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Requirements of climate protection with regard to the quality of ecosystems: Use of synergies between the Framework Convention of Climate Change and the Convention on Biological Diversity

by

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On behalf of the Federal Environmental Agency

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Foreword

It has been almost ten years since the international community adopted both the Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD) at the World Summit in Rio de Janeiro. A huge workload has been tackled in recent years in order to flesh out the two conventions and speed up their implementation. In this context, both UN conventions have been supplemented by protocols which serve to implement their objectives, such as the Kyoto Protocol or the Biosafety Protocol.

Yet, the international community is currently confronted with problems which can only be solved if cooperation and coordination takes place between the two conventions' bodies, which have until now acted independently of each other. In particular, it is a question of preventing climate protection measures having potential negative impacts on biodiversity, which may arise in the case of some afforestation projects or the construction of large dams. The need to identify and utilise synergies results from the functional relationship between the biosphere and the climate system and from the objectives of UNFCC and CBD, whose ultimate goal is sustainable development.

Initial steps towards this end have already been taken at convention level. For example, the Intergovernmental Panel on Climate Change (IPPC, the scientific panel of the UNFCCC) is currently preparing a technical document on climate change and biodiversity at the request of the CBD secretariat. Likewise, an expert group set up under the Convention on Biological Diversity will present a comprehensive report on climate change and biodiversity.

In addition to this, especially the Contracting Parties of both conventions should strive to support the convention bodies in searching for ways to identify and promote tasks for intensified cooperation at both international and national levels. One possibility for this has opened up through the newly established executive board of the clean development mechanism under the UNFCCC, which will verify climate protection projects, and through the Joint Liaison Group which has recently been set up between the two conventions. Tasks at national level include, for example, improved coordination between action plans on climate protection and species protection and in the areas monitoring and mandatory reporting, and ensuring a mutual exchange of information.

The present report which gives a detailed thematic analysis of the links between climate protection and protection of biodiversity is a contribution to the necessary discussion on how to avoid undesirable developments in the implementation of protective measures, and provides input to the negotiation process at a time when methodologies and verification tools are on the agenda.

The report is an innovative contribution by Germany aimed at promoting cooperation between the two UN conventions and consolidating the European Union's leading role in the negotiations on both climate and species protection.

Prof. Dr. Andreas Troge
(President of the Federal Environmental Agency)

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16. Abstract The report identifies synergies and conflicts in the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD), the Ramsar Convention on the protection of wetlands and the international forest process. Currently discussed options for climate change mitigation under the FCCC include land-use, land-use change and forestry activities, which can have both positive or negative impacts on biodiversity and ecosystems. On the other hand, activities undertaken under the CBD can have an impact on the ability of ecosystems to provide climate-relevant services like carbon sequestration, regulation of N2O and CH4 emissions, water cycling and the energy budget. Synergies between climate change mitigation and biodiversity conservation can be reached in the areas of conservation of old-growth forests and wetlands. Clear conflicts could arise e.g. from the introduction of exotic species for carbon sequestration, the construction of hydroelectric dams or from the implementation of so-called "hard" adaptation technologies under the Kyoto Protocol. Most mitigation and adaptation activities discussed under the Kyoto Protocol, however, have ambivalent effects on biodiversity and climate-relevant processes that depend largely on the ecosystem type and the management practices chosen. The report discusses instruments such as guidelines, indicators, impact assessments, positive lists or participation of stakeholders that could promote the consistence between climate change mitigation and biodiversity conservation. The report also presents recommendations for improved cooperation between the conventions in the areas of monitoring, reporting, protected areas, financial resources , the financial mechanism of the conventions and further research needs.		
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LIST OF ABBREVIATIONS

ACSAD	Arab Centre for Studies of Arid Zones and Drylands
AOAD	Arab Organization for Agricultural Development
ATO	African Timber Organization
BAHL	Biosperic Aspects of Hydrological Cycle
bST	Bovine Somatropin
CBD	Convention on Biological Diversity
CCAB-AP	Consejo Centroamericano de Bosques y Areas Protegidas
CCAD	Central American Commission on Environment and Development
CCD	Convention to Combat Desertification
CDM	Clean Development Mechanism
CGE	Consultative Group of Experts on Non-Annex I National Communications
CIFOR	Center for International Forest Research
COP	Conference of the Parties
CSD	Commission on Sustainable Development
ECOSOC	Economic and Social Council
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organisation
FCCC	Framework Convention on Climate Change
FMU	Forest Management Unit
GBIF	Global Biodiversity Information Facility
GEF	Global Environment Facility
Gg	Gigagram = 10^9 gram
GHG	Greenhouse Gas
GPP	Gross Primary Production
GWP	Global Warming Potential
IFF	Intergovernmental Forum on Forests
IGBP	International Geosphere-Biosphere Programme
IPCC	International Panel on Climate Change
IPF	Intergovernmental Panel on Forests
ITTA	International Tropical Timber Agreement
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature and Natural Resources
JI	Joint Implementation
KP	Kyoto Protocol
LAI	Leaf Area Index
LUCF	land-use change and forestry
LULUCF	land-use, land-use change and forestry
MCPFE	Ministerial Conference on the Protection of Forests in Europe
NBP	Net biome productivity
NEP	Net Ecosystem Production
ng	nanogram = 10^{-9} gram
NGO	Non-governmental organization
NPP	Net Primary Production
OP	Operational Programme

PAR	Photosynthetic Active Radiation
Pg	Petagram = 10^{15} gram
RC	Ramsar Convention
SBSTA	Subsidiary Body for Scientific and Technological Advice of the UNFCCC
SBSTTA	Subsidiary Body on Scientific, Technical and Technological Advice of the CBD
SC	Ramsar Standing Committee
SEA	Strategic Environmental Assessment
SFM	Sustainable Forest Management
SOM	Soil organic matter
STRP	Scientific Technical Review Panel (Ramsar Convention)
Tg	Teragram = 10^{12} gram
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WCFSD	World Commission on Forests and Sustainable Development
WWF	World Wildlife Found

ABSTRACT

The report identifies synergies and conflicts in the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity, the Ramsar Convention on the protection of wetlands and the international forest process. Interlinkages between climate change and biodiversity conservation are discussed at the scientific and the policy level.

Currently discussed options for climate change mitigation under the FCCC include land-use, land-use change and forestry activities, which can have both positive or negative impacts on biodiversity and ecosystems. On the other hand, activities undertaken under the Convention on Biological Diversity (CBD) can have an impact on the ability of ecosystems to provide climate-relevant services like carbon sequestration, regulation of N_2O and CH_4 emissions, water cycling and the energy budget. Synergies between climate change mitigation and biodiversity conservation can be reached in the areas of conservation of old-growth forests and wetlands. Clear conflicts could arise e.g. from the introduction of exotic species for carbon sequestration, the construction of hydroelectric dams or from the implementation of so-called "hard" adaptation technologies under the Kyoto Protocol. Most mitigation and adaptation activities discussed under the Kyoto Protocol, however, have ambivalent effects on biodiversity and climate-relevant processes that depend largely on the ecosystem type and the management practices chosen. The report discusses instruments such as guidelines, indicators, impact assessments, positive lists or participation of stakeholders that could promote the consistence between climate change mitigation and biodiversity conservation. The report also presents recommendations for improved cooperation between the conventions in the areas of monitoring, reporting, protected areas, financial resources and the financial mechanism and further research needs.

The report was carried out on behalf of the Federal Environmental Agency of Germany and is intended to provide inputs to the ongoing policy process under the FCCC and the CBD.

Executive Summary

The UN Conference on Environment and Development in Rio in 1992 started a series of negotiations of conventions, protocols and other instruments in different environmental areas. The most important processes and results are currently:

- The Framework Convention on Climate Change and the Kyoto Protocol,
- The Convention on Biological Diversity and the Protocol on Biosafety,
- The Convention to Combat Desertification,
- A number of international initiatives on forest issues, which addressed the issue in the Statement of Forest Principles and Chapter 11 of Agenda 21. Many of these initiatives fed into the Commission on Sustainable Development's (CSD) review of Agenda 21's Chapter 11 in 1995, the Intergovernmental Panel on Forests (IPF) and the Intergovernmental Forum on Forests (IFF),
- The Convention on Wetlands of International Importance which already entered into force in 1971 and broadened the focus from protection of wetlands for birds to the general protection of wetland ecosystems.

The international work process under these Conventions is split into separate processes, which focus on different functions and aspects of multifunctional ecosystems and biological units. These different perspectives might lead to synergies as well as to conflicts between the Conventions. A systematic analysis of positive and negative impacts is still lacking. This report focuses on the climate system and analyses the effects of biological units on the climate system. The objectives of this study are

- a compilation of all impacts of biota on the global atmosphere and of the key functions and roles of ecosystems in the global and regional carbon cycle, for the radiation balance and the water cycle;
- the analysis of the negotiation and implementation processes under the FCCC and the CBD with the question, whether existing research of biota's influences is taken into account;
- the analysis of linkages, especially of synergies and conflicts, of different international conventions (FCCC, CBD, Ramsar Convention and Forest process);
- the analysis of the relationship between the protection of biodiversity and the resulting goods and services in relation to the FCCC,
- the elaboration of recommendations for the policymakers for the ongoing international negotiations, especially with regard to specific rules and procedures under the FCCC.

1.1 Interactions and influences between biological units and the climate system

The biosphere, its living organisms and organic substance play a major role for the regulation of climate processes and global warming (IPCC 2000, WBGU 2000). The main processes or **key functions** through which the terrestrial and marine biota influence the climate are

- **carbon release and uptake,**
- **albedo and radiation balance,**
- **water cycling** (especially evapotranspiration)emissions and uptake of **other greenhouse gases** such as **methane and nitrous oxide.**

These processes occur naturally in ecosystems, but human activities, above all land use change, have altered the process rates significantly. By changing the distribution of biological units and by changing biogeochemical cycles within these units, their ability to perform climate-stabilizing ecosystem services is significantly altered. Climate change itself feeds back on these processes, changing the role ecosystems can play in the mitigation of global warming. The main report reviews these key functions of the biosphere for the climate system and evaluates the role of human-based activities on these biological units. Table 1 gives a **summary of the functional significance of the biological units for climate-related processes**. The analysis shows that **all biological units have some significance for the different functions in the global climate system**.

Table 1: Qualitative estimates of the functional significance of biological units for climate-relevant cycles and processes

Process	Forest			Grassland		Desert	Marine Biota
	Tropical	Temperate	Boreal	Savanna	Tundra		
Albedo	-	-	--	0	+	++	-
Water cycling	++	+	-	-	?	--	-
NPP	++	++	+	0	-	--	-
Carbon storage	++	+	+	0	+	-	++

++: very high, +: high, 0: medium, -: small, --: very small, ? uncertain.

Source: WBGU 2000

1.2 Relationships and impacts between biodiversity and the climate system

The consequences of declining biodiversity are yet unclear, but many studies suggest that **alterations of the biodiversity of ecosystems are able to change biogeochemical cycles in a way that climatic processes and functions are modified**.

At the species level, many case studies have shown that **species richness, species**

composition and **invasions by non-native species** have an **influence on important climate-related ecosystem functions, especially on carbon storage**. For example, many experimental studies in grasslands found a positive correlation between plant species number and productivity that affects carbon storage. Experiences with invasive species can be used to highlight the effects of single species or species composition on ecosystem functions. Research has provided evidence that invasive species can significantly alter carbon cycling and fire regimes in various regions. Influences of biodiversity on methane or nitrous oxide emissions are less well studied.

