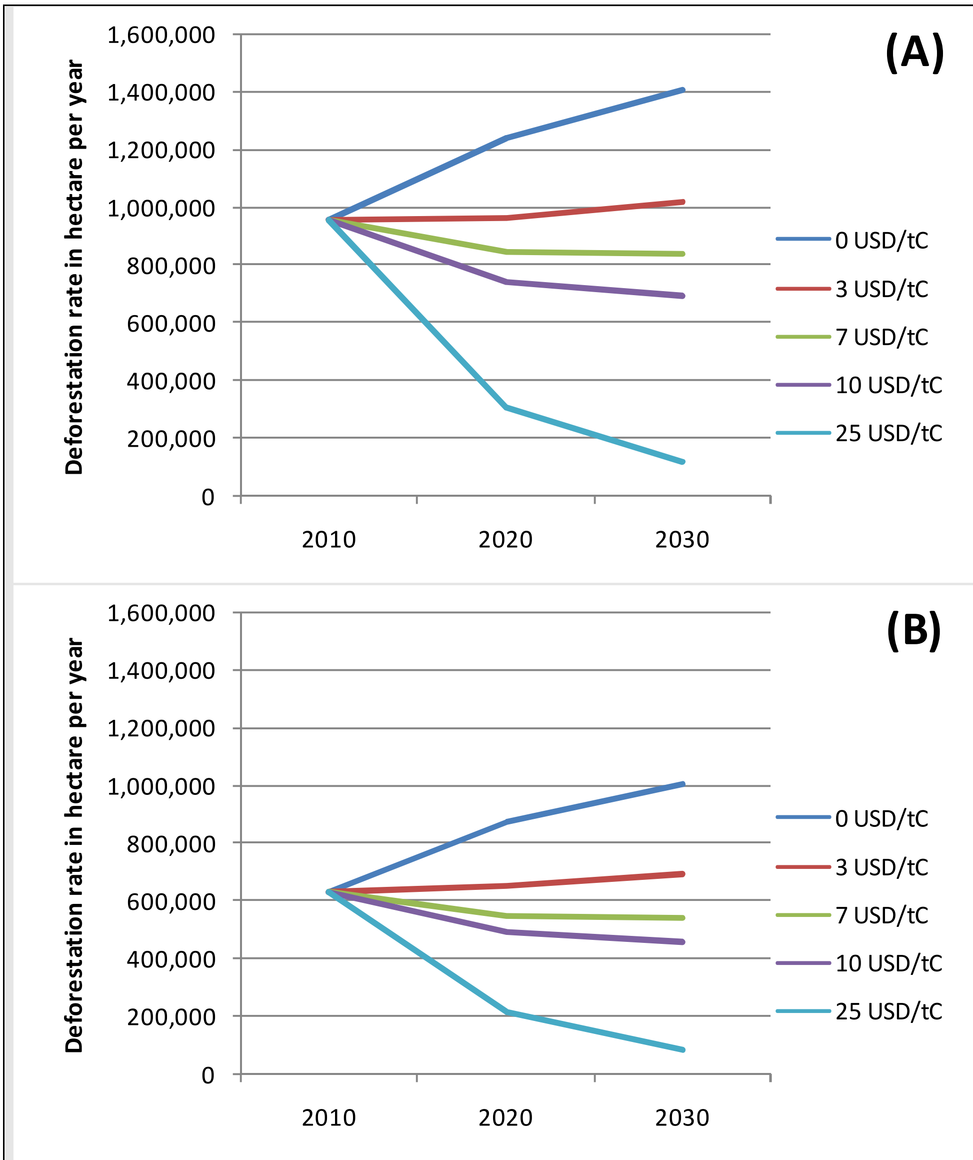
Figure 7.7: Estimated deforestation rates in the 6 Congo Basin countries for 2010, 2020 and 2030 for BAU 1 Scenario (A) and BAU 2 Scenario (B) without incentive payments (business as usual under constant governance)



[Source: IIASA]

Figure 7.8 shows the effects of incentive payment with different carbon prices (USD/tC) for the two BAU scenario variants under constant governance in the Congo Basin countries (total deforestation rate). The deforestation rate is decreasing by increasing incentive payment.

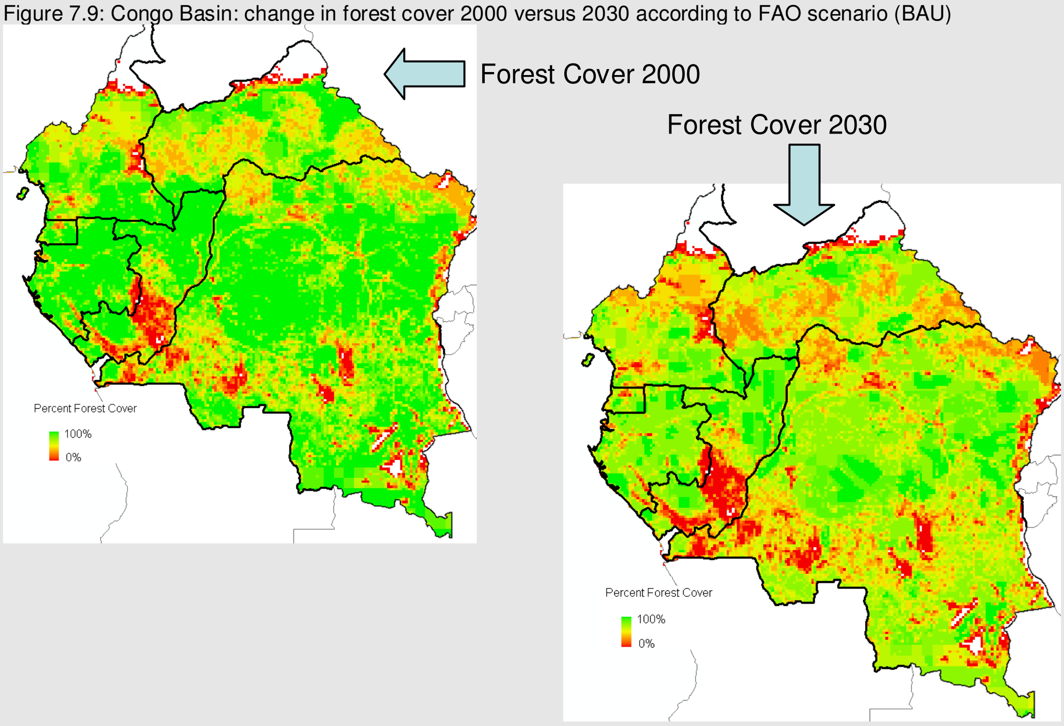
Figure 7.8: Effects of incentive payment (carbon price in USD/tC) on deforestation rates in the Congo basin (6 countries) in 2010, 2020 and 2030 under BAU 1 Scenario (A) and BAU 2 Scenario (B)



[Source: IIASA]

Having a closer look at what these overall figures mean in a geographic context, figure 8.9 indicates that the BAU scenario without REDD shows significant deforestation particularly in the southern and central regions of the Republic of the Congo, the north western tip of Angola and the central regions of the Democratic Republic of the Congo. A further area with decreased forest cover by 2030 is the most northern reaches of the basin in the Central African Republic.

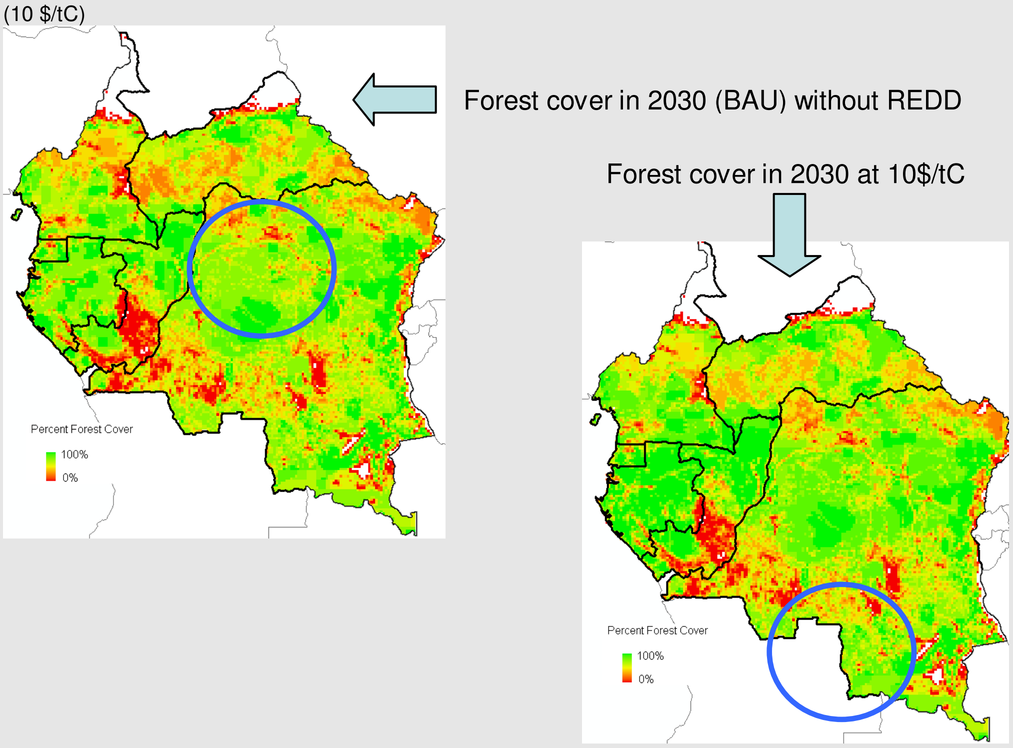
Figure 7.9: Congo Basin: change in forest cover 2000 versus 2030 according to FAO scenario (BAU)



[Source: IIASA]

When comparing this BAU scenario with the one including a REDD scheme at 10$/tC at constant development of governance (Figure 7.10), only a small incremental improvement can be observed as to the percentage of forest cover remaining by 2030.