The performance of some functions for the climate system is often not directly correlated to biodiversity of species, but to structural and functional traits of biotic units. These traits have an influence on energy, carbon and water-related functions of biological units. For example, the mosses in boreal forests insulate and thus stabilize the permafrost layer in the ground. Removal of the moss layer, e.g. by increased fire frequency, can cause a destabilization of the permafrost layer with possible changes in emissions of greenhouse gases like methane or CO_2. Boreal regions are characterized by **low redundancy in each functional group and by large oscillations of population dynamics by insect pest invasions and fire. In such areas, the impact of removal of one species on the performance of key functions can be high.** In arid ecosystems, the elimination of a group of plants actively using soil water at a particular season or from a particular depth in the soil could lead to a decrease in productivity if that water is lost from the system. Arid lands are significant determinants of the earth's albedo. This is influenced by total plant cover, but also by the different properties of woody plants versus herbaceous plant cover.

1.3 Functional synergies and conflicts between the CBD and the FCCC

Mitigation activities that are discussed under the Kyoto Protocol, e.g. sequestration activities under Articles 3.3 (afforestation, reforestation, deforestation) and 3.4 (additional activities) or adaptation measures can have positive or negative impacts on biodiversity conservation. Table 19 summarizes the possible synergies and conflicts between climate change mitigation and biodiversity conservation. **Only few activities discussed under the FCCC are clearly positive or negative for biodiversity, with the exception of the conservation of natural ecosystems.**

Whether **impacts** of activities are **positive or negative for biodiversity** mainly **depend on**

- the selection of **practices within the activity**,
- the **management options** related to the activity,
- **biological and physical conditions of the area** where the activity takes place,
- **socio-economic conditions** of the region where the activity takes place.

Table 2 Summary of possible impacts on biodiversity of land use activities considered under the Kyoto Protocol

Possible land use activities	Circumstances for positive impacts on biodiversity	Circumstances for negative impacts on biodiversity
Conservation of natural forests	General positive	Priority areas for conservation could be different
Conservation and restoration of wetlands	Conservation general positive, further research needs	Restoration positive for biodiversity, but could result in increase in CH_4 and N_2O emissions
Afforestation and reforestation	• On degraded pasture and agricultural sites • If natural regeneration and native species are used that reflect structural properties of surrounding forests • If mixed age classes stands are established • If clearing of pre-existing vegetation and thinning is minimized • If chemical use is minimized • If areas for habitats for different species are considered • If rotation length is extended • If tree density respects biodiversity needs • If low impact harvesting methods are used	• On areas where natural ecosystems are destroyed for the activities • If monocultures of exotic species are used on large areas • If single age-class stands are established • If other vegetation is completely cleared before and during the activity • If chemicals are used abundantly • If no habitats are created • If short rotation periods are used • If tree density is very high • If harvesting operations clear complete vegetation • If sites with special significance for the in-situ conservation for agrobio-diversity are afforested
Restoration of degraded lands/ ecosystems	• Often positive because restoration increases species richness • Positive effect will depend on the definition of "degraded"	• Habitats of species that are adapted to extreme conditions could be destroyed • Possible increase on N_2O emissions because of fertilizer use

Possible land use activities	Circumstances for positive impacts on biodiversity	Circumstances for negative impacts on biodiversity
Forest management	• If natural forest regeneration occurs	• If monocultures of exotic species are planted and natural regeneration suppressed
Agroforestry	Mainly positive if not established on areas of natural ecosystems	Negative if natural forests or other natural ecosystems are replaced
Cropland management	• If reduced tillage is used without increased application of herbicides	• If reduced tillage is used with increased application of herbicides and pesticides • Increase in cropping intensity has mainly negative impacts • If established on areas of natural ecosystems
Grassland and pasture management	• Mainly positive if no natural areas are destroyed • If no exotic species are used • If fire management respects natural fire regeneration cycles	• If established on areas that previously contained natural ecosystems • If non-native species are introduced
Introduction of species	If species are known as non-invasive in the affected ecosystem, restore natural ecosystems and provide habitat for other native species	Mainly negative
Storage dams	-	Large storage dams are mainly negative
Adaptation activities	Adaptation activities that conserve or restore natural ecosystems are generally positive	Adaptation activities that use hard technologies and that strongly change natural ecosystems are generally negative

Source: Öko-Institut

Because of this situation, few unambiguous generalizations can be drawn with regard to recommendations for the eligibility of activities under the FCCC. If the implementation of activities under the FCCC is compatible with the objectives of the CBD depends on the following circumstances:

- if **activities** eligible for accounting could be **defined in such a way** that **practices** and related management options **with negative impacts** on biodiversity **can be excluded**,
- if **adequate rules and criteria** are developed **for the implementation** of eligible activities that ensure that adverse impacts on biodiversity are avoided,
- if **functioning tools and instruments** are developed at the global and the national level that ensure the consideration of adverse impacts on biodiversity with the implementation of activities,
- if **appropriate monitoring and controls** are established that ensure with and after the implementation that negative impacts are avoided and minimized.

1.4 Regions with special significance for biodiversity

The **identification of priority areas under the CBD** could be used either to **promote cooperative activities between FCCC and CBD in specific areas** or to **separate certain areas where mitigation or adaptation activities should either be avoided** or should only be **implemented under stringent conditions** in order to avoid damage to biodiversity.

The selection of priority regions for biodiversity conservation depends largely on the examined aspect of biodiversity (ecosystem, species and genetic diversity). A **comparison of the regions with high significance for biodiversity and** regions with **high significance for the climate system** (WBGU 2000) shows **some overlaps as well as differences between the regions.** Of the 25 biodiversity hotspots, 13 are also important for the climate, three hotspots fall partly into climatically important areas and nine lie in regions that probably have only a low importance for the climate system. These numbers are only preliminary results that are derived from a simple comparison of two maps without exact regional definition. However, they show that **protection of biologically rich regions will not automatically lead to optimum climate protection and vice versa**. Regions like Central Chile or the Cape Floristic Province that show a minor importance for the global climate system may be overlooked if climate stabilization is chosen as a major criterion for conservation priorities. On the other hand, the **overlapping areas indicate regions where measures to mitigate climate change through land-use-related activities should be selected very carefully**.

1.5 Improvement of linkages between the FCCC and the CBD

Potential collaborative activities between FCCC and CBD fall into two main groups:

1. analysis of the impacts of climate change on biological diversity, and
2. the integration of biodiversity considerations in the implementation of the FCCC and the Kyoto Protocol, such as in the implementation of land-use change and forestry activities or adaptation measures.

This report only analyses the second category of cooperation activities and excludes the area of climate change impacts on biodiversity. The main focus of the analysis was a closer consideration of the contributions of the work under the CBD to resolve the conflicts with biodiversity issues encountered with the implementation of the KP.

Recent decisions under both conventions have established new institutional structures aiming at closer cooperation. Work in some important areas was already started. These approaches are first steps to use synergies and should continue.

1.5.1 Key thematic areas under the CBD with relevance for the FCCC

Table 3 provides an overview of the key thematic areas where both conventions are linked including the relevant articles.

Table 3 Overview on interfaces between the FCCC, the KP and the CBD

Topic	Framework Convention on Climate Change / Kyoto-Protocol	Convention on Biological Diversity
Sustainable forestry	FCCC Art. 4.1.d KP Art. 3.3, 3.4, 3.7	CBD Art. 10
Adaptation measures	FCCC Art. 4.1.b, 4.4 KP Art. 12.8	-
Plans, programmes, policies and measures	FCCC Art 4.1.b, Art. 4.2.a KP Art. 2	CBD Art 6, 11
Monitoring	FCCC Art. 4.1.a, KP Art. 5, 7 and provisions under Art. 6, 12	CBD Art. 7
Environmental impact assessment	FCCC Art. 4.1.f,	CBD Art. 14
Financial mechanism	FCCC Art. 11, 4.3, KP Art. 11	CBD Art. 20, 21
Technology transfer	FCCC Art. 4.1.c, 4.5, 4.8, 4.9 KP Art. 10.c	CBD Art. 16
Research and training	FCCC Art. 4.1.g, 5, 6 KP Art. 10.d	CBD Art. 12
Education and public awareness	FCCC Art. 4.1.i, 6 KP Art. 10.e	CBD Art. 13
Forestry and agriculture	Projects in the area of land-use change and forestry FCCC Art. 4.1.d, KP Art. 3.3, 3.4, 6,. 12	Thematic programmes (forest and agriculture biodiversity)

Source: Öko-Institut

The detailed analysis concentrates

- on the **ecosystem approach** as one of the key frameworks developed under the CBD, which is promoted as the framework to be used by other conventions,
- on **in-situ conservation** and the potential relevance of areas of special relevance to

the CBD and their possible use for the purposes of the FCCC,

- on **monitoring and reporting** as appropriate data and information is the fundamental prerequisite for a successful cooperation,
- on **instruments** such as environmental impact assessment (**EIA**) as the application of established instruments across conventions could provide an integrated approach for conflict resolution,
- on the **financial mechanism** as the FCCC and CBD are linked through the use of the Global Environment Facility (GEF) so that GEF provides for experiences in integrating aspects of both conventions.

Ecosystem approach

Conservation organizations promote to adopt and to integrate the ecosystem approach as developed under the CBD in the context of the FCCC and the KP. The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. A more detailed look at the principles and the operational guidance for the ecosystem approach developed under the CBD leaves **some doubts whether the approach is really able to contribute significantly to resolve the problems under the KP**. At least **some of the operational principles** could be read in a way that **no further action under the KP is needed** and that stakeholders at the national or regional level should deal with potential conflicts and adverse impacts. However, the ecosystem approach could provide **useful guidance in other areas** than those described above, but it clearly **does not yet provide the adequate means to balance climate change, biodiversity and social objectives at the implementation level** for project activities or concrete adaptation measures.

Sustainable use

The **services** of the biosphere as **discussed under the CBD** related to climate protection **should** be extended to other services than carbon storages and **include services with regard to water cycle, energy budget and albedo**. Recommendations with regard to sustainable use of forests and grasslands should be developed under the CBD.

Conservation and protected areas

It would be helpful to have a clear **list** from the CBD **that identifies sites of high interest for biodiversity**. For such sites, coordinated and mutually supportive approaches could be developed between activities under both Conventions and LULUCF activities. Project developers at the regional level could more easily be aware of sites where thorough considerations of biological diversity are needed. **Articles 8.c, 8.d, 8.k and 8.l. of the CBD** are key Articles for the linkages between the two conventions because they present the **basis for an effective legal framework for biodiversity protection of all areas within a Party's jurisdiction** at the national level. If such legal frameworks exist, they will provide adequate guidance at the national level to minimize or eliminate potential negative impacts of activities under the FCCC and the KP. Therefore **implementation of these provisions should be promoted and objective assessments of the actual implementation progress by Parties are needed**. The results of such assessments can determine the need for further actions at the global level either under the FCCC or the CBD.

1.5.2 Monitoring, reporting and information exchange

Identification and Monitoring

Article 7 CBD on identification and monitoring is a key article for the integration of both conventions as only the information and data on important components of biodiversity identification allows adequate measures for conservation when mitigation or adaptation activities are implemented. Further work on identification and monitoring is needed under the CBD, such as a programme to further study the direct links between the pressures on and the state of biological diversity. At the **implementation level**, which is important for activities under the FCCC and the KP, there is still a **lack of standardized monitoring programmes for biodiversity issues**. This fact complicates considerably the integration of biodiversity issues in the implementation of activities or projects. The work under the CBD on monitoring issues should be strengthened and promoted to establish an adequate knowledge base for cross-conventional problems. **Easily accessible biodiversity data would also be an important pre-requisite for an adequate integration of biodiversity aspects with mitigation or adaptation activities under the FCCC and the KP**. The global accessibility of monitoring data is also an area where further progress is needed.

The information from Parties presented in their **second national CBD reports** is very valuable to assess **whether and to which degree present monitoring activities in different countries match with the need to monitor adverse impacts of forest related mitigation measures and projects**. If information from second national reports shows that biodiversity monitoring is very limited or inexistent in a country, a more careful approach with regard to project validation and monitoring could be required under the FCCC. An assessment of the existing progress on monitoring of biodiversity could also provide useful information for the scientific discussions on monitoring, accounting and eligibility under the FCCC. Currently only few second national reports are available. Therefore **a more complete assessment of second national reports should be conducted at a later stage**.