Figure 7.10: Congo Basin: difference in forest cover in 2030 according to FAO BAU scenario and REDD scenario (10 $/tC)



[Note: Blue circles highlight apparent differences]
[Source: IIASA]

Deforestation rates (biodiversity loss) under improving governance and other policy factors

The next step is to model changes in governance, i.e. improvements in institutional accountability and other policy factors and to assess their impact on deforestation rates. The governance scenarios are modelled by overlaying them on top of the two previous business-as-usual deforestation scenarios (BAU1 and BAU2). We considered the effects of governance by using hurdle rates over time, which represent net present values of forestry decreasing in time.

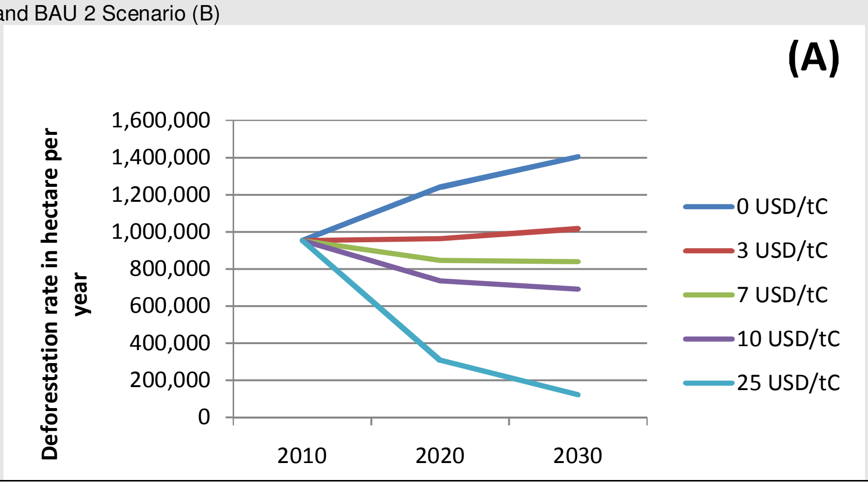
Table 7.7: Applied hurdle rates for the Congo Basin countries in 2010, 2020 and 2030

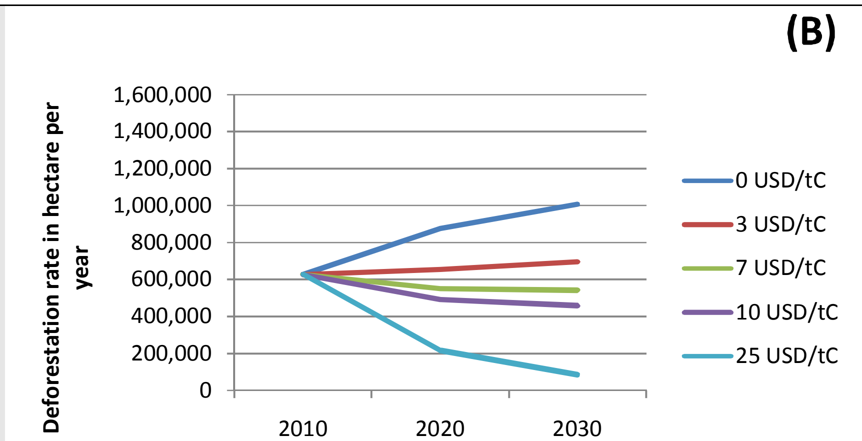
Hurdle rates	2010	2020	2030
Cameroon	100%	79.4%	82.6%
Central African Republic	100%	77.9%	81.0%
Congo	100%	78.4%	81.5%
Democratic Republic of the Congo	100%	78.3%	81.6%
Equatorial Guinea	100%	87.0%	90.4%
Gabon	100%	78.4%	81.8%

[Source: IIASA]

Figure 7.11 shows the effects of incentive payment under different carbon prices (USD/tC) on deforestation rates. This time it includes the effects of governances (hurdle rates). However, the difference between Figure 8.6 and Figure 7.11 is minimal because the model is forced heavily.

Figure 7.11: Effects of incentive payment (carbon price in USD/tC) on deforestation rate in the Congo Basin (6 countries) with governance development scenario in 2010, 2020 and 2030 of deforestation BAU 1 Scenario (A) and BAU 2 Scenario (B)

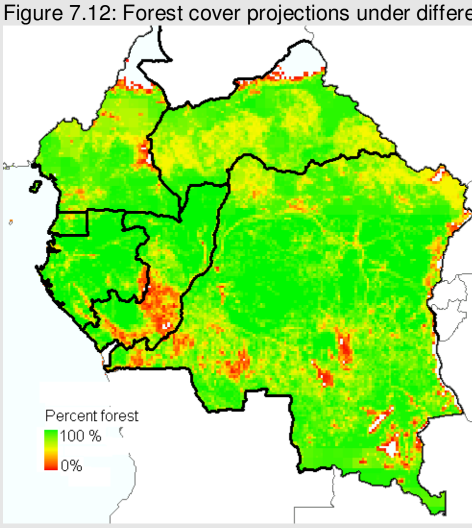




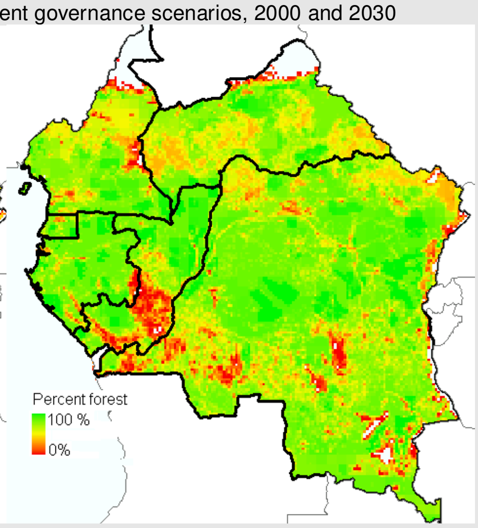
[Source: IIASA]

The following figure maps the predicted governance policy shock effects in a geographically explicit manner. As can be seen from this figure, a changing governance scenario including a REDD scheme can help prevent some deforestation by 2030.

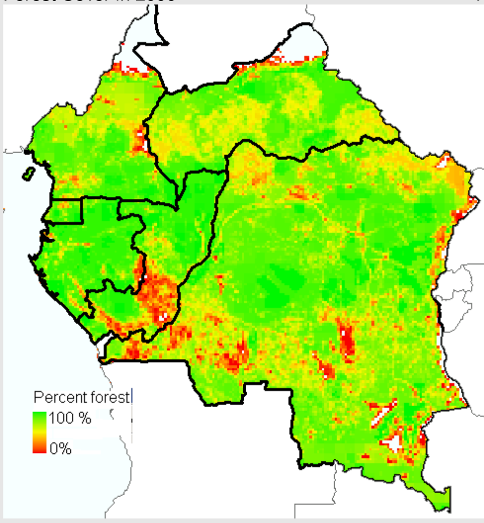
Figure 7.12: Forest cover projections under different governance scenarios, 2000 and 2030



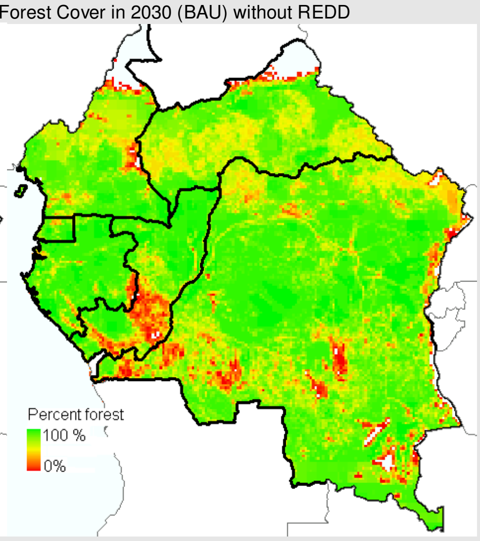
Forest Cover in 2000



Forest Cover in 2030 (BAU) without REDD



Forest Cover in 2030 at 10 $/t C



Forest Cover in 2030 at 25 $/t C

[Source: IIASA]

Comparing constant and improving governance scenarios

The following tables depict the above graphical results in precise numbers. When comparing the two constant governance BAU scenarios with those of changing governance, only little variation in terms of less deforested area under a variety of carbon prices is seen. Numbers that differ are marked in *red*.

Table 7.8: Deforestation rates in hectares per year for various governance scenarios

Deforestation rate in hectare per year at different carbon prices in the 6 Congo basin countries					
US$/tCO2 → Year ↓	0 US$/tCO2	3 US$/tCO2	7 US$/tCO2	10 US$/tCO2	25 US$/tCO2
BAU 1 Scenario (A) results under constant governance					
2010	953.839	953.839	953.839	953.839	953.839
2020	1.241.068	*963.916*	845.514	*736.297*	306.994
2030	1.404.202	1.017.381	839.609	691.218	*121.182*
BAU 1 Scenario (A) results under changing governance					
2010	953.839	953.839	953.839	953.839	953.839
2020	1.241.068	*963.916*	845.514	*736.304*	306.994
2030	1.404.202	1.017.381	839.609	691.218	*121.192*
BAU 2 Scenario (B) under constant governance					
2010	627.818	627.818	627.818	627.818	627.818
2020	875.672	*653.583*	*550.304*	*491.673*	*215.043*
2030	1.007.228	*695.806*	*542.219*	*457.092*	*82.783*
BAU 2 Scenario (B) under changing governance					
2010	627.818	627.818	627.818	627.818	627.818
2020	875.672	*653.672*	*550.385*	*492.447*	*215.757*
2030	1.007.228	*696.036*	*542.608*	*458.575*	*84.498*

[Source: IIASA]

The relatively minor impact of the governance shock scenario in the Congo Basin can be seen in this table. This relatively minor effect can be explained by the fact that already under the BAU 1 and 2 scenario variants (constant governance), deforestation rates based on FAO and remote sensing data are extremely high and improvements in governance do not make a major difference in terms of reducing deforestation. The little difference appears as a “model artefact” due to calibration of the model to follow a historical BAU path. The model is not informed by “true” driver information and can, thus, not react to changes in parameters that mimic governance. Therefore, a different governance assessment methodology will need to be developed to assess changes in governance. This would include detailed field studies on how to eliminate practices of illegal logging, their drivers and geography.

- **Rule of law:** The rule of law governance indicator is once again assessed by the World Bank’s Worldwide Governance Indicators from 1996 to 2007. African countries score among the lowest countries as fart as the rule of law results is concerned worldwide. The rule of law is the most established in South Africa and Ghana with those two countries ranking above between the 50th and 75th percentile of worldwide countries. However, the largest number of African countries is ranked within the 25th and 50th percentile and a large number of countries is ranked within the lowest decile (10%). These countries are Nigeria, Angola, Sudan, DR Congo, Zimbabwe and Ivory Coast.

- **Control of Corruption:** When assessing the control of corruption in Africa, the already named countries have to be mentioned again. In general control of corruption is very poorly established in Sub-Saharan Africa. While corruption control is rated to be within the 50-75th percentile in South Africa, Ghana and Madagascar, countries such as Angola, Sudan, Ivory Coast, DR Congo and Zimbabwe are rated very poorly on a worldwide scale and rank in the lowest decile. In between, the majority of countries, such as Niger, Niger, Burkina Faso, Zambia and Tanzania, care ranked and placed between the lowest 10-50th percentile.

Cultural and socio-political drivers

A special feature from Africa which affects the entire range of public sectors, including the forestry sector, is the critical situation of HIV/AIDS. FAO recently stressed the impacts from HIV/AIDS as i) Drastic decline in resources - human and financial - leaving less for long-term investments, ii) Increased dependence on forest products, especially those that are easy to collect, iii) Loss of traditional knowledge, iv) Shortage of skilled and unskilled labour - undermining forestry by affecting all key sectors such as wood industries, research, education, training, extension and forest administration, v) Increased costs to industry on account of absenteeism and higher bills for treatment, and vi) Reduced public-sector investment in forestry, as most governments will have to devote more of their budgets to health care and combating HIV/AIDS.[219]

7.1.3 Actors and policy framework

A wide range of diverse actors are influencing deforestation in Africa in one way or another reflecting a complex set of interrelations. The most influential actors and the role they play in the drivers identified are described below:

Primary actors

The primary actors identified are:

- Farmers/villagers (*small-scale permanent agriculture* and *large-scale permanent agriculture*) clear the forest to obtain more land for agricultural production and in search of fuelwood for cooking and lightning.[220]
- Commercial loggers directly cause deforestation by logging and timber production for export as well as by constructing roads giving easy access to unplanned settlements.
- Settlers following the track of the commercial logging companies and expanding the deforested areas around the newly implemented roads.

[219] FAO. State of the World's Forests Report 2009.

[220] Lobet, I, Living on Earth's; Interview 2nd of January 2009, Why tropical Forest Fall: http://www.loe.org/shows/shows.htm?programID=09-P13-00001#top

Secondary actors

The secondary actors identified are:

- Governmental bodies/politicians (local, national, international) are important actors influencing agricultural expansion, logging and infrastructure expansion.
- Producers of timber products are not necessarily the same as the commercial logging companies, but represent a direct buyer of – and thus demand for - the timber for processing it into wood products.
- Foreign agricultural companies. For example, companies that buy the important agricultural export product such as cotton, cacao and coffee. External investments in large-scale agriculture in response to high food prices could have a negative impact on forests, which is regarded a potential major driver of deforestation in the future by FAO.[221]

Tertiary actors

The tertiary actors identified are:

- Consumers in the developed and transition economies are influencing both secondary and primary actors via demand for tropical timber products.
- The international community in general can positively or negatively affect governments and politicians through political messages and international treaties related to forest issues.

7.1.4 Possible solutions

As this qualitative case study as well as more quantitative estimations of previous studies[222] have shown: in the Congo Basin region biodiversity is lost at a rapid pace due to very high deforestation and thus habitat destruction rates. This negative trend is likely to further intensify in the future.

The case studies for the Congo basin on biodiversity and governance signalled some potential directions of future policy efforts / solutions: it has surfaced that while increased biodiversity protection can make a difference in terms of avoiding deforestation and especially in terms of protecting also non-forest biodiversity hotspots in the region, improved governance currently does not reduce deforestation to great extent. However, one has to wonder why improved governance currently does not seem to signal a large improvement in terms of forest biodiversity protection since similar investigations for other regions show that governance can indeed play a vital role in tackling biodiversity loss. The most probable answer lies with the basic reason that the Congo Basin is facing such a large compilation of serious underlying drivers of biodiversity loss that an improvement in any single one of them cannot make a significant difference; only improvements in the overall state of many of these underlying drivers will be able to make a meaningful difference in terms of protecting forest biodiversity.

Therefore, while direct causes of forest biodiversity loss also play a crucial role, for this region it is more urgent to first start tackling the underlying causes. These underlying

[221] FAO. State of the World's Forests Report 2009.

[222] ECORYS-IIASA study on avoided deforestation (DG ENV).

factors are essential building blocks for a healthy and well-functioning society. Without these basic elements, it is almost impossible to start tackling the more direct causes of forest biodiversity loss, such as illegal logging.

Possible solutions to start addressing the main bottlenecks - the underlying causes of forest biodiversity loss in this region - include:

- ✓ Fostering political stability in the region;
- ✓ Stabilising population size;
- ✓ Tackling poverty and inequality issues;
- ✓ Finding pathways to sustainable economic growth;
- ✓ Improving inter-sectoral linkages so as to reduce the current policy focus on only the most important sectors (energy, mining, industrial development);

Slowly, these steps should then lead to better opportunities in the future for:

- ✓ Improving governance levels, and therefore improving law enforcement, reducing corruption, increasing accountability, etc.; and for
- ✓ Creating a sound legal framework with a corresponding implementation structure (including well-defined property rights) that mainstreams biodiversity goals into other important related policies and measures.

Furthermore, the following efforts could help foster momentum and support for moving towards any of these above mentioned possible solutions:

- ✓ Involve stakeholders of all levels in the decision-making process;
- ✓ Raise awareness about crucial importance of biodiversity for sustainable future of the region;
- ✓ Share traditional & scientific knowledge;
- ✓ Lobby for signing an international payment system for ecosystem services (REDD). In terms of the current REDD debates, Africa would likely prefer a fund based approach in order to best use this international policy tool for avoiding future deforestation and decreasing the decline of biodiversity levels because credits would be rather little and the most secure and stable income could be generated by a fund.
- ✓ Support community-based forest management efforts.

When reviewing the more direct causes of forest biodiversity loss for this region of the world, in particular, increased biofuel demands as well as increased meat demand could significantly contribute to additional deforestation in the future. Increased infrastructure development, on the other hand, will likely not be a significant driver of deforestation in Sub-Saharan Africa. Since it is most likely that wood, meat and infrastructure demands will increase in this region of the world, future biodiversity solutions addressing direct causes should probably focus on tackling the impacts of meat demand in particular.

7.2 Case study 3b: the Amazon forest ecosystem

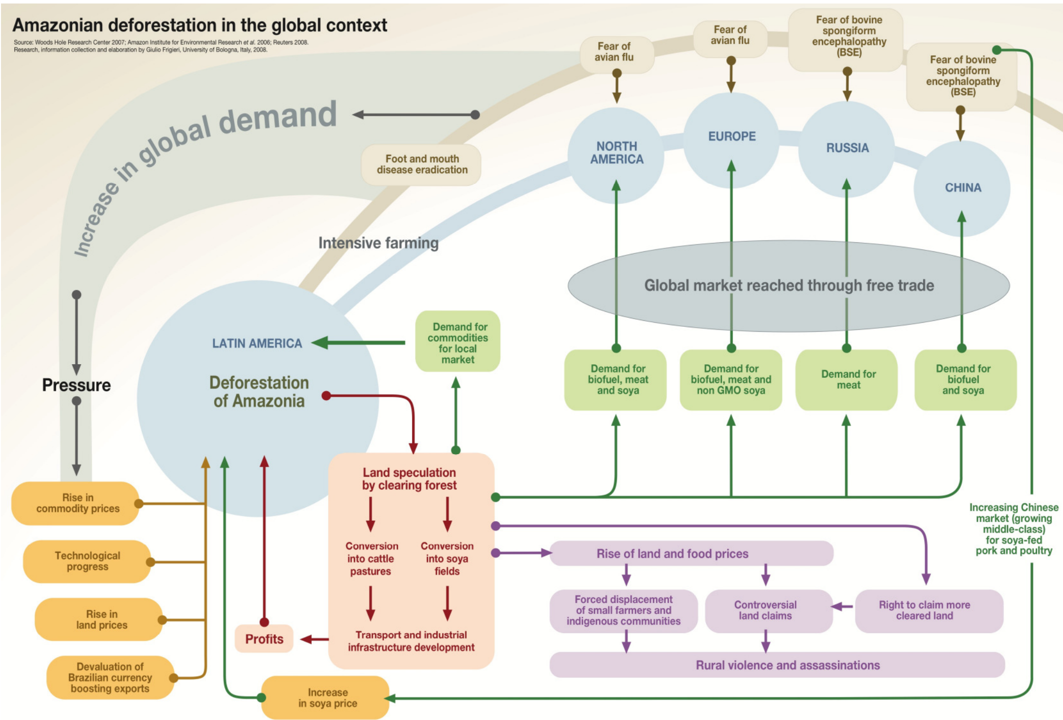
The Latin America and the Caribbean region has abundant forest resources – about 47 percent of the land – and accounts for 22 percent of the world's forest area. The annual rate of change of forest area from 2000 to 2005 was -0.51%, compared with -0.46%

during the 1990s. In total, from 1990 to 2005, Latin America and the Caribbean lost about 64 million hectares of forest. Within the region, the largest area loss was in South America, while the largest percentage loss of forest area was in Central America.