The **CBD** is providing work on **biodiversity indicators at the global level**, which has to be rather general, abstract and aggregated to be globally applicable. For the resolution of conflicts between mitigation or adaptation activities **under the FCCC** and biological diversity in many cases **concrete, specific, regional** or **site-specific biodiversity indicators** would be **most useful** and would guarantee to be appropriate and applicable to the specific problems. This means that there is a clear **gap between the progress that can be achieved under the CBD on biodiversity indicators and the factual need under the FCCC and the KP**. The secretariat under the CBD is currently assessing experiences gained in the implementation of national and regional processes with indicators for forest biodiversity. This issue will be substantially reviewed at the seventh meeting of the subsidiary body (SBSTTA) of the CBD. Any future initiatives should be further analysed with regard to possible contributions to the FCCC and the KP. Nevertheless, the gap between the needs at project and at global level will remain.

Reporting under the FCCC

Useful **information on biodiversity** issues is **already provided in national communications of Parties under the FCCC** without any formal requirements in the respective guidelines. The **reporting** on biodiversity issues in national communication to the FCCC is somewhat arbitrary and **incidental, incomplete, very different in scope, extension and degree of detail** because of the **lack of guidance**. This does not allow a systematic use of the reported information under the CBD, even if individual contributions are very valuable and informative. In two areas it seems especially relevant to **improve the reporting guidelines under the FCCC** to encourage reporting on linkages between climate change and biodiversity. The first area is the **reporting on mitigation policies and measures in the forest and agricultural sectors**, the second area is the **impacts of climate change on ecosystems and biodiversity**, related research activities as well as the consideration of biodiversity aspects with the planning and implementation of adaptation measures. Country-specific experiences on these issues could enhance global understanding and formulation of adequate international policies. These requirements should not be mandatory but encourage Parties to report in order to improve understanding and exchange of information. It should also be considered how this information could and should be made available for the CBD process. More specific proposals are included in the respective section of the report.

The Consultative Group of Experts (CGE) on Non-Annex I national communications under the FCCC is currently developing proposals to **improve guidelines for Non-Annex I national communications**. It is likely that the section on vulnerability assessment, climate change impacts and adaptation in reporting guidelines for Non-Annex I national communication will be revised in order to provide more specific and structured guidance to Parties how to report on these issues and which elements to include. **Any revision should address the linkages between adaptation activities and biodiversity as well as climate change impacts on biodiversity.** Parties addressed these issues without any formal requirements in their national communications in the past, but there seems to be a lack of awareness that this information could be provided in a more systematic way and should be exchanged with the CBD. In this regard it is recommended to develop specific proposals how biodiversity issues could be integrated in the reporting guidelines for national communications under the FCCC.

Reporting under the CBD

Many proposals under the FCCC that addressed possible ways to consider adverse effects of climate change related measures and projects on biodiversity, have been limited to very general recommendations and in most cases they have not been based on the analysis of country-specific information in relation to the tools or solutions that countries have in place to address such conflicts (e.g. criteria and indicators, EIA, SIA, management rules and guidelines etc.). The **information already provided under the CBD in national reports and thematic reports should be assessed in a more comprehensive analysis** as it could contribute significantly to fill this gap. Such an analysis could be one important step in the direction of a discussion on recommendations that base on country experiences and established activities. **Reporting guidelines and formats under the CBD could be improved to enhance the mutual usefulness of the reported information**. Cross-linkages are often not considered in the elaboration and revision of reporting guidelines and formats. **Under the CBD** it should be considered how Parties could be encouraged to provide **more specific and detailed information** if so available. If Parties only fill in the multiple choice formats without providing additional information in the respective boxes, the answers are not very helpful for any further analysis and assessment, as the most relevant information usually is contained in the comment boxes. In the revision of guidelines and formats it should also be considered whether and how an improved mutual cooperation between the conventions could streamline reporting obligations and reduce reporting burdens of Parties. Recommendations should not only increase reporting requirements but also use existing linkages to avoid repeated reporting of similar issues in different reports.

Information exchange and monitoring

Under both Conventions, **ways to enhance the mutual information exchange should be explored**. One option would be to produce **specific compilation and synthesis reports or technical papers** that summarize the reported information relevant under the other convention. Other ways and means for such information exchange exist, such as the development of a **meta-database** covering both conventions, the development of an **inter-convention web site** and search engine, the development of a **lessons-learned network** or **joint working groups** under both conventions. These possibilities should be further explored and promoted.

1.5.3 Instruments and tools to address and resolve conflicts under both conventions

The analysis in the report shows that potential conflicts between the CBD and the implementation of the KP mainly arise at the implementation level of specific activities and projects. Whether an activity is a benefit or threat for biodiversity also often depends on the management option chosen. Therefore it is difficult to agree to common global criteria, indicators and standards as such an agreement would be needed at a very detailed level. In such a situation, it seems **important that frameworks for common instruments and tools are agreed on the international level** that provide **guidance for potential conflicts at the national level**. Different instruments are developed under different conventions, e.g. CBD focuses on environmental impact assessment **(EIA)** and strategic impact assessment **(SEA)**, the Aarhus Convention on **participation of stakeholders**, the forest process on management **rules and principles**. All elements could contribute to an appropriate implementation of articles related to forestry and agriculture under the KP. However, the success of such an approach will depend on the implementation and appropriate application across all Parties involved in those conventions. **Improved exchange and discussion of actual progress of implementation and application of such instruments across conventions** is recommended. Further research based on actual progress of implementation of these instruments is necessary to evaluate the usefulness and the possibilities of application of these instruments under the FCCC.

Impact assessments

As EIAs require national legislation, the specific implementation of the general rules provided in Art. 14 CBD can vary significantly. This may substantially reduce the value of the instrument if no comparable implementation can be achieved across Parties. A **closer analysis of EIA legislation and procedures in different countries is needed** in order to provide a clearer view on the usefulness and the problems of the practical implementation of EIAs as a general tool to harmonize objectives of CBD with objectives of FCCC in relation to LULUCF activities.

The considerable discretion left to Parties in relation to "appropriate" procedures and arrangements under Art. 14 CBD should be reduced. This lack of preciseness considerably weakens the comparable implementation of the Article. In this regard the development of guidelines on the incorporation of biodiversity-related issues into legislation and/or processes on environmental impact assessment should be supported and it should be ensured that the development process considers the use of these guidelines for projects in forestry and agriculture. The guidelines should elaborate some **minimal standards for implementation of procedures and arrangements to ensure some basic standards across Parties**.

With regard to Articles 3.3 (accounting of afforestation, reforestation and deforestation) and 3.4 (accounting of additional LULUCF activities) it should be evaluated if EIAs and SEAs are the most appropriate instruments to integrate biodiversity aspects into forest policies. In general SEAs and EIAs are less focused on forestry activities as many countries have chosen a different approach that establishes binding principles and criteria for forest management in the framework of the national forest policy. Further analysis on the mutual usefulness, or contradiction between EIAs/SEAs and criteria and principles for sustainable forest management should be conducted.

In developing countries adequate planning processes are often lacking as well as capacities for ecological assessments. Financial and human resources and political support are also limited. Even if the concrete implementation of EIA under the CBD varies considerably between countries, it can strengthen the importance of adequate planning processes considering ecological impacts. In this regard Article 14 CBD has a strong potential to promote effective planning systems and an enhanced importance for strategic planning in developing countries. This process will also be useful in the case of any project activities under the CDM in developing countries. It is important that the **appropriate application of instruments and tools such as EIA are promoted by the**

financial mechanisms and capacity building activities under the conventions as the capacities to apply such tools ensure the implementation of the objectives under both conventions.

Participation

With Articles 8 and 14 the **CBD acknowledge the key role of public participation** for the implementation of the Convention. In addition, CBD also recognizes the important role of local participation and participation of indigenous and local communities to the conservation and sustainable use of biological diversity.

The key role of participation of stakeholders is **not taken into account in the discussions and documents on forest activities under the FCCC and the KP**. **Rules under the Kyoto Protocol for the Clean Development Mechanism (CDM) and Joint Implementation (JI) should incorporate the principles of public participation as already implemented under the CBD** or as affirmed in recent international environmental agreements, including the Rio Declaration and the UNECE Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters, known as the Aarhus Convention. Involvement of civil society can ensure that the CDM and JI contribute to the overall objective of sustainable development and assist in verifying that standards and criteria for projects at the national or international level are met. In this regard involvement of indigenous and local communities is a general requirement that CDM and/or JI projects should fulfil and should include biodiversity issues but should not be limited to such aspects.

National legal frameworks and necessary administrative measures to respect, preserve, maintain the knowledge, innovations and practices of indigenous and local communities relevant to the conservation and sustainable use of biological diversity should be further supported under the CBD. Such a legal status would facilitate the consideration of these issues in the project validation phase under the KP.

Negative and positive lists

It would be useful for the discussions under the FCCC, if the **CBD would help to identify elements for negative or positive lists in relation to adverse impacts on biodiversity**. For the identification of such lists, expertise under the FCCC does not seem to be appropriate. Any such tool can only be implemented for forest or land-use related activities under the FCCC if more scientific guidance is provided.

1.5.4 Financial resources and financial mechanism

GEF brings a number of advantages to the challenge of linking FCCC and CBD. As perhaps the largest provider of assistance for biodiversity and climate projects, GEF has considerable influence. There are several factors that provide GEF with opportunities to link thematic areas, governments, international organizations, and NGOs and with a facility to serve as a catalyst for increased coordination between biodiversity conservation and climate change:

- its relationship with both conventions
- its reliance on implementing agencies that are major development organizations with extensive relationships in recipient countries,
- its network of national focal points,
- and its governance structure.

GEF's operational programs stress the importance of taking a holistic approach and to integrate objectives of both conventions. These are all strengths that GEF should continue to promote and exploit strategically.

Besides these well-articulated strategies and programs, the **actual project portfolio contains only very few projects that explicitly address the contributions and benefits of projects to both conventions**. Therefore, at the implementation level, there is a **need to further promote an integrated approach and to communicate the results to both conventions**. The holistic approach is mainly addressed through one operational program out of twelve and it is essential that **not only specific programs on cross-conventional issues are developed, but also that the possible synergies and conflicts are better integrated under each GEF operational program** where such effects occur.

The **operational program on forest ecosystems** (operational program number 3 under the biodiversity focal area) should address inter-linkages in addition to the current focus on biodiversity issues. Key **indicators** developed under the program **should consider carbon sequestration effects** and integrated approaches should be clearly encouraged.

In the **climate change focal area clearer linkages to biodiversity aspects should be included in the elaboration of adaptation strategies and programs**. The approach for global projects under the climate change focal area that address key underlying roots for forest degradation should continue as this seems to be more cost-efficient than many small individual projects.

GEF should **continue to strongly support participation of affected stakeholders,** including indigenous peoples, under for the biodiversity-related operational programs. The **experiences gathered in GEF projects should be collected, summarized and made available for further guidance** on land-use change and forestry projects under the KP.

Monitoring, the systematic collection of information of impacts on biodiversity and the establishment of baselines before the start of projects **should be strengthened under the biodiversity focal area**, as the current lack of impact assessment of biodiversity projects is also a considerable barrier for consideration of biodiversity issues under the FCCC.

At present GEF's monitoring and evaluation of project activities focus also on biodiversity and climate change as separate areas and neither consider the linkages, nor elaborate recommendations with regard to a better integration of both issues into GEF projects.

1.5.5 General recommendations

Clearer guidance on priorities under the CBD to other processes

For experts from areas other than biodiversity, it is difficult to clearly understand what type of biodiversity the CBD tries to conserve as the term "biodiversity" typically refers to ecosystem, species, or genetic diversity. Maintaining desired diversity at one level will have very different requirements than conserving it at another. This situation complicates the integration of biodiversity goals in the work under other conventions such as the FCCC. Clearer guidance on the priorities under the CBD for crosscutting themes would help other conventions.