The leading cause of deforestation was the conversion of forest land to agriculture.

The following diagram shows the complex web of interlinking global and local direct and underlying causes of Amazonian deforestation.

Figure 7.13 Diagram depicting interlinkages of global and local direct and underlying causes of Amazonian deforestation



Source: UNEP-GRID

7.2.1 Direct causes of deforestation

In general term the proximate causes in Latin America are (in order of importance): agriculture, infrastructure expansion, and wood extraction. The main agricultural causes are cattle ranching, permanent cultivation (subsistence agriculture), colonization and shifting cultivation (swidden agriculture). If infrastructure plays a role in deforestation, transport extension is more often the cause than settlement or market extension.
In case of wood extraction as a proximate cause, commercial logging is more often mentioned in deforestation studies in Latin America than fuelwood extraction.[223]

[223] Geist, H.J., Lambin, E.F. 2002. Proximate causes and underlying driving forces of tropical deforestation. BioScience 52 (2), 143-150.

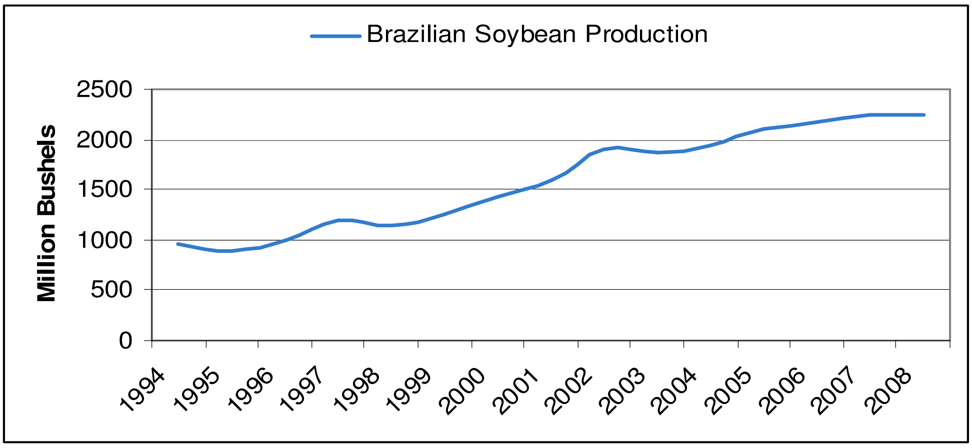
Agricultural expansion and other land use changes

More and more land is used for agricultural production. In order to fulfil the demands of a growing population two different groups are engaged in agriculture. One group are national and foreign commercial agricultural firms applying large scale cattle ranging and crop farming in order to supply these agricultural commodities for exportation and national food production.[224] The other group comprises an increasing number of subsistence farmers which clear forests for short-term agriculture in order to feed their families. The different approaches and effects are presented below.

Commercial farming:

- *Cattle ranching* has become an important business in various Latin American countries. The farming of cattle for the production of beef is big business in rainforest countries such as Brazil which is the world's largest beef exporter. Around 70% of the area deforested in that country is now cattle pasture.[225]
- *Soy production* – Soybean production has increased in many Latin American countries, especially in Brazil, Argentina and Paraguay. To highlight the Brazilian example, figure5.1 shows that the production of soybeans in Brazil has increased by approximately 135% from 1994 to 2008. This increase is due to new strains of soy suitable for the region's climate.[226] From the total of 2,241 million bushels of soybeans produced in Brazil in 2008 (which equals ca. 61 million metric tonnes), 932 million bushels were exported, which presents a production/export ratio of ca. 42%.

Figure 7.14 Brazilian soybean production from 1994-2008 in million bushels



Source: The American Soybean Association

Another aspect concerns the traditional diet in countries like Brazil, Argentina or Paraguay. In those countries meat is an essential part of the daily nutrition. As soy farming is highly profitable due to high prices, agricultural land is used increasingly

224 According to Pomareda and Hartwich, Latin America is home to at least 15 million farms and more than 100,000 agricultural industries—small- to medium-size plants that process food and agricultural products or produce inputs (Pomadera and Hartwich, 2006).

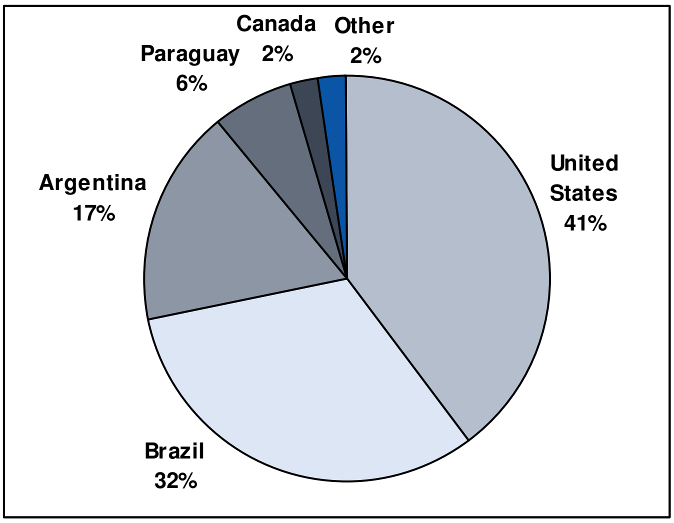
225 Azevedo-Ramos, C. (2008): El desarrollo sostenible y los retos de la deforestación en la Amazonia brasileña: lo bueno, lo feo y lo malo. Unasylva 230, Vol. 59, 2008.

226 Azevedo-Ramos, 2008 and Grau and Aide, 2008.

for soy farming in order to meet the global demand for soy. Beef ranches and farms of other crops, which, in turn, move farther into the forest.

Figure 7.15 presents the 2008 soybean export percentages by major exporting countries. It if obvious that, besides Brazil, Argentina and Paraguay account for a large percentage of world soybean exports.

Figure 7.15 World 2008 soybean exports in percent by major exporting countries



Source: The American Soybean Association

- *Sugarcane* – the causality link between soy production and sugarcane production needs to be explored in terms of indirect land use change: sugarcane cultivation claiming land that was previously available for soy cultivation, the latter advancing into rainforest areas. Again, it is worth to exemplify this development on the basis of the Brazilian case. Besides a decreased production in the 2005/2006 crop year, sugar production increased substantially. At the same time export rates decreased, which may be paid to the fact of increased domestic demand of sugar for biofuel production.

Table 7.9 Brazilian sugar production and export

Crop Year	Sugar production in tones	Annual change in production in %, indexed at 2004/2005 levels	Sugar export in tones	Sugar exports in %
2005/2006	25.905.723	-2,69	17.598.792	67,9
2006/2007	29.882.433	12,25	19.596.754	65,6
2007/2008	30.760.165	15,55	18.608.154	60,5

Source: UNICA - Sugar Cane Association Brazil

Subsistence farming:

- *Shifting Cultivation* – people without money and political power use trees for building material as well as slash-and-burn techniques to clear forest for short-term agriculture, planting crops like bananas, palms, manioc, maize, or rice.[227] After the soil has lost its productivity the people move on to new areas.[228]

- Illegal crops- e.g. coca, opium or cannabis are often cultivated in marginal areas, mainly because of poor accessibility, which reduces legal controls.[229]

Other:

- *Mining* – a variety of minerals are known to exist in the Amazon Basin. Among those are diamonds, bauxite (aluminium ore), manganese, iron, tin, copper, lead and gold.[230]

Infrastructure development

Infrastructural development plays an important role in deforestation in Latin America. A strong link between road building and logging activities exists throughout Latin American countries, e.g. in Brazil. That link is furthermore supported by the fact that countries, in which the costs for building roads are rather high, such as Bolivia, experience comparatively low rates of deforestation.[231] In addition, the construction of dams for the generation of hydroelectric power as well as oil and gas pipelines and new settlements can be seen as a cause of deforestation.[232]

Wood extraction

As seen in section 3.1 the total net loss of forest area is very high in Latin America which is codetermined by the high wood extraction in Brazil. Wood is extracted from approximately 1.5 million hectares per year in the Amazonian region of Brazil.[233] Of the entire Brazilian wood production ca. 10 % are exported to the EU-27. These 10% equal 30% of the entire Brazilian wood exports. The EU imports approximately 2% of the roundwood, 25% sawnwood, 20% veneer and 42% plywood from Brazil (based on FAOSTAT and TTAP import data). In addition, figure 5.3 presents the share of the ten major importing countries of Brazilian forest products in 2006.[234]