Improved cooperation on impacts of adaptation measures

For forest activities, potential negative impacts on biodiversity are intensively discussed. For adaptation measures potential negative impacts on biodiversity are rarely highlighted. The examples for possible adaptation activities given in the report show that a close cooperation between both conventions should also be established with the further development of adaptation strategies, frameworks and measures under the FCCC and the KP. In the past, few concrete activities have taken place, but this will change considerably with the implementation of the KP, as additional funds for adaptation projects are provided. Since activities under the KP are yet at a planning stage, the implementation of adaptation activities could be used as a new approach for cooperation between the two conventions to start early communication and integrated work.

Leadership of Parties needed

At the international level leadership from Parties to improve the linkages and cooperation between the two conventions is lacking. Activities are mainly pushed by some NGOs and conservation organizations, international organisations and by the Convention secretariats. Few cooperative or informing activities at the national level seem to be reflected by few activities pushing for improved cooperation at the international level. Leadership from Parties is strongly needed to improve the cooperation and to achieve an integrated approach.

1.6 Contribution from work on criteria and indicators in the multilateral forest processes to the FCCC

Considerable work on criteria and indicators for sustainable forest management has been developed in a series of multilateral forest processes, including the UN forest process, ITTO, the Helsinki and Montreal process and others. The analysis in the report evaluates whether and how this work could provide inputs to the FCCC and the KP in order to enhance synergies and to avoid adverse impacts with regard to sustainable forest management.

The **crucial aspect concerning the use of criteria and indicators** developed in multilateral forest processes for purposes under the FCCC is the **geographical scope** (global, regional, national) and the **implementation level** (from generic principles to individual level of a forest management unit) they address. **Conflicts between biodiversity and activities under the FCCC and the KP mainly arise at the implementation level** with regard to the **specific area** and **specific management options**. Thus, the main challenge is to bring down the internationally developed and agreed criteria and indicators to a level on which implementation becomes feasible. Unfortunately **many processes do not address the level of forest management, but remain at a rather general level** and only few processes have already developed criteria and indicators or guidelines at the level of forest management (see Table 4). Examples are the Pan-European Operational Level Guidelines for Sustainable Forest Management or the criteria and indicators of the Tarapoto Proposal.

Table 4 Ongoing international processes on criteria and indicators for sustainable forest management and the respective implementation level

Process	Number of Criteria	Number of Indicators	Level of Implementation	Forest Type
Helsinki	6	27	Regional and National Level Operational Guidelines on Forest management unit	Boreal and Temperate
Montreal	7	67	National Level	Boreal and Temperate
Tarapoto	1 7 4	7 47 22	Global Level National Level Forest management unit Level	Amazon Forests
Dry-Zone Africa	7	47	National Level	Sub-Sahara Forests and Highland Forests
Near-East	7	65	National Level	Dry-Forests
Central America	4 8	40 42	Regional Level National Level	All Types of Forests
ATO	26	60	Regional /National Level	Congo Basin Forests

Source: FAO / UNEP 1999

A fundamental problem with the use of indicators from multilateral forest processes to resolve problems or conflicts under the KP is the **different focus of the criteria and indicators catalogues**. The essential idea of the development of criteria and indicators catalogues was not the aim to provide tools for a problem resolution in a special case and under specific circumstances of the KP. Therefore it is not a surprising fact that often criteria and indicators catalogues do not address the detailed implementation level at which conflicts occur and which would be necessary to resolve the discussed problems.

Another problem is the fact that the **development of criteria and indicators needs to be accompanied by certain standards, quantitative limits or thresholds that**

provide guidance for decision-makers. Only the existence of such standards allows identifying whether a certain trend, monitored by the periodical assessment of certain indicators under a criterion, should be categorized as a positive or negative fact. Standards must be regionally adapted because of different characteristics of ecosystems. Such standards do not exist for the different multilateral processes. Therefore it remains doubtful how the guidance and trends that are measured with the indicators developed could already be used for decision-making at the present stage of development.

The comparison in the report shows that the Montreal indicators are much closer to full carbon accounting approaches as discussed under the KP, which means a more complete accounting of all ecosystem compartments. Positive is also the description of the carbon pools that should be assessed. However, the Montreal Process Working Group itself defines the relevant indicators as in the category of indicators that may require the gathering of new or additional data and / or a program of systematic sampling or basic research. This highlights another important deficiency of indicator approaches which is the **lack of monitoring data**. Even for less ambitious indicator approaches than the Montreal indicators participating countries reported considerable problems to measure the proposed indicators. This means that there are **technical challenges with regard to the practical implementation of criteria and indicators** to assess the sustainability of certain management methods or forest-related projects on the scale of the forest management unit.

Despite the considerable work that was already performed in relation to sustainable forest management in these processes, the **major problem** for the use of this work under the FCCC is the **lack of international agreement on a specific set of rules, criteria and indicators for sustainable forest management** that is shown by the multitude of forest-related processes. Thus, a global agreement on criteria and indicators that encompasses the regional approaches seems to be the most important need in order to integrate the work under the forest processes in provisions and activities under the FCCC and the KP.

1.7 Improvement of linkages between the FCCC and the Ramsar Convention on wetlands

The initial process of closer co-operation between the two conventions should be intensified, because well co-ordinated provisions under both conventions can have a positive impact on both conventions' objectives.

The **Ramsar Convention Process** should **integrate the objective of carbon storage in the objectives for protection and wise use of natural wetlands** because of the immense capacity of carbon storage in wetlands soils and biomass of wetlands. Existing attempts for closer cooperation with FCCC should continue and should be strengthened especially with regard to the following areas:

- the predicting and **monitoring of the impacts of climate change** on wetland areas;
- the **role of wetlands in adapting to, and mitigating the impacts** of climate change and;

- the **role of wetlands**, notably peatlands and forested wetlands, in **reducing greenhouse gas emissions**.

Under the FCCC it is recommended to integrate the following issues in the FCCC process:

- The Ramsar **principle of protection and wise use** of natural wetlands should be acknowledged under FCCC process for any mitigation or adaptation activities;
- The process under the FCCC should seek **to integrate the Ramsar's list of wetlands with global importance** in the recommendations relating to mitigation and adaptation activities. The list could for example be used in the certification process of CDM activities to avoid that land project activities take place in protected areas under the RC.
- Despite their large potentials, mitigation activities related to wetlands such as wetland restoration or prevention of peatland fires should receive more attention in the work on the implementation of mitigation activities under the FCCC.
- The FCCC should **closely cooperate** with the RC in the **future development of work on adaptation strategies and activities**.
- Funding institutions responsible for the future adaptation fund under the KP should closely cooperate with institutions of the RC in the design of adaptation frameworks and activities.
- Future **research** and assessment activities should continue to provide information **on climate change impacts on wetlands**.

In relation to both conventions,

- the linkages between the conventions should be further analysed and documented at different levels (e.g. global and national) including the assessment of any perverse incentives and conflicts created under the provisions of the FCCC which may lead to further degradation and losses of wetlands.
- the dialogue between the respective convention secretariats should be enhanced to identify and implement mechanisms for enhanced cooperation and information exchange.

1.8 Future research needs

Climate related functions of the biosphere

The role of the biosphere for the carbon cycle has been the subject of many studies and research projects in the past. Biological units are also involved in the processes of generation, storage, transport, and release of biogenic methane. Less research activities are dedicated to these processes and scientists have only recently begun to understand the mechanisms and the potential for a natural methane feedback to climate change. Significant uncertainty surrounds many of the results. Thus, **additional research in the field of natural methane emissions** is needed to reduce this uncertainty, especially with regard to **wetlands**. This research should focus on systems not previously measured, in addition to developing better information on areas of different ecosystem types. Great uncertainty exists in the future wetland emission scenarios.

Similar large uncertainties as for CH_4 emissions occur for the correct estimation of global **emissions of N_2O from different natural sources**. A better understanding at the process level and better availability of global data for different sources is needed to arrive at a more accurate estimate and better assessments of future climate effects.

However, even building on a much larger amount of research activities, there are still gaps in the knowledge related to carbon storage in ecosystems. Especially for certain forest types, forest management options, grasslands and estimates of the soil carbon pools are lacking. There are also methodological problems associated with the estimation of carbon processes in ecosystems.

This report highlights that the biosphere performs other important functions in the climate system beside carbon storage, e.g. in water cycling processes or for the energy balance of the land surface

The **roles of the biosphere in water cycling processes that influence the climate system are not well understood**. Research over long timescales is lacking. Often assumed perturbations of ecosystems used in model scenarios to determine the influence of vegetation are too large-scale to be realistic (e.g. deforestation of the whole Amazon forests as a modelling scenario). There is also a need to integrate the findings of experimental and modelling studies at different levels. Long-term measurements over large spatial scales are needed. Another important aspect for future research is that the role of biological units and geographical regions for the water cycling processes has not been studied in a detailed and systematic way. The question how local and regional effects add up to global effects is still unanswered. With respect to management options, the evaporative characteristics of different tree species are still unclear, and consequently information on the influence of large-scale reforestation / afforestation on the water cycle are missing.

Research gaps also exist for the influence of the biosphere on the albedo and energy balance of the land surface. Experimental and modelling studies have concentrated on either a global evaluation or an evaluation of processes in some key regions (Sahel, boreal forests). Most modelling studies on change of land-use operate with very drastic effects (replacement of the whole Amazonian forest by grassland), so that the effect of smaller-scale changes is not yet quantified. Many studies in desert and savanna ecosystems are often performed under the aspect of desertification, so that they lack conclusions with regard to links with global climate change. It is thus recommended to extend studies on albedo, surface effects and radiation budgets to other regions and to include the aspect of global climate effects in desertification studies.

Influence of biodiversity on the climate system

Correlations with biodiversity have been found for some of the functions of the biosphere within the climate system (carbon cycle, water cycle and energy balance), but

more research is needed on general influences and quantification of effects. Some functions are not directly correlated to biodiversity of species, but to structural and functional traits of biotic units. This means that the replacement of single species or whole vegetation types can lead to significant changes in climate-relevant processes. However, most studies are either case studies that examine a single species or a single process and it is difficult to derive general conclusions for whole ecosystem types. Quantification of the contribution of single processes (e.g., species invasions) on climate-relevant cycles is also not yet possible. The report shows that interesting findings on the role of individual species for climate related functions can be derived from the research on invasive species. **A systematic review of the effects of species invasions on climate-relevant processes is outstanding** and would be helpful.

Need for more integrated research activities

In the past, research has mainly concentrated on either biodiversity or climate change. Thus the number of studies that reveal information about the linkages and interactions remain very limited. There are still large knowledge gaps around the questions:

- Which ecosystems are important for both climate processes and biodiversity conservation?
- Which management / mitigation options favour both climate protection and biodiversity conservation in different ecosystem types?

Many studies are now undertaken that examine the carbon sequestration potential of different ecosystem types or management options with respect to the Kyoto Protocol. Such studies should generally look at the role of biodiversity within these systems, and analyse how different management options affects biodiversity on and off site.

Useful approaches have started to identify regions with significance for both biodiversity and the climate system and to create maps for both thematic areas and combine these maps in a second step. Further research in this area is needed to arrive at a valuation of the different functions of the biosphere, biodiversity and its components.

1 Introduction and objectives

The United Nations Conference on Environment and Development in Rio in 1992 started a series of negotiations of conventions, protocols and other instruments in different environmental areas. The most important processes and results are currently:

- The Framework Convention on Climate Change and the Kyoto Protocol (FCCC),
- The Convention on Biological Diversity and the Protocol on Biosafety (CBD),
- The Convention to Combat Desertification (CCD),
- A number of international initiatives on forest issues. Many of these initiatives fed into the Commission on Sustainable Development's (CSD) review of Agenda 21's Chapter 11 in 1995. Under the CSD an Intergovernmental Panel on Forests (IPF) and an Intergovernmental Forum on Forests (IFF) have been established,
- The Convention on Wetlands of International Importance that already entered into force in 1971 and which broadened the focus from protection of wetlands for birds to the general protection of wetland ecosystems.