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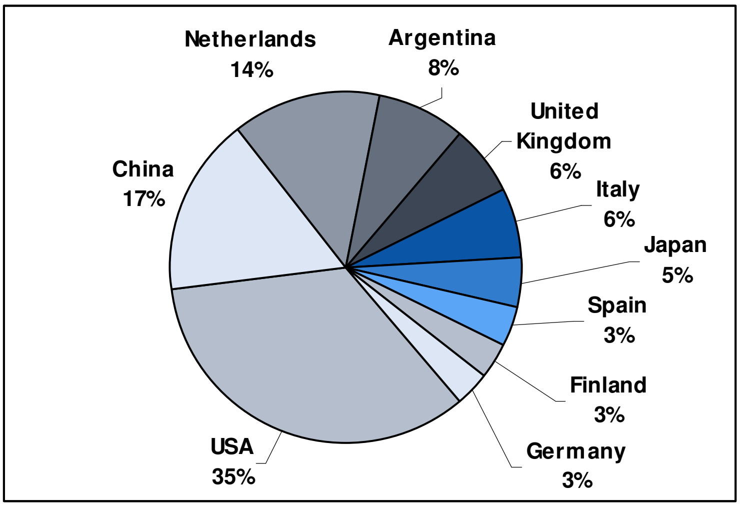
[227] Manta Nolasco, M.I. (2007): Evaluación de las causas naturales y socioeconómicas de los incendios forestales en América del Sur. Facultad de Ciencias Forestales, Universidad Nacional Agraria, Lima, Perú.
[228] Martin, R.M. (2008): Deforestación, cambio de uso de la tierra y REDD. Unasylva 230, Vol. 59, 2008
[229] Grau, H.R., Aide, M. (2008): Globalization and Land-Use Transitions in Latin America. Ecology and Society 13(2): 16.
[230] Gurmendi, A. (1999): The mineral industry of Brazil. U.S. Geological Survey Minerals Yearbook – 1999.
[231] Jaramillo,C.F. and T. Kelly. 1998. Deforestation and Property Rights in Latin America. IDB. Washington D.C. Mimeo.
[232] Manta Nolasco, M.I. (2007): Evaluación de las causas naturales y socioeconómicas de los incendios forestales en América del Sur. Facultad de Ciencias Forestales, Universidad Nacional Agraria, Lima, Perú.
[233] Azevedo-Ramos, C. (2008): El desarrollo sostenible y los retos de la deforestación en la Amazonia brasileña: lo bueno, lo feo y lo malo. Unasylva 230, Vol. 59, 2008.
[234] The FAOSTAT definition of “Forest products”includes the following products: Roundwood, Fuelwood and Charcoal, Industrial Roundwood, Sawnwood, Wood-based panels, Pulp, Paper and Paperboard, Species.

Figure 7.16 Export shares of Brazilian forest products to the ten major importing countries in 2006



Source: FAOSTAT Database

Related to the logging activities in Brazil is the issue of selective logging. Selective logging describes the practice of felling one or two trees and leaving the forest around those trees intact. Often believed to be a sustainable alternative to clear-cutting, data from Brazil show that the when selective logging is added to the overall figure of forest loss the number increases two-fold.[235]

The FAO stated that fuelwood is usually not recorded and that the actual amount of wood removals is undoubtedly higher.[236] Harvesting trees for fuelwood, a major cause of deforestation in other tropical areas of the world, especially in Africa, is only a secondary contributor to deforestation rates in Latin America.[237] Table 7.10 presents the trends of industrial- and fuelwood removals in Latin America, Africa and Asia. The FAO has outlined that the reported figures on fuelwood removals are particularly weak, as a large part of fuelwood gathering is informal.[238]The decrease in removals of fuelwood presents a reduced demand for this product in the region, but was partly offset by an increase in removals of industrial wood.

[235] Stanford University. "Selective Logging Causes Widespread Destruction Of Brazil's Amazon Rainforest, Study Finds." ScienceDaily 24 October 2005

[236] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38. Rome (also available at www.fao.org/forestry/site/10368/en).

[237] Jaramillo,C.F. and T. Kelly. 1998. Deforestation and Property Rights in Latin America. IDB. Washington D.C. Mimeo.

[238] FAO (2006) Global planted forests thematic study: results and analysis, by A. Del Lungo, J. Ball and J. Carle. Planted Forests and Trees Working paper 38. Rome (also available at www.fao.org/forestry/site/10368/en).

Table 7.10 Industrial- and fuelwood removal figures from 1990, 2000 and 2005

	Induastrial roundwood removals in 1990 (in million m³)	Fuelwood removals in 1990 (in million m³)	Induastrial roundwood removals in 2000 (in million m³)	Fuelwood removals in 2000 (in million m³)	Induastrial roundwood removals in 2005 (in million m³)	Fuelwood removals in 2005 (in million m³)	Fuelwood remolvals in 2005 in %of total
Latin America	144	302	207	183	224	173	44
Africa	54	445	69	547	75	591	88
Asia	239	215	192	195	174	189	52

Source: FAO 2006

Illegal logging

Illegal logging of trees presents a further serious problem for the forestry sector in Latin America. The drivers behind illegal logging and its exact extent remain hard to detect, also due to a lacking common legal definition. Furthermore, the following factors, with some of them already surfaced above, are believed to enhance illegal logging[239]:

- unclear or poorly enforced forest tenure;
- weak political institutions;
- poverty;
- corruption;
- inadequate natural resources planning and monitoring;
- lax enforcement of sovereign laws and regulations.

Mentioned above, the exact extent of illegal logging in Latin America, in terms of forest area lost due to illegal logging remains unclear as different estimations exist. Estimates vary widely and depend on what is perceived as "illegal". For the case of Latin America, estimations for illegal logging range from 20-90% for Brazil, 80% for Bolivia, 70% for Ecuador, 80-90% for Peru and 42% for Columbia.[240] As illegal logging is believed to play a greater role for local people and firms, only 5 to10 percent of the global round wood production is assumed to be derived from illegal logging.

7.2.2 Underlying causes of deforestation

The most important underlying causes in Latin America are (in order of importance): economic, institutional and cultural. In addition, certain technological and demographic causes can be identified. The most prominent underlying causes are presented below.

Population growth

Among the causes for deforestation is the issue of population growth. In 2008 the Latin American population was at approximately 500 million, and it is expected to increase by 50% by 2050.[241] Furthermore, the per capita consumption in Latin America is below the level of the developed world, and it can be expected that the overall consumption will

[239] Seneca Creek Associates, LLC & Wood Resources International, LLC, 2004.
[240] Ibid.
[241] Grau, H.R., Aide, M. (2008): Globalization and Land-Use Transitions in Latin America. Ecology and Society 13(2): 16.

increase as well.[242] The growing population on the one hand and the economic growth on the other hand demand for more natural commodities and are likely to cause more deforestation as rural and agricultural lands will inevitably have to increase.

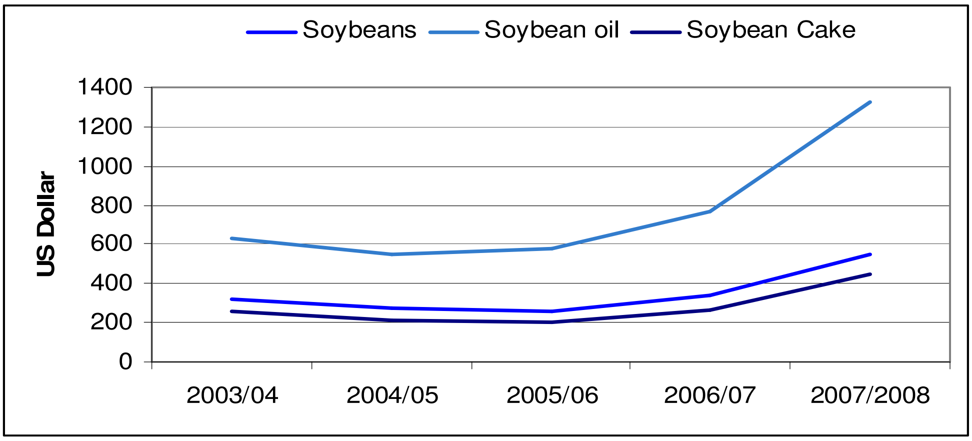
Market growth

Since the enforcement of Structural Adjustment policies as recommended by the International Monetary Fund and the World Bank throughout some Latin American countries, these economies have applied economic development proposals based on the export of raw materials. Export oriented industrial agriculture has therefore become the main driver of deforestation in Latin America. In countries such as Brazil, Bolivia, Paraguay, and Argentina, extensive areas of seasonally dry forests with enough rainfall for rain-fed agriculture are now being deforested, mainly for soybean production. The largest portion of this soybean yield is exported to China and the European Union.[243]

The above mentioned increase in soybean production, which is to some extent based on transgenetic cultivars, is also beneficial as these "cash crops" are able to supply cheap calories and protein to the growing population in Latin American countries but especially in Southeast Asia.[244]

The increasing demand in international commodity markets (e.g. cash crops) is a driver of deforestation as the value attached to the land and minerals covered by forests has been consistently increasing throughout recent years. Recent trends over the first quarter of 2009 show that deforestation decreased by some 70 percent due to falling commodity prices. The figure below presents the price developments for various soy products over the past years.

Figure 7.17 International Soybean product price development in US Dollar per tonne



[Source: FAO monthly price and policy update February 2009]

A large number of studies address the causes of deforestation. However, there are not many studies addressing the effect of cash crop agriculture on deforestation and therefore a lack of empirical data exists.

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242 Grau, H.R., Aide, M. (2008): Globalization and Land-Use Transitions in Latin America. Ecology and Society 13(2): 16.
243 Ibid.
244 Ibid.