The international work under these Conventions is split to separate processes, which focus on different functions and aspects of multifunctional ecosystems and biological units. For example, the ecosystem of tropical rainforests is relevant for the FCCC because of the carbon storage function in biomass and soils, for the CBD because of species richness and species diversity and for the work process on forests in relation to forest use. It can be assumed that these different perspectives in separate processes might lead to synergies as well as to conflicts between the Conventions. A systematic analysis of positive and negative impacts is still lacking. This study focuses on the climate system and analyses the effects of biological units on the climate system. The objectives of this study are

- a compilation of all impacts of biota on the global atmosphere and of the key functions and roles of ecosystems in the global and regional carbon cycle, for albedo, radiation balance and the water cycle;
- the analysis of the negotiation and implementation processes under the FCCC and the CBD with the question, whether existing research of biota's influences is taken into account;
- the analysis of linkages, especially of synergies and conflicts, of different international conventions (FCCC, CBD, Ramsar Convention and Forest process);
- the analysis of the relationship between the protection of biodiversity and the resulting goods and services in relation to the FCCC,
- the elaboration of recommendations for policymakers for the ongoing international negotiations, especially with regard to specific rules and procedures under the FCCC.

2 Interactions and influences between biological units and the climate system

The biosphere, its living organisms and organic substance play a major role for the regulation of climate processes and global warming (IPCC 2000, WBGU 2000). The main processes or key functions through which the terrestrial and marine biota influence the climate are

- carbon release and uptake,
- albedo and radiation balance,
- water cycling (especially evapotranspiration)emissions of other greenhouse gases such as methane and nitrous oxide.

These processes occur naturally in ecosystems, but human activities, above all land use change, have altered the process rates significantly. By changing the distribution of biological units and by changing biogeochemical cycles within these units, their ability to perform climate-stabilizing ecosystem services is significantly altered. Climate change itself feeds back on these processes, changing the role ecosystems can play in the mitigation of global warming. The following chapters review these major key functions of the biosphere for the climate system and evaluate the role of human-based activities on these biological units.

2.1 Carbon cycling

Besides the atmosphere, carbon is stored in vegetation, soils and the oceans. The oceans contain the largest amount of carbon, about 50 times more than the terrestrial ecosystems (Schlesinger 1997). Vegetation and soils form the major carbon stores on land, with one fourth stored in vegetation and three fourths stored in soils (WBGU 1998a). The most important factors for the contribution of the carbon cycle to global warming are how carbon pools in ecosystems can be maintained in the future (carbon storage) and how ecosystems can contribute to a removal of additional carbon from the atmosphere (carbon sequestration).

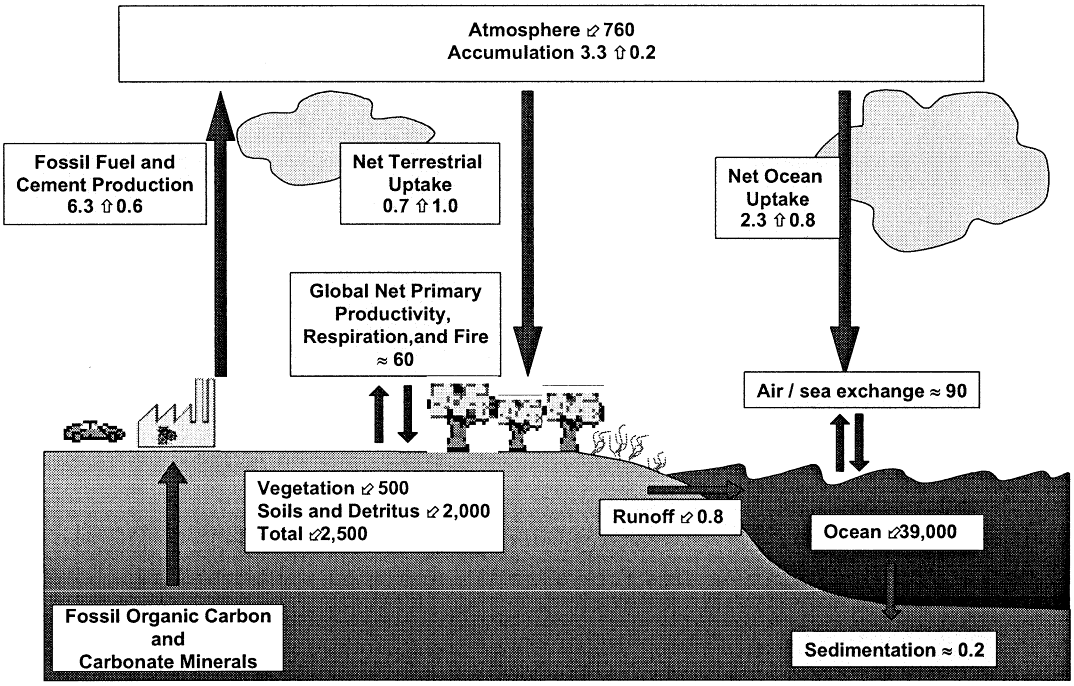
Carbon cycling in the biosphere varies considerably from biome to biome, on different time-scales, and between ecosystem compartments and depends on several factors that make predictions of future behaviour of carbon cycling in terrestrial and marine ecosystems extremely difficult. In the 90s, terrestrial ecosystems have been a net sink for CO_2 of 0.7 ± 1.0 GtC ha^{-1} a^{-1}. The terrestrial sink has thus increased from 0.2 GtC ha^{-1} a^{-1} in the 80s (Farquhar et al. 2001). Reasons for this increase are assumed to be ecosystem responses to CO_2 and N fertilization (Farquhar et al. 2001). Recent calculations indicate that this terrestrial sink may turn into a source of carbon dioxide after the next half of the 21st century (Cox et al. 2000).

2.1.1 Functions and processes

Photosynthesis and respiration

The basic process, which leads to the transfer of carbon from the atmosphere to the biosphere, is photosynthesis, a process performed mostly by plants in terrestrial ecosystems and by phytoplancton in marine and aquatic ecosystems. Photosynthesis or gross primary production (GPP) is influenced by light intensity, stomatal conductance, partial pressure of CO_2, water and nutrient availability. About half of the GPP is used for autotrophic respiration of the plant itself; the remaining half is called net primary production (NPP) and is used for plant growth (Table 5). Temperature is the main factor controlling respiration.

Figure 1 The global carbon cycle with carbon stocks in reservoirs (white boxes) and carbon flows (yellow boxes) as annual averages over the decade from 1989 to 1998 [Gt C]



Source: IPCC (2000), IGBP Terrestrial Carbon Working Group (1998)

Heterotrophic respiration

Within the ecosystem, heterotrophic respiration leads to a further breakdown of photosynthates and to a loss of further 45 % of GPP (WBGU 1998a), leaving less than 5 % of the originally assimilated carbon in the ecosystem (NEP, Net ecosystem production). Litter quality, C/N ratio, soil acidity and presence or absence of secondary metabolic products like waxes, resins and aromatic compounds determine the decomposition rate as well as the structure and composition of the decomposer community. Episodic disturbances like fire or harvest diminish the carbon gain even more, so that the resulting long-term storage of carbon (net biome productivity, NBP, Schulze and Heimann 1998) is probably less than 0.5 % of the initial CO_2 assimilation (NPP). Charcoal and recalcitrant humus macromolecules are the only components of terrestrial ecosystems that can be regarded as a long-term reservoir of carbon. Recent estimates consider global NBP to be about 1.0 Pg C a^{-1} (Farquhar et al. 2001). Table 5 shows the different carbon processes in ecosystems and gives an estimate of their magnitude.

Table 5 Global estimates of carbon processes in ecosystems

Process	Use in ecosystem	Process rate - Pg C a^{-1} -
GPP = CO_2 assimilation	Maintenance	120
NPP = GPP – autotrophic respiration	Biomass growth	60
NEP = NPP – heterotrophic respiration	Litter and soil organic matter (SOM) formation	10
NBP = NEP – disturbances (fire, harvest)	Charcoal and recalcitrant humus formation	1

Source: IPCCa 2001, WBGU 1998

The processes of carbon uptake and release vary in different time-scales ranging from seconds to decades. Climate change, land-use change or shifts in the ecosystem community can affect assimilation, respiration and decomposition in different ways, so that they cancel each other out or act as amplifiers. This situation is even more complicated when interactions with the physical environment, like albedo effects, are taken into account. For example, the assimilation of green plants increases almost immediately with CO_2 fertilization, whereas heterotrophic respiration lags behind for 20 to 30 years. This makes predictability extremely difficult. A comparison of 17 models of global NPP has shown a range of modelled NPP from 44.4 - 66.3 Pg C a^{-1} (Cramer et al. 1999).

Ocean uptake

Of all biological units, the ocean is the largest carbon reservoir. But only a small fraction of this reservoir is exchanged with the atmosphere, the net annual uptake of CO_2 from the atmosphere is about 2 Pg C a^{-1} (Schlesinger 1997) and has slightly increased during the 90s (from 2.0 ± 0.6 to 2.4 ± 0.5 Pg C a^{-1}, Farquhar et al. 2001). Physical and chemical processes are thought to be more important in the uptake of CO_2 than biological processes, which are thought to be in a steady state (Farquhar et al. 2001). However, the marine biota play an important role in the oceanic carbon cycle via the downward transport of biogenic carbon. Marine phytoplancton produces a NPP of 45 - 50 Pg C a^{-1} (FARQUHAR ET AL. 2001a), an amount that is slightly smaller than terrestrial NPP. Zooplancton and bacteria consume most of this NPP. After the death of these organisms, tissues and structural materials sink down to deeper layers, where most of the carbon is decomposed or dissolved again. Marine biological production and the subsequent downward transport of biogenic carbonates and detritus have kept atmospheric CO_2 concentration 100-200 ppm lower than in the absence of marine life

(Maier-Reimer 1996). Two main processes can be distinguished:

(1) the downward flux of organic carbon makes up between 3.4 - 20 Pg C a^{-1}, recent estimates consider this value to be about 16 Pg C a^{-1} („biological pump", Falkowski et al. 1998).

(2) sinking of carbonate shells, which are partly dissolved in deeper layers and to a very small fraction incorporated into sediments (calcium carbonate pump). The formation of $CaCO_3$, however, leads to a release of CO_2 in the surface water body, so that this process partly counterbalances the CO_2 removal effect of biotic activities.

2.1.2 The role of biological units

Oceans

Of all biological units, the ocean is the largest carbon pool on the earth, with about 39,000 Gt C stored as dissolved inorganic carbon, 700 Gt organic carbon and 3 Gt carbon in the living biota (WBGU 2000). This is about 18 times more than the terrestrial carbon pool. The intensity of this biotic sink activity is not CO_2- but nutrient-limited, and various suggestions to increase the oceanic sink by adding nutrients like iron or phosphates have been made. The IPCC (2001a) sees only very limited applicability of iron fertilization of the ocean. There are still a lot of unresolved questions associated with this mitigation option, e.g. the possible influence of biodiversity and species distribution in the Southern Ocean. A large-scale iron-induced algal growth is very likely to have a large influence on the marine ecosystem (WBGU 2000). According to the IPCC, the future sink activity of the ocean may be decreasing because of decreasing CO_2 uptake at higher CO_2 concentrations and higher temperatures (FARQUHAR ET AL. 2001a). Future changes of the biologically driven processes are more difficult to predict, and are affected by factors as nutrient supply from deep ocean waters, atmospheric and riverine inputs, species composition of marine communities (Arrigo et al. 1999) and acidification of the ocean water (Farquhar et al. 2001). Estuarine, coastal and continental shelf waters occupy only 10 % of the ocean surface, but account for 18 % of ocean productivity and 83 % of the carbon stored in sediments (Schlesinger 1997). Some regions are more effective in drawing down CO_2, especially the upwelling areas at high latitudes (Falkowski et al. 1998). The Northern and Southern Hemispheric Oceans act as sinks for CO_2, while the equatorial areas seem to be sources of carbon (IGBP Secretariat 1997)

Coral reefs

Coral reefs have been claimed to be small sinks of CO_2, but this view has been questioned recently (Gattuso et al. 1999). Gattuso et al. provide evidence that reefs can be a source of carbon if the calcification process is included in the calculations. In geological time-scales they are net sinks because of the accumulation of carbonate in their structures, but this is not relevant in the context of human-induced climate change. Covering an area of 0.1 – 0.5 % of the ocean floor (Moberg and Folke 1999), they contribute 900 Mt C a^{-1} ($1/6^{th}$) of the total carbonate production in the oceans (Langer et al 1997). Although the calcification process is a net source of CO_2 (Done et al. 1996), the carbon stored in the corals is much more stable than in terrestrial ecosystems because the calcium carbonate is not decomposed after the death of the corals like terrestrial biomass. On a global scale, they seem to play only a minor role in the carbon cycle, but under biodiversity aspects, they belong to the most diverse ecosystems on earth and provide a variety of important goods and services (food, tourist attraction, construction material, wave protection, medicines) (Moberg and Folke 1999) with an annual global value of 3.75 billion US\$ a^{-1} (Costanza et al. 1997).

Forests

Forests are the most important terrestrial carbon pool, storing 46 % of the global terrestrial carbon (WBGU 1998a). Other estimates arrive at even higher values of 80 % of global carbon (Saugier and Roy 2000). The reason for this large discrepancy is that forested peatlands are sometimes counted as forest, sometimes as wetlands. Managed forests usually have a carbon pool that is reduced by 25 – 50 % compared to pristine forests (WBGU 1998a). Nitrogen fertilization may lead to an increased sink of -0.2 to -1.4 Pg C a^{-1} (Holland 1997), especially in temperate forests. Table 6 shows the distribution of carbon storage in the major ecosystem types of the world. Unfortunately it is not possible to distinguish between natural and plantation forests for the temperate and boreal biome, as the distinction between these two forest types is not made in data compilations for the regions that contain most of these forests like North America and Europe with the Russian Federation (World Resources Institute 2000).

Table 6 Global terrestrial carbon pools

Biome	**Carbon pools - Gt C -**		
	Vegetation	**Soils**	**Total**
Boreal Forests	88	471	559
Tropical Forests	212	216	428
Tropical Savannas	66	264	330
Temperate Grasslands	9	295	304
Wetlands	15	225	240
Deserts and Semideserts	8	191	199
Temperate Forests	59	100	159
Agricultural lands	3	128	131
Tundra	6	121	127
Total	***466***	***2011***	***2477***

Source: WBGU 1998a

Boreal forests

Due to their large extent and high amounts of carbon stored in soils, boreal forests make up the largest C pool that stores 23 % of the global terrestrial carbon. NEP estimates for boreal forests range from 1 – 2.5 t C $ha^{-1}a^{-1}$ (Farquhar et al. 2001a), but NBP is probably almost carbon neutral. Therefore boreal forests can be regarded only as a small sink in the long term. Growth in boreal forests is often nitrogen-limited, so that nitrogen deposition may lead to an increase of the carbon storage potential. Disturbances like insect pest invasions and fires are typical features of boreal forests that influence the carbon cycle. Kasischke (2000) estimates that each year 5 - 12 Mio. ha of boreal forest burn, creating the typical mosaic pattern of stands of different age. Fires release large amounts of carbon into the atmosphere, but on the other hand, they could stabilize a small fraction of the carbon by charcoal formation (Gleixner et al. 2000). The most important carbon-related ecosystem service of the boreal forest thus consists in the storage of carbon in the soil and partly in vegetation. Trends that affect this service are deforestation, forest degradation, fragmentation and climate change. Global warming can turn the soils from a net sink to a net source (IPPC 2000). This depends on the types of plant communities and decomposition rates of organic matter in the soil. Boreal forests are mainly threatened by logging and climate change (Mooney et al. 1995).

Tropical forests

Tropical forests are the second largest terrestrial C pool. Unlike boreal forests, they store carbon in equal parts in soils and vegetation. NPP and NEP are high, with NEP reaching values from 1 to 6 t C $ha^{-1}a^{-1}$. One of the main services of tropical forests consists in the storage of carbon in soils and vegetation and is affected by deforestation, land use change (slash-and-burn and conversion to pasture) and climate change. In the 80s, tropical land use change led to a net flux of 2.0 ± 0.8 Pg C a^{-1} to the atmosphere (Houghton 1999).

Temperate forests

Due to their smaller area and their smaller carbon pools in soils and vegetation, temperate forests are less important than boreal and tropical forests or savanna ecosystems as carbon reservoirs. NEP, however, is high, estimates range from 0.8 to 7.0 t C $ha^{1}a^{-1}$ (Farquhar et al. 2001) or even from 1.4 to 15.4 t C $ha^{-1}a^{-1}$ (WBGU 1998a). WBGU (1998a) thus considers temperate forests to be the largest terrestrial sink for carbon (per unit area). Most of the temperate forests are managed forests; many of them are forest plantations. During the last 30 years, temperate forests have shown increased growth rates which are attributed to CO_2 fertilization, nitrogen deposition or a combination of both (Lloyd 1999).

Tropical savannas

Tropical savannas are the third largest carbon pool of all biomes and are characterized by a mixed cover of grassland and shrubs / trees. Most of their carbon is stored in the soils; however, the proportion is smaller than in temperate grasslands. NPP varies between drier and more humid savannas (0.7 – 3.4 Gt C $ha^{-1}a^{-1}$, IPCC 2000) and also shows large interannual and spatial variation. NEP has been measured in Australian and Sahelian sites and shows a small to moderate carbon accumulation of 0.12 – 0.75 t C $ha^{-1}a^{-1}$. Fire, herbivory and grazing management are factors that strongly influence carbon cycling in savanna ecosystems. The IPCC (Farquhar et al. 2001) considers tropical savannas to be a terrestrial sink, but this ecosystem type also has one of the highest carbon source potentials in terrestrial ecosystems. Tree thickening as a result of fire suppression and reduced grazing may lead to a carbon sink of up to 0.17 Pg C a^{-1} in the USA and 0.03 Pg C a^{-1} in Australia (Houghton et al. 1999, Burrows 1998). The main ecosystem service of savannas is carbon storage in the soil. Major threats to this service are land use change, increased grazing or fire intensity and climate change. Introduction of species can also affect the carbon balance of savanna ecosystems.

Temperate grasslands

Most of the temperate grasslands have been converted to pasture and cropland in the past, which caused a net carbon release of 16 Gt C (Houghton et al. 1999). Like savannas, they store most of their carbon in the soil, containing four times more carbon in soils than savannas. NPP is 0.5 $t\,C\,ha^{-1}a^{-1}$. After boreal and tropical forests and savannas, they contain the fourth largest carbon pool and a high amount of carbon stored per hectare. Decomposition is slower than in savannas, especially under moisture-limited conditions. The main service of temperate grasslands is the storage of carbon in soils which is affected by land use change, fire and climate change.

Wetlands

Wetlands are transitional between terrestrial and aquatic ecosystems and generally include swamps, marshes, bogs, and mangroves. Wetlands occur where soils are naturally or artificially inundated or saturated by water due to high groundwater or surface water during part or all of the year. They are common in river deltas, estuaries, floodplains, and tidal areas, and they are widespread in riverbeds, depressions, footslopes, and terraces of undulating landscapes. Wetlands cover 3 to 6% of the earth's surface, but store about 10 to 30% of the global terrestrial carbon[1]. Peat building wetlands store about one third of the carbon in terrestrial soils (541 Gt). The carbon stocks for peat building wetlands are about 25 Gt, which is a share of 4% of peat building wetlands in the total carbon stocks (WGBU 1998a).

The share of tropical wetlands in global wetlands is 30 to 50% (depending on the estimation), including rice cultivation areas. Without rice cultivation areas, the share is about 10 to 30%. Although the surface share of tropical wetlands is lower than that of wetlands in the Nordic hemisphere, they store approximately the same amount of carbon. In tropical wetlands the carbon stocks per surface in soil and biomass are much higher than in wetlands of the Nordic hemisphere (WBGU 1998a). Estimations say that peat building wetlands store globally about 0.1 $Gt\,C\,a^{-1}$ (WBGU 1998a).

Deserts and semi-deserts

The carbon pool of deserts is about as high as the carbon pool of temperate forests. This relatively high amount is mostly due to their large geographical extension (four times that of temperate forests). Their carbon density, however, is much lower. NPP is usually low and moisture-limited and varies on a spatial and temporal scale. The vegetation consists of shrubs, perennial and annual herbs and grasses and stores only a small fraction of desert carbon. Almost all carbon is stored in the soils.

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1 Other sources give data of wetlands covering 8 to 10% of the earth's surface and containing 10 to 20% of the global terrestrial carbon (Bergkamp and Orlando 1999).

Agricultural lands

Agricultural lands comprise about 11 % of the terrestrial land and contain less than 1 % of the terrestrial carbon stored in biomass and 8-10 % of global soil carbon budgets (WBGU 1998a). NPP of agricultural crops is usually high, among the highest in the world, but as most carbon is removed through harvest, only small amounts of carbon remain within the system. Conversion of natural ecosystems to agricultural land leads to a net carbon release. Carbon is also released by certain management practices that are discussed later in detail. Tillage intensity, crop rotation, irrigation, fertilization and residue management can affect carbon cycling in agroecosystems. Various suggestions and estimates exist on how carbon storage could be enhanced in agricultural systems. These will be discussed in section 4.1.7.

Tundra

Tundra ecosystems are relatively unimportant carbon pools, except for peatlands and mires where high carbon densities occur. These areas are usually counted as wetlands. Temperature and changes in the water table as well as changes in the depth of the permafrost layer are crucial factors in determining whether high-latitude ecosystems become net sources or sinks for carbon.

Soils

Soils are the most important carbon pool in terrestrial ecosystems, storing more than 80 % of the global carbon reservoir (WBGU 1998a). Boreal forests and grassland ecosystems are the ecosystem types with the highest carbon soil pools. Peatland soils are also very important because of their high carbon density.

2.1.3 Human-induced factors that influence the net terrestrial uptake of carbon

The following sections focus on the impacts on direct human-induced activities on the net terrestrial uptake of carbon. A complete description of all factors would also include the impacts of climate change on carbon sequestration as well as natural and biogeochemical factors, which are not discussed in this study.

Deforestation

Deforestation is taking place mainly in the tropical region. Between 1980 and 1995, the annual deforestation rate was 15.4 Mio. ha a^{-1}. Forest expansion in temperate and boreal regions has led to a global net deforestation rate of 12 Mio. ha a^{-1}. However, inclusion of forest degradation, which also leads to carbon loss, results in a total area of 18 Mio. ha a^{-1} of deforestation (Nabuurs et al. 1999). The carbon losses associated with tropical land use change are estimated to be 2.0 Gt C a^{-1}, with the highest amount resulting from conversion of forest to cropland (IPCC 2000) The conversion of primary forests into secondary forest leads to a reduction in the carbon pools (WBGU 1998a). Table 7 shows typical values for the reduction of carbon pools of natural forests and plantations within the same climatic zone.

Table 7 *Reduction of carbon pools in plantations compared to natural forests in the same climatic region*

Forest type	Reduction of carbon pool in plantation compared to primary forest - % -
Tropical forest	25 - 50
Temperate forest	40 - 50

Source: WBGU 1998a

Forest degradation

Forest degradation has various reasons (fire, unsustainable forestry, insect pests, pollution) and usually has a negative influence on the carbon storage in forests. Degradation takes place in boreal, temperate and boreal regions. Reliable quantitative estimates of how much carbon is released by forest degradation alone are currently not available at a global scale.