Yet another issue is that part of the agricultural land is claimed by other export cash-crops such as sugarcane. If the trend is sustained, this may exacerbate the competition for land use and the resulting risk of deforestation, as low-income groups will be in inclined to cut (new) forest to make land available for grazing and subsistence agriculture.

Market failures
Besides the growing demand for commodities derived from forests, certain market failures have occurred due to failed agricultural policies and enhanced deforestation. Efforts to promote agricultural production systems characterised by high biodiversity but also low productivity have not been sufficient to meet the demand for agricultural products of a growing population.[245]

Income and employment
In Latin America, the forestry industry plays an important role in many countries economies. Once again focussing on Brazil, the forestry sector accounts for 7.1 percent of exports, ca. 2 million jobs, and about 4 percent of the GDP (based on FAOSTAT Data).

Agrotechnological change
The size of farms and the use of technology have an impact on deforestation. According to a study which addressed the interrelation of technical efficiency and tropical deforestation in the Brazilian Amazonian Forest, the technology used and the size of farms has an impact on deforestation. Farms which use very outdated and less efficient technology for their agricultural activities cause more deforestation. Interesting is the fact that the same counts for farms using very efficient and modern machinery as well as technology as these farms are able to reclaim more land for the agricultural activities. Technology is therefore closely linked to the deforestation rate through the intensification of agricultural production within the commercial branch due to technological improvements on the one side, and the intensification of slash and burn farming in the subsidence sector due to a lack of technology on the other side. The same study further states that smaller farms convert more forested land into agricultural land than large landowners.[246]

It has been mentioned that various soy cultivations make use of transgenetic cultivars. This can also be regarded as a technological factor as the transgenetic soybeans are now suitable for geographical regions that were ineligible for non-transgenetic cultivars. As these cultivars find their way into new regions massive transportation infrastructure projects (waterways, highways, railways, etc) are required and additional forest area has be cleared.[247]

Governance
Governance, including policy and institutional factors are important underlying factors of deforestation and forest degradation. For Latin America the main issues are the following:

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[245] Grau, H.R., Aide, M. (2008): Globalization and Land-Use Transitions in Latin America. Ecology and Society 13(2): 16.
[246] Marchand, S., (2009): Technical efficiency, farm size and tropical deforestation in the Brazilian Amazonian Forest. MPRA Paper No. 13648. Online at http://mpra.ub.uni-muenchen.de/13648/
[247] Manta Nolasco, 2007 and Azevedo-Ramos, 2008.

- **Voice and Accountability**: Another aspect, as far as governance of environmental and forest policies are concerned, is the lack of participation of social organizations, indigenous people, black people and peasant communities in policy design and implementation. It is argued that the knowledge potential of indigenous people related to forest land and environmental maintenance is not taken into account by not actively involving these communities in the policy making process. Furthermore, the indigenous groups and organic cultural regimes do not cope with the goals the capitalist regimes (State, capital) strive to achieve.[248]

  Non-recognition of local communities: It has surfaced that indigenous people and local communities are thought to have substantial knowledge as far as forest land and environmental maintenance is concerned. Nonetheless, the inclusion of local communities and indigenous groups in the policy making process remains weak. Grau and Aide state that in some cases, logging concessions have been granted without asking local and indigenous communities living in those areas first. In other cases, concessions had been titled to both, the local communities and the concessionaires which caused severe conflict and in the end increased deforestation. The study states that a stronger involvement of indigenous and other traditional communities could enhance that forests are managed in a more sustainable manner.[249]

- **Political Stability**: Latin America is often seen as relatively political stable. However, the World Bank's Worldwide Governance Indicators from 1996 to 2007 indicate a shift among Latin American countries. While the report rates Uruguay and Costa Rica amongst the 25% of countries worldwide with the highest degree of political stability, most Latin American countries, amongst them Brazil, Argentina and Mexico are rated not to belong to the 50% of worldwide countries with the highest rate of political stability. The politically most unstable country in Latin America is rated to be Colombia, belonging to the 10% of most politically unstable countries in the world.

- **Government Effectiveness/Regulatory Quality**: Land policies and property rights: Tenure issues and policies play an important role in the manifold dynamics associated to deforestation in Latin America. At present, many Latin American governments do not have the capacity to fully enforce adequate agrarian reforms which distribute land equally and may also provide financial assistance to poor farmers.[250]

  In many Latin American countries, a lack of property rights exists in agricultural and forest areas and many regions experience inefficient agriculture and land use. According to economic theory, improving property security in established agricultural areas should increase productivity, labour use, and the efficiency of

[248] Manta Nolasco, 2007 and Azevedo-Ramos, 2008.
[249] Grau, H.R., Aide, M. (2008): Globalization and Land-Use Transitions in Latin America. Ecology and Society 13(2): 16.
[250] Jaramillo,C.F. and T. Kelly. 1998. Deforestation and Property Rights in Latin America. IDB. Washington D.C. Mimeo.

land market transactions.[251] As this tenure security is missing - some policies even state that trees are a public resource standing on private lands, and therefore encourage forest exploitation - and governments have further not been able to enforce alternative property regimes for forested areas, the deforestation continues in order to raise agricultural production and establish new settlements.

Policies on economic growth: Surfaced above, several policies have been implemented in order to enhance economic growth rather than protect the environment and forests. Macroeconomic and sectoral policies have stimulated inefficient land uses and enhanced agricultural expansion in many Latin American countries.[252] Subsidies and tax reliefs for agricultural machinery and the construction of infrastructure had the effect of stimulating forest industries and agriculture expansion.[253]

Another aspect that is believed to enhance deforestation in Latin America is the foreign debts of many countries and the related structural adjustment policies by the International Monetary Fund and the World Bank. Gullison and Losos have found that external debts have contributed to economic stagnation and an increase in poverty in Latin America, this, among other factors, has caused the degradation of marginal lands. Furthermore, debt payments are likely to lead to governmental budget cutbacks in environmental spending.

Environmental policies: The lack of clear forest management policies for the conversation of forested areas provides a further incentive for deforestation. The already mentioned promotion of colonisation, infrastructural projects, energy, bio fuel, timber and pulp production fall under such policies.[254] The agricultural reform in the Brazilian Amazonian region has for example promoted the creation of additional settlements and therewith enhanced forest loss.

- **Rule of law**: Weak and centralized regulatory systems: for the most part, Latin American governments do not have the means to enforce effective environmental policies due to poor governance, poor governmental supervision and endemic corruption.[255] However, a study aiming to quantify the impacts of governance on deforestation states that enhanced regulatory quality, corruption control as well as voice and accountability could help again deforestation in Latin America.

- **Control of Corruption**: Some Latin American countries are rated amongst the most active countries worldwide, as far as corruption control is concerned. According to the ranking, Chile belongs to the 10% of worldwide countries with the most effective control of corruption, followed by Uruguay in the 75-90th percentile. On the lower end as far as this indicator is concerned are Nicaragua,

[251] Jaramillo,C.F. and T. Kelly. 1998. Deforestation and Property Rights in Latin America. IDB. Washington D.C. Mimeo.
[252] Azevedo-Ramos, C. (2008): El desarrollo sostenible y los retos de la deforestación en la Amazonia brasileña: lo bueno, lo feo y lo malo. Unasylva 230, Vol. 59, 2008.
[253] Jaramillo,C.F. and T. Kelly. 1998. Deforestation and Property Rights in Latin America. IDB. Washington D.C. Mimeo.
[254] Azevedo-Ramos, 2008 and Grau and Aide, 2008.
[255] Jaramillo,C.F. and T. Kelly. 1998. Deforestation and Property Rights in Latin America. IDB. Washington D.C. Mimeo.

Ecuador, Paraguay and Venezuela.All these three countries rank within the lowest 10t-25th percentile of worldwide countries.

Consumption patterns

Cultural homogenization, as far as consumption patterns are concerned, can be seen as a further cause for deforestation. Latin American countries still have a low per capita consumption level compared to the developed world. This per capita consumption will increase as the regions economy grows and the changes in diet will increase the regional and global demand for food. The "soy-boom" presents a good example as soy beans easily help to feed the growing global population. The implications of the "soy-boom" on deforestation may even be amplified in Latin America due to existing consumption patterns in many Latin American countries. The daily nutrition in countries as Brazil, Argentina or Paraguay consists to great extent of meat. Therefore large agricultural areas are occupied by cattle farming. In order to gain space for soy cultivation, forest has to be cut.[256]

7.2.3 Actors and policy framework

The deforestation and land-use in general throughout Latin America is driven by a complex set of actors as well as international and national economic and demographic developments.[257] These actors all follow different goals which often correlate and therefore cause further deforestation. The most influential actors and their goals are seen as the following:

Primary actors:

- *(Small-scale) Farmers* from the poor social stratum using deforestation as a method to provide new land for food crop cultivation;
- *(Large-scale) Farmers* looking for new land in order to increase "production" of food crops (e.g. soy beans) and cattle for export;
- National and international wood and timber companies; as well as
- The mining industry.

Secondary/tertiary actors:

- *National companies* looking for additional land to harvest non-food crops e.g. sugar cane for the production of biofuels;
- *Governmental bodies/politicians* (local, national, international) interested in economic growth and pressured to provide infrastructural development for a growing population. These politicians often have to implement contradictory policies as far as forest and environmental conservation is concerned.