Conversion of forest into pasture and secondary grassland

The conversion of forest into pasture or grassland is mainly taking place in the tropics, especially in South America. Most carbon losses occur during clearing, but emissions from soils can continue several years after forest conversion because of increased microbial activity in the top soil. This type of conversion mostly leads to an irreversible forest loss and soil degradation.

Conversion of forest into cropland

The conversion of forest into cropland leads to losses both in vegetation (nearly 100 %) and in the soil, where C losses between 25 and 30 % can occur (WBGU 1998a).

Conversion of grassland into cropland

The conversion of grassland in cropland also leads to carbon losses that can vary between small losses of a few per cent to high losses of up to half of the original carbon pool. Especially in temperate grasslands, where most carbon is stored in the soil, high losses can occur.

Forest management

The impacts of forest management activities on carbon stocks in forests are relatively small (WBGU 1998a; IPCC 1996). The IPCC (2000) estimates a potential of 101 Mt C a^{-1} for Annex-I countries[2] and 69 Mt C a^{-1} for Non Annex-I countries[3] in 2010. Management options include

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2 Annex I Countries are those Parties listed in Annex I of the Annex of the Framework Convention on Climate Change which include industrialized countries and economies in transition

3 Non-Annex I Countries are those not listed in Annex I of the Annex of the Framework Convention on Climate Change which include developing countries.

- forest regeneration,
- forest fertilization,
- pest management,
- forest fire management,
- harvest quantity and timing,
- low-impact harvesting and
- reducing forest degradation.

The IPCC (2000) also states that there is considerable variation between ecosystems, countries and regions and that few empirical studies exist. It is difficult to separate the carbon gains of a single activity if several activities are undertaken on the same site.

Conversion of wetlands

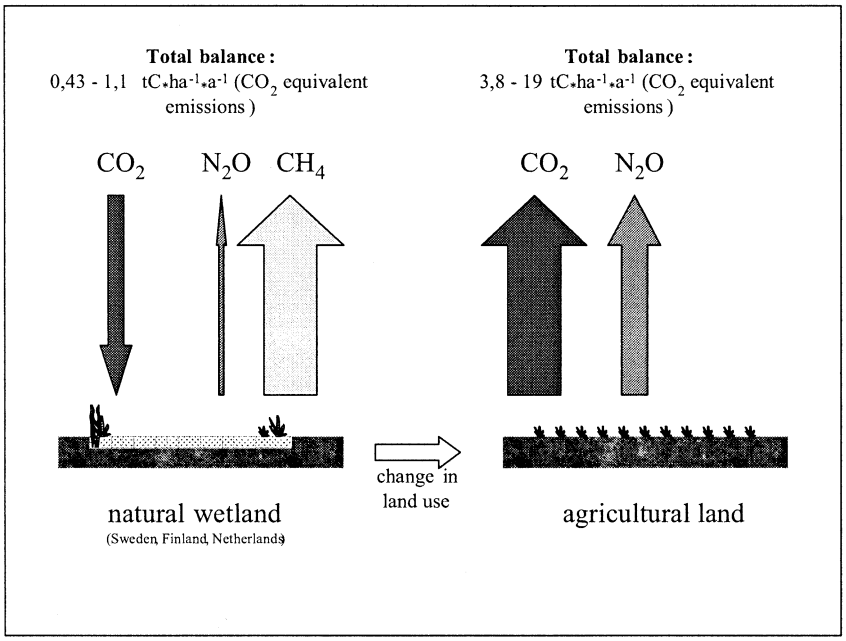
Wetlands as well in the tropics as in temperate or boreal zones are endangered by land use change activities (first of all agricultural use). These activities change the biology and soil chemistry of wetlands and influence the capacity of carbon storage of these ecosystems. Changes in land use in wetlands can cause high losses in carbon stocks and are therefore relevant for the global climate. In the following sections these effects are documented for boreal/temperate and tropical wetlands. Draining of arctic wetlands causes high losses of carbon stored in soil (IPCC 2001a). The lowering of the water level increases oxidation of organic matter and carbon flows of high density occur. Figure 2 shows the changes in carbon dioxide, nitrous oxide and methane flows by cultivating natural wetlands. Natural wetlands emit high quantities of methane (0.075 – 0.15 tC ha^{-1} a^{-1} as CO_2-equivalents are reported for Sweden, Finland and the Netherlands) and low quantities of nitrous oxide. They store about 0.16 – 0.25 tC ha^{-1} a^{-1}. In contrast to this, cultivated wetlands emit high quantities of CO_2 and N_2O (total balance: 3.8 – 19 tC ha^{-1} a^{-1} as CO_2-equivalents). In total, cultivation of wetlands causes a loss in carbon stocks. Table 8 shows CO_2 emissions caused by land use change.

Table 8 Carbon dioxide emissions from the conversion of wetlands (swamps and bogs only)

	Drainage - tC ha^{-1} a^{-1} -	**Agriculture** - tC ha^{-1} a^{-1} -
Global wetlands	0.23 – 0.26	1 – 10
Boreal/temperate wetlands	0.1 – 0.32	1 – 19

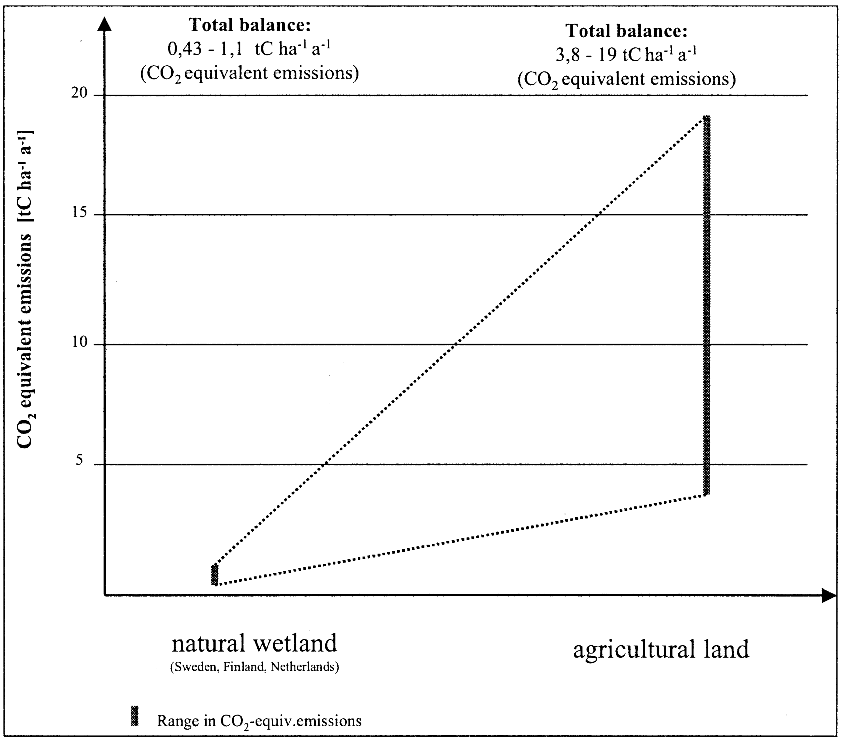
Source: WBGU 1998a

Figure 2 GHG emission changes caused by land use change in wetlands



Source: WBGU 1998a

Figure 3 Range of changes of GHG emissions caused by land use change in wetlands (natural wetland to agricultural land)



Source: WBGU 1998a

There are exceptions from the general processes of CO_2 emissions from bogs and fens after drainage. The situation can differ for boreal and subartic peatlands and the emissions also depend on the time-scale taken into account. Peatlands are characteristic of waterlogged situations in which, owing to anoxic and cool conditions a few centimetres or decimetres beneath the surface, organic detritus accumulates to depths from 30-40 cm up to several metres. Long-term research on the effects of forest drainage on carbon storage in peat soils in Finland showed a total increase in carbon stocks after drainage (Minkkinen and Laine 1998, Domisch et al. 1998). Direct measurements of changes in peat thickness 60 years after drainage on almost 300 sites in Finland showed increased carbon density and carbon stores after drainage. This contradicting result to other research data was caused by a considerable increase in litter production, which compensated the smaller increase in peat decomposition rate after drainage. These studies also showed that the post-drainage subsidence of peat surface is mainly caused by changes in the physical structure of peat after the removal of water, while oxidation of peat is of less importance. The changes in C density and C storage seems to depend on the input of new C into the system through net primary production, especially through fine roots of trees. Gorham (1991) summarizes research on carbon flux in boreal peatlands and differentiates between high short-term release of carbon by drainage, but estimates that long-term release is only about one-fifth of the short term release rate.

Fire

Fire has an ambivalent effect on carbon cycling in terrestrial ecosystems: on the one hand, each fire releases CO_2 and other greenhouse gases into the atmosphere. On the other hand, fire leads to charcoal formation (black carbon) and to a stabilization of terrestrial carbon. About 0.24 – 0.7 Gt C a^{-1} (Kuhlbusch 1994 in Heimann et al. 1997) are stored as charcoal. Fire is also a typical feature of many vegetation types from the boreal forest to tropical savanna ecosystems. Many species and plant communities are fire-adapted or even fire-dependent (e.g. for seed germination). Anthropogenic fires, however, have increased in the last decades. UNEP (2000) estimates that each year, 3940 Mt C are released by biomass burning – more than half of the amount of fossil fuel combustion. Most of this carbon is released in savanna ecosystems (1660 Mt C a^{-1}), followed by agricultural waste, tropical forests and fuel wood burning. Temperate and boreal forests only make up for 130 Mt C a^{-1}.

Nitrogen fertilization

Nitrogen fertilization leads to increased growth, and increased humus accumulation (forests), especially in temperate ecosystems where nitrogen deposition can be as high as 40 – 60 kg N $ha^{-1}a^{-1}$ (Flaig and Mohr 1996). However, it cannot be expected that increased N inputs lead to a long-term increase of the carbon sink for several reasons:

- Many forests and other ecosystems in industrialized countries are N-saturated, therefore additional N inputs do not lead to increased growth.
- In many tropical lowland forests, phosphorous is the limiting factor that restricts growth (Hall and Matson 1999). Increased N inputs will have no effect or even lead

to reduced growth because nitrate leaching increases the amount of nutrient cation leaching (Ca, K, Mg).

- Increased humus accumulation due to N inputs may only lead to a temporary C storage that is released when the forest is logged.

CO_2 fertilization

The concentration of CO_2 in the atmosphere has increased since the beginning of industrialization. The rate of increase over the past two decades has averaged 1.5 ppm per year (equivalent to 3.3 Pg C a^{-1}) (IPCC 2001c). The effect of current and possible future concentrations of atmospheric CO_2 on plants and ecosystems has been studied intensively in the last years and ranges from experimental studies with single plants up to free air enrichment experiments in whole ecosystems. Increased CO_2 usually leads to an increase of NPP in agricultural crops (about 33 % for a doubled CO_2 concentration, Farqhuar et al. 2001), whereas in natural vegetation types, only small increases of NPP were observed (WBGU 1998a).

The IPCC states (IPCC 2000) that at present the long-term effect of CO_2 fertilization on carbon sequestration by forest stands remains unclear. This is mostly because experiments have so far dealt with seedlings or young trees, and long-term observations have not yet been performed. De Lucia et al. (1999) have measured increased NPP (by 25 %) in a young pine forest, but some of this additional NPP has been shown to increase the efflux of carbon from the soil. Another caveat in the context of the terrestrial carbon sink capacity through CO_2 fertilization is that at the same time, ambient temperatures will increase and lead to increased heterotrophic respiration. It is estimated that within the next 30 years, respiration will exceed assimilation. Elevated CO_2 concentrations can increase carbon allocation into the soil, but it is still unclear how this will influence net ecosystem productivity (NEP) and long-term carbon dynamics.