Each of the presented actors faces certain pressures and constraints caused by the mentioned international and national economic and demographic developments. The so-called primary actors have to be seen as the ones directly responsible for deforestation. In this respect the subsidence and commercial farmers, the wood and timber companies as

[256] Grau, H.R., Aide, M. (2008): Globalization and Land-Use Transitions in Latin America. Ecology and Society 13(2): 16.
[257] Ibid.

well as the mining industry has to be mentioned. These actors directly see an advantage and direct value in clearing forested land and using the wood or land for further agricultural or industrial purposes. These actors are partly driven by individual considerations and pressures (e.g. in the case of the increasing number of small scale farmers that has to nourish his growing family) as well as regional, national and international market demands (e.g. commercial large scale farmers, timber and mining companies having to supply commodities to satisfy growing demand). The group of secondary actors includes national governmental bodies and institutions which actively propose and implement policies related to deforestation. In Latin America this group has indirectly promoted deforestation by primary actors through policies in favour of agricultural expansion and infrastructure development.

A third category of actors comprises international governmental bodies, institutions and companies that indirectly stimulate deforestation without being directly involved in the country where deforestation takes place. This actor group promotes economic and political stimuli which may raise the demand for which primary actors then have to directly engage in deforestation. Examples for Latin America can be seen in the import substitutions applied by the EU for importing soy oil from Latin America and the industrial expansion by China implying increasing demand for minerals. The growing demand for resources linked to or from forests in other regions of the world presents an incentive for Latin American countries to increase supply as well. In order to profit from increasing demand and prices, many industrial sectors are eager to develop further and exploit more natural resources. This process then leads to deforestation.

7.2.4 Possible solutions

As this qualitative case study as well as more quantitative estimations of previous studies[258] have shown: in the Latin American (Amazon) region biodiversity is lost at a rapid pace due to very high deforestation and thus habitat destruction rates. This negative trend is likely to further intensify in the future.

Similar to the Congo Basin forest biodiversity hotspot, the most effective approach to tackling biodiversity loss drivers in this region of the world is probably to focus on the underlying causes.

Possible solutions to start addressing the main bottlenecks - the underlying causes of forest biodiversity loss in this region - include:

- ✓ Tackling poverty and inequality issues;
- ✓ Improving property rights for indigenous peoples;
- ✓ Mainstreaming various sectoral policies to support biodiversity protection.

Slowly, these steps should then lead to better opportunities in the future for:

- ✓ Strengthened regulatory systems (e.g. to reduce corruption; penalise illegal logging, etc.).

[258] ECORYS-IIASA study on avoided deforestation (DG ENV 2009).

Furthermore, the following international efforts could help foster momentum for moving towards further improvements of biodiversity protection in the Amazon region:

- ✓ Signing an international payment system for ecosystem services (REDD). In terms of the current ongoing REDD discussions, a market-based mechanism would be the preferred policy solution for Latin America;
- ✓ Agreement on clear international framework for biofuels production (including criteria, standards, etc.).

When reviewing the more direct causes of forest biodiversity loss for this region of the world, in particular, increased biofuel production demands, as well as increased meat demand cause the highest vulnerability to intensified rates of deforestation. Infrastructure expansion and increased wood demand play a less important role as drivers of deforestation in this region. Since it is very likely that, in the short and medium term, worldwide demand for biofuels and meat will indeed increase, future policy efforts to reduce deforestation and thus to address the more direct causes of biodiversity loss, could focus on improving policies and law enforcement regarding plantations for growing biofuels as well as for conversion of forests into cattle grazing land.

7.3 Case study 3c: Forest ecosystems in Tanzania

Tanzania is one of the most biodiverse countries in Africa. In particular its woodland, montane and coastal forests boast large numbers of species and a high value in mammal species.[259] The country also includes one of the world's 20 biodiversity hotpots: the Eastern Arc Mountains. This large national biodiversity is found in a range of biomes, from coral reefs in the Indian Ocean to coastal mangrove forests, various types of wetlands, tropical forests, savannah woodlands, etc.[260]

75% of the population still live in rural areas and thus rely heavily on the use and conservation of natural resources: plants animals and fisheries provide a crucial source of food, forests provide fuel and perform water catchment services, land is key for farming and livestock husbandry. Additionally, Tanzania has built up a thriving tourism industry based on its wildlife resources.

Ever since the colonial era, centralised conservation policies have prevailed in Tanzania, thus limiting opportunities for community engagement. For example, an exclusionary protected area approach is used in national parks and game reserves. This has turned Tanzania into on the world's countries with the highest proportions of protected lands: 26% of the country is under strict protection and new protected areas are still being created.

Despite these protection efforts, biodiversity levels are decreasing in Tanzania. Part of the overall problem is the current inadequacy or lack of inventories of biodiversity resources in protected areas and consequently the limited knowledge of the biodiversity potential and extinction rates. This lack of inventories and cataloguing is exacerbated by the fact

[259] Mwalyosi, R. and Sosovele, H. (2001)

[260] Bisanda (2003).

that the country lacks experts and educational programmes in the fields of physiology, pathology, anatomy and taxonomy.

7.3.1 Direct causes of biodiversity loss

Four key direct causes of terrestrial biodiversity loss can be identified for Tanzania.[261]

Agricultural expansion
One of the most important direct causes of biodiversity loss is unsustainable use of existing pastures and continuous expansion of agricultural lands. The migratory lifestyle of many rural indigenous populations further adds to the overgrazing and continuous deforestation for the production of food.

Wood extraction
Forests are of vital economic importance in Tanzania and thus, if improperly managed, there is much room for overexploitation and deforestation. The forestry sector employs about 1 million people officially, and 5-10 times more unofficially and on a part-time basis. Forest products account for 10-15% of Tanzania's export earnings and 2-3% of its GDP. 75% of the country's construction material consists of wood. Furthermore, 100% of indigenous medicinal products stem from the country's forests. The national carbon value (carbon sequestration) has been estimated at US$664 to US$1,500 depending on the information source.[262]

Illegal logging
Illegal logging operations operate in many parts of Tanzania, mainly driven by increasing demand for timber from Asia and a lack of effective controls. This often occurs with the full support of village leaders and high-level staff in district and national government. Current centralised management and law enforcement structures thus are not adequate to counteract this direct cause of biodiversity loss.

Mining
Yet another key direct cause of biodiversity loss is the conflict between the fact that the highest percentage of terrestrial biodiversity in Tanzania occurs in protected areas and as a consequence conflicts over the value of biodiversity often ensue between the important national mineral extraction sector and the natural resources sector when minerals occur in these protected areas.

7.3.2 Underlying causes of biodiversity loss

As is the case for most countries, Tanzania also faces a complex web of underlying causes of biodiversity loss. The two most important underlying drivers of biodiversity

[261] Mwalyosi, R. and Sosovele, H. (2001).
[262] URT and Danida (2007).

loss in Tanzania are its rapid population growth as well as various institutional and governance factors.[263]

Population growth
The rapid growth of rural and urban populations leads to loss of habitats due to settlement expansion, agricultural expansion, grazing around new settlements, as well as intensifying mining and logging activities. See population growth predictions for Africa presented in case study 3a.

Institutional factors
While progress has been made over the past decades in improving specific environmental policies, such as a Sustainable Wetlands Management Programme, or the National Biodiversity Strategy and Action Plan, there is still a **lack of umbrella environmental legislation** to make these individual efforts the central policy focus and to incorporate them into other sectoral policies.

Another ongoing institutional weakness for enforcing already existing biodiversity related policies, are the currently **inadequate quality control mechanisms**, as well as the often **improper execution of established planning processes and regulations** throughout the country.

Yet another inconsistency between existing institutional mechanisms for biodiversity protection and continued environmental degradation is the fact that **most biodiversity hotspots**, including the Rufiji Delta, coastal forests and Eastern Arc Mountain catchments, **remain unprotected** and open to overuse and wanton destruction.

Finally, the highly centralized approach to natural resource management in the past has resulted in **poor interaction between stakeholders**. This is yet another mismatch of the national institutional approach and the situation on the ground, where daily management and use of natural resources in reality is performed primarily by players in communities and thus **community related issues** and activities ought to be addressed for appropriate biodiversity conservation policy-making.

7.3.3 Actors and policy framework

As mentioned before, Tanzania has developed various policies relevant for biodiversity conservation. This section highlights a few of the most relevant and interesting policies and actors.

National Biodiversity Strategy and Action Plan
One of the most relevant ones is the National Biodiversity Strategy and Action Plan. This plan was developed based on the Guidelines for National Biodiversity Planning by the World Resources Institute, UNEP, and IUCN. During the drafting process starting in 1998, the Division of Environment in the Vice President's Office (the focal point for the Convention on Biological Diversity) was mandated to establish partnerships with

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263 Mwalyosi, R. and Sosovele, H. (2001).

Government sectors and institutions, NGOs, Community leadership as well as industry and business community, with a view to solicit balance and viable inputs for the formulation of the NBSAP. The action plan that was developed via this consultative process is meant to address the implementation of the strategic choices within the broader themes related to biodiversity, thus:

- Policy Issues and International Co-operation;
- Planning and Co-ordination;
- Education and Information;
- Research and Development;
- Ecosystems and species conservation and sustainable utilization;
- Biodiversity Monitoring and Evaluation; and
- Capacity building.

The NBSAP is yet to be adapted by government for implementation in Tanzania. Thus, nothing can be said about the effectiveness of implementation. However, one of the potential constraints for implementing this programme will be the political will and capacity (both financial and human) by the lead and collaborating institutions to perform their roles as proposed by the programme.

National Forest Policy

In 1998, Tanzania also implemented its National Forest Policy which encourages for the first time participatory forest management (PFM) and seeks to integrate biodiversity values in forest management. Under the Land and Village Land Acts (1999) and the Forest Act (2002), communities can now register unreserved forest land as village forests to gain full ownership and management responsibility. This legal transfer of rights and responsibilities from central to village government is better known as community-based forest management (CBFM). This revised national forest policy thus builds substantially on local experience with community forestry. Prior to implementation of this new policy, a number of pilot projects had been initiated in the early 1990s. including the HASHI community-based forest management project for soil conservation (see Box 7.2). The success of the HASHI and similar pilots implemented by a range of actors and supported from bilateral donors played a crucial role in brining about the new participatory forest management policy because they demonstrated the viability of PFM under a range of social and ecological conditions throughout the country. They also coincided with reforms in Tanzania's economic and political spheres, all of which directly contributed to a favourable legal environment for PFM.[264]

A recent policy assessment in 2006 found that PFM is operating or being established in over 1800 villages and extends to 11% of the total national forest cover. Examples include the East Usambara forests of the Tanga region, highland forests of Iringa, miombo woodlands and coastal forests in the Tanga, Mtwara and Lindi regions.[265]

[264] Krystyna Swiderska, et al (2008).
[265] Blomley (2006).

Box 7.2 The HASHI community-based forest management project

Trees are key components of natural resource and risk management in dry, risk-prone environments. They provide food and medicines, fodder for livestock and building materials, and also have important cultural value. *Ngitili* or "enclosure" is an indigenous resource management system used by pastoralists and agropastoralists in such environments to provide dry season food and fodder. It involves the conservation of fallow and rangelands by encouraging vegetation regeneration through controlled livestock grazing during the wet season for use in dry times. The concept of these dry season fodder reserves was developed by the Sukuma people in response to acute and frequent drought. The Sukuma people suggested that restoring *Ngitili* was an easier and better option than planting trees, many of which were exotic and not the people's first choice (Barrow and Mlenge, 2003).

A strong memory of the *Ngitili* system and some remaining *Ngitili* provided the basis for HASHI. HASHI has significantly improved incomes, health and education, while regenerating a huge area of degraded woodland. The original objectives of *Ngitili* were expanded to cover other tree products and services required by local people, as well as dry season fodder.

The benefits of *Ngitili*

By 2000, the *Ngitili* approach had spread from 180 to 830 villages (including beyond the project area), with the benefits reaching about 2.5 million people. Forest biodiversity has been restored through 300,000-500,000 hectares of *Ngitili*, in an area previously known as the Desert of Tanzania. The area had been heavily degraded as a result of *tse-tse* fly eradication and agriculture policies. A study of HASHI conducted by the Tanzanian government and IUCN found 152 tree, shrub and climber species in surveyed *Ngitili*, along with small and medium sized mammals and many bird species (Monela *et al.*, 2005).

Average incomes in participating villages have risen to twice the average for rural Tanzanians, due to increased fodder, livestock and fuelwood, and sale of forest products such as honey and poles. The health and nutrition of villagers have improved through an increase in the availability of medicinal plants and fruits from *Ngitili*, and through better water quality. *Ngitili* also act as a safety net in times of crisis. Education services have improved through investment of revenues from *Ngitili*. The GoT/IUCN study found that as many as 64% of households are better off economically. The reduced effort involved in collecting fuelwood, water and fodder has improved women's workloads.

Each community has its own rules for managing *Ngitili;* most are managed by a mix of traditional and modern institutions, but rely strongly on the former (eg. Council of Elders) to enforce regulations and sanctions. This is because traditional institutions cut across hierarchies established by government and can sympathise with diverse people in their communities (Monela *et al.*, 2005).

HASHI has highlighted the following ingredients of successful forest restoration (Barrow and Mlenge, 2003):

- Local need for restoration to supply much needed goods and services.
- Desire by local people to invest in restoration.
- Presence of existing local management institutions.
- Activities by HASHI which catalysed restoration: extension, training and technical advice.
- Sensitive use of external assistance.

Village boundaries have been surveyed to help villagers obtain title deeds, which provide an incentive for future improvement. The National Land Policy (1997), the Land Act (1999) and Village Land Act (1999) have also actively supported the formal establishment of *Ngitili*. Village governments are increasingly empowered to enact village by-laws to protect *Ngitili*, using traditional rules and village guards.

Some challenges

The benefits of *Ngitili* are not evenly distributed. Men own and control land and *Ngitili*, meaning that women often require men's consent to harvest from *Ngitili*. Furthermore, access to benefits is influenced by socio-economic differentiation among or within communities. The success of *Ngitili* is in some ways widening this gap. Resourceless people are unable to own *Ngitili*, especially in areas where they would have to purchase land.

Furthermore, the establishment of new *Ngitilis* is limited by scarcity of land, insecurity of tenure, and a fear of prosecution by local authorities (Barrow and Mlenge, 2003). Similarly, the sustainability of existing *Ngitili* is threatened by population growth, land conflict and weak conflict resolution mechanisms. The sustainability of *Ngitili* hence depends to a large extent on the effectiveness of the management institutions and their ability to keep winning community trust in this mission. Key recommendations include (Monela *et al*., 2005):

1. Promote access to markets and added value for *Ngitili* products; and promote high value species and benefits in *Ngitili*.
2. Document and disseminate innovative *Ngitili* research achievements for local use.
3. Remove barriers to *Ngitili* establishment and development, including perverse legal incentives such as punitive laws and regulations, and requirement of centralised logging permits to harvest protected tree species.
4. Strengthen local and formal institutions to promote *Ngitili*.
5. Conduct further research on mechanisms for valuing non-market goods and services.

Source: Krystyna Swiderska, et al (2008). The Governance of Nature and the Nature of Governance: Policy that works for biodiversity and livelihoods.

Inclusion of biodiversity considerations in Environmental Impact Assessments

One final policy to be considered during this case study is Tanzania's effort to include biodiversity considerations in its Environmental Impact Assessments (EIAs) of new projects and programmes. EIA performance in Tanzania to-date has been extremely poor, to the extent that EIA has had only a marginal impact on decision-making and planning. Apart from the lack of EIA policy and legislation as well as lack of supporting guidelines to 'set the rules' for EIA, there are many weaknesses related to quality control mechanisms, poor enabling environment for EIA, inadequate stakeholder involvement, and inadequate local EIA capacity.

In addition to the above weaknesses, biodiversity impact assessment has never been an important element of Tanzanian EIAs. After all, the National Biodiversity Strategy and Action Plan is still being formulated. Therefore, it should not come as a surprise that the impact of EIA on biodiversity conservation and its sustainable use has been largely insignificant. Thus, in the absence of a robust legal and institutional framework for EIA in Tanzania, EIA will continue to be undertaken on ad-hoc basis, and thus will never address biodiversity concerns adequately.

The current EIA practice does not address biodiversity comprehensively and adequately. Where ecological impacts are included, these have focused on brief habitat surveys and species lists of commercial/tourist importance. They have been less likely to address other aspects of biodiversity such as diversity between species and habitats, trends over time, species abundance and distribution, and the functional components of biodiversity. A more ecosystem approach would be needed in the future, which looks at potential impacts on the ecosystem as a whole.

Nevertheless, Tanzania has had some successful experience with a biodiversity-minded EIA approach on a local level: experience in Tanzania's national parks – where EIA policy and guidelines exist – indicate that legislation, if backed by regulatory and compliance monitoring powers, can make an important contribution to effective EIA and biodiversity conservation.

7.3.4 Possible solutions

Similar to the case studies on the Congo Basin and the Amazon region, Tanzania is also a relatively poor developing country with limited financial resources. Typically, these countries face challenges on a variety of urgent issues, including poverty, hunger, HIV/AIDS, etc. and thus environmental issues are typically not a priority on the policy and funding agendas.

Yet another point that has to be taken into account when pondering about potential solutions for Tanzania is the fact that following the ongoing Local Government Reform Programme, the management of biodiversity in Tanzania devolves to the District and local levels. While this definitely offers a large potential advantage for improved community-based management (as shown by the successful Forestry Policy Reform), it may at the same time be difficult for initiatives launched at the national level, such as the NBSAP to be effectively supported and implemented at the district and local levels. This is particularly likely because local governments still lack adequate legal powers and financial resources and thus their newly gained management responsibilities do not match up with their legal status and financial resources.

Bearing this basic situation in mind, various potential future actions to improve the effectiveness of biodiversity conservation and the sustainable use of resources could be implemented in Tanzania. These include:

- Speed up the process of preparing the NBSAP and adopt it for immediate implementation.
- Prepare guidelines for undertaking biodiversity assessment.
- Prepare simple and effective tools to planning and managing biodiversity at local and district levels.
- Integrate biodiversity conservation in national and local economic planning.
- Develop a comprehensive national research/capacity-building programme on biodiversity monitoring.
- Establish and promote training programmes for ecologists, taxonomists and parataxonomists to deal with identification and conservation of biodiversity.

Upscaling biodiversity-focussed EIAs to the national level

Finally, some potential solutions can also be proposed when looking at the more specific task of incorporating biodiversity into the policy assessment framework of all future policies in the country. In case the government would like to upscale the local experience of biodiversity EIAs in national parks to a national scale, supporting guidelines would need to be developed that take account of the current deficiencies identified above. For example, it is important to ensure that screening procedures and guidelines include clear biodiversity criteria, so that projects with potentially detrimental effects on biodiversity are subject to comprehensive EIA. Also, the scoping stage should require that identified impacts related to biodiversity are adequately addressed in the full EIA. Finally, the post-project monitoring and audit stages determine whether or not biodiversity impacts were predicted accurately, and if recommended mitigative measures are effective. More important the approach should seek to identify opportunities for sustainable use of resources and enhancing biodiversity. Thus, biodiversity impact assessment demands a more sophisticated investigation and analysis of potential impacts on an ecological unit and the species and communities within it.

These changes will definitely take time. However, in the meantime, good practice in considering biodiversity can be established and promoted. For example, case studies could be identified and publicised, to illustrate what can be achieved.

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