2.2 Water cycling

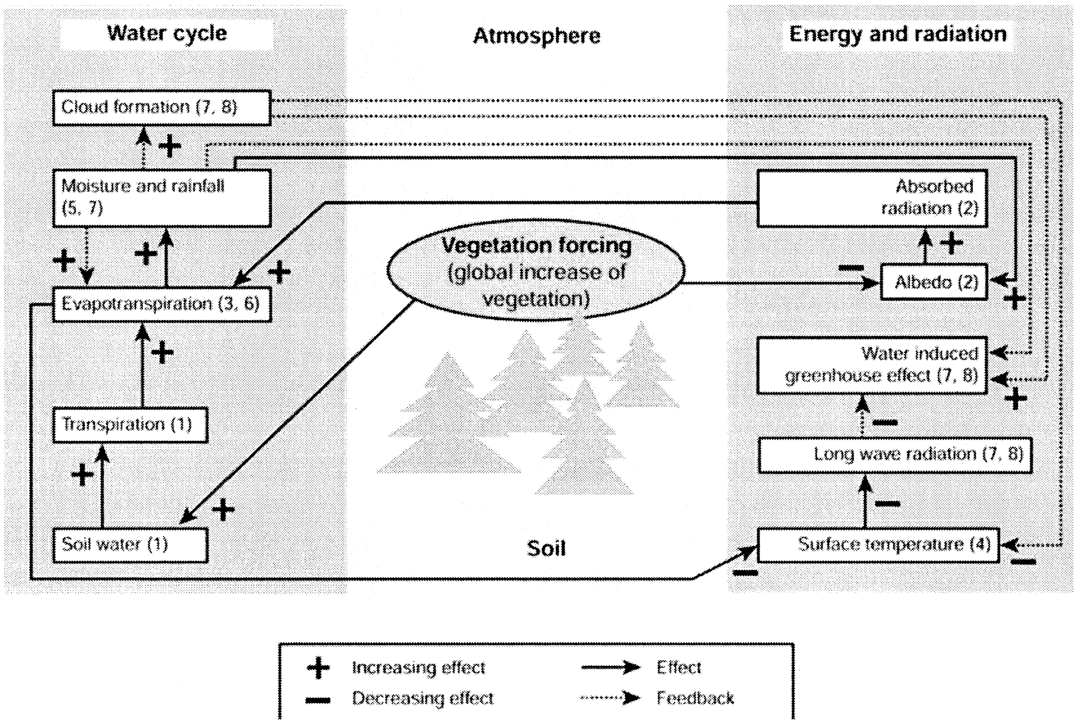
2.2.1 Functions and processes

Land surfaces and terrestrial vegetation have a large influence on the cycling of water on land and in the atmosphere, thus feeding back on climate. The main processes through which vegetated land surfaces influence the hydrological cycle are:

- evapotranspiration,
- water retention and retardation of runoff,
- and cloud formation.

Figure 4 shows the relevant processes through which the biosphere and the climate system are coupled. These processes interact with the radiation balance of the surface, which are explained in section 2.3.

Figure 4 Mechanisms and feedbacks between biosphere and atmosphere



Source: WBGU 2000

The role of these processes on different time and spatial scales has been studied in both observational and modelling studies within the IGBP-BAHC Programme (International Geosphere-Biosphere Programme - Biospheric Aspects of the Hydrological Cycle). A general finding of the studies in this programme is that the biosphere on all scales, feeds back on the hydrological cycle and influences the climate – from local to global effects (Pitman et al. 1999). A comprehensive summery of the results of BAHC is expected for 2001.

The modification of the water cycle and energy budget occurs through two major processes: plants increase the transpiration compared to the bare soil (1) and they absorb more incoming radiation because of their smaller albedo (reflectivity) (2). These effects together lead to an increase of evapotranspiration from the surface (3), resulting in a reduction of the surface temperature (4) and an increase of humidity in the atmosphere (5). This leads to three feedback mechanisms: The water cycle is increased by this increase in humidity, cloud formation and precipitation are stimulated in arid regions (6). The increasing cloudiness and humidity increase the long-wave radiation of the atmosphere and thus the greenhouse effect that is induced by water vapour (7). Reduced short-wave irradiation (because of increased cloud cover) and increased evaporation leads to a cooling of land surfaces, reduces the long-wave radiation of the soil and thus weakens the water-vapour-induced greenhouse effect (8). The net effect of these partly counteracting processes is a reduction of the greenhouse effect by vegetation (WBGU 2000).

Evapotranspiration

Evapotranspiration depends on surface roughness, stomatal conductance, water availability in the soil and the atmospheric water pressure deficit. It is estimated that the process of plant transpiration and evaporation contributes about 71,000 km^3 of water to the atmosphere annually (Schlesinger 1997) and feeds cloud formation processes at the mesoscale (Avissar and Liu 1996). In the tropics, deep-rooted vegetation that draws water from deeper soil layers increases evapotranspiration and latent heat flux (Kleidon and Heimann 2000).

Precipitation

Vegetation also has an influence on the amount and spatial distribution of precipitation. Observational and modelling studies have shown that over vegetated surfaces, precipitation usually increases compared to bare ground. Land cover loss in the past 7000 years has led to an increase in climate variability both regionally and globally (Pitman et al. 1998). Another important factor is the phenomenon of precipitation recycling (Eltahir and Bras 1996), which is defined as the contribution of local evaporation to local precipitation and is influenced by vegetation. Recent estimates of the percentage of precipitation recycling range from 12 % for Eurasia, 24 % for the Mississippi, 25 – 35 % for Amazonia to 35 % for the Sahel region (Eltahir and Bras 1996).

Runoff and water retention

On a local and regional scale, vegetated surfaces influence runoff and water retention in water catchments. Through interception and subsequent evaporation and through root uptake and transpiration, they reduce rain energy, diminish surface runoff and thus can delay or prevent floods in river catchments. Deforestation and land degradation threaten this buffer function and thus increase the risk of flooding, although this effect has been questioned recently by a World Bank study (Chomitz et al. 1998).

2.2.2 The role of biological units

The following biological units have been identified as important for the interaction between the water cycle and climate:

Forests

Forests are important for the water cycle both on a local and on the global scale. Myers (1997) mentions watershed services and rainfall regulation as the most important water-related services of forests; Costanza et al. (1997) estimate the value of global forests for water regulation to be US$ 11.4×10^8 annually. This service is mostly performed by tropical forests.

On a global scale, a simulation study that compares two extreme scenarios of global land cover – global forest and global desert (Fraedrich et al. 1999) – shows that the water cycle on the „green planet“ is much more active than on the desert planet, with 100 % increased precipitation, 250 % increased evapotranspiration, a 30 % increase of relative humidity and a 16 % increase of cloud formation. The increased water cycle leads to changes in atmospheric circulation, e.g. an intensification of the tropical convergence zone, a weakening of the Aleute low, warming in East Asia and cooling in Alaska (WBGU 2000).

On mesoscale levels, important influences of past, current and future forest distribution have been observed or modelled. Some regions are especially important with regard to water cycling. A frequently quoted example is the Amazon basin with its high proportion of precipitation recycling (WBGU 2000). Deforestation can reduce precipitation in this region by up to 30 % (Couzin 1999). Pitman et al. (1999) have identified South-East Asia as a region with key functions for the global water cycle and consider consequences of land cover changes in this area even more important than in South America. This is a contradiction to previous studies (Henderson-Sellers et al. 1995) that found that complete deforestation of the Amazon would reduce precipitation in the rainy season by 30%, while complete deforestation of Southeast Asia would have no effect on precipitation. Reale and Shukla (2000) found that deforestation in the Roman era was responsible for the current dryness of the Mediterranean climate. Water cycling is affected by land use and land use change: In a study in Thailand and Amazonia, evaporation increases in a succession from non-irrigated, actively and recently cultivated sites over secondary vegetation to forest (Giambelluca et al. 2000). Forest loss often leads to soil erosion, which can cause changes in the water cycle of a watershed. Plantations where litter is removed or burned seem to be much less able to prevent erosion than undisturbed plantations or natural forests (Wiersum 1984, quoted in Matthews et al. 2000). Matthews et al. (2000) conclude that ground cover seems to be a more important determinant for soil loss than forest canopy cover. However, information on these processes is sparse, and further research is needed to clarify the role of forests in water cycling.

On a local scale, the ability of forests for water retention and buffering of extreme precipitation events is important. The value of India's forests alone for flood prevention and river flow regulation was estimated to be US$ 72 billion annually (Panayotou and Ashton 1992). Compared to other biological units like grassland or fields, forests have the highest water retention and infiltration capacity (WBGU 1998a). Afforestation and deforestation influence the water yield in catchments areas, as shown by an analysis of 145 experiments. A 10 % reduction in cover increased the water yield from conifer-type forest by some 20-25 mm, whereas that for eucalyptus-type forest increased by only 6 mm. A 10 % afforestation with scrub led to a 5 mm decrease in water yield, a 10 % reduction in the cover of deciduous hardwood gave a 17-19 mm increase in yield (Sahin and Hall 1996). This indicates that large-scale deforestation and afforestation programmes for carbon sequestration significantly affect water yield in a region.

Wetlands

Wetlands are important for the storage of water and act as buffers for water flows. Evaporation from open water surfaces has a cooling effect on local climate. Larger lakes and river basins influence the climate on a local / regional scale. Costanza et al. (1997) estimate the value of global wetlands for water regulation at US$ 4.95×10^9 annually.

No value is given for the climate regulation effect through water-related processes. The vegetation of some wetland areas like mangroves is an important buffer against wave energy and thus helps to protect the coastline from erosion. Generally, the focus on interactions of climate and wetlands is more on methane emissions from wetlands and the factors that influence these emissions than on water-related effects.

Savannas and grasslands

The role of grasslands and savanna ecosystems for the global hydrological cycle is not as important as the role of forests, although vegetation in these ecosystems has an important function for hydrological processes at the regional scale. The effect of changes in vegetation cover has been mainly discussed in the context of desertification and land degradation, especially because of the positive feedback cycles that characterize the process of desertification. Field studies and modelling studies indicate that desertification (here: replacement of grassland by desert) and land use changes in grasslands and savannas lead to reduced precipitation (Zheng and Ni 1999), reduced evapotranspiration and a general weakening of the hydrological cycle (Wie and Fu 1998). On the other hand, irrigation of semiarid land can cause an increase in convective precipitation (De Ridder and Gallee 1998). The conversion of natural savanna to secondary grassland leads to reduced precipitation by 10 % and increase of dry periods within the wet season (Hoffmann and Jackson 2000) due to a modelling study.

Introductions of non-native tree species can affect the water balance especially in dryland regions: Afforestation and subsequent spread of *Pinus pinaster* in South African fynbos ecosystems has led to a suppression of the biologically diverse natural vegetation and to a reduction in freshwater yields because of the increased evapotranspiration of pine trees (World Resources Institute 2000). It is unclear if this has a significant effect on the local climate.

Sala and Paruelo (1997) also describes an example from the Sonoran desert where differences in land use between Mexico and the US lead to lower grass cover with higher albedo on the Mexican side of the border (see also chapter 4.1.3). This results in decreased convective precipitation.

2.2.3 Human-induced factors that influence the water cycling processes

This chapter gives a summary of the most important factors that influence water cycling. Trends that affect the ability of forests to provide water-related ecosystem services are deforestation, degradation and fragmentation and other land-use related activities. The most important processes that lead to changes in the hydrological cycle are land use changes.

Deforestation reduces evapotranspiration in water catchments so that runoff is increased and less water infiltrates into the ground. The process of precipitation recycling is also reduced by deforestation (e.g. 30 % in the Amazon basin, Couzin 1999).

Replacement of primary forest by secondary vegetation and cultivated sites can also reduce evapotranspiration, because the root system is usually altered to more shallow roots. The replacement of forest by other vegetation types also leads to a reduction of leaf area and leaf biomass, so that evapotranspiration is reduced.

Afforestations with non-native species like pine or eucalyptus plantations lead to significant changes in the water cycle, especially if they replace other non-woody vegetation types or change from hardwood to coniferous forests. It is not clear on which scale these effects lead to changes that go beyond the local scale.

Forest management also influences hydrological properties of forests; depending on species composition, stand age and structure, soil compaction by harvest machines, creation of preferential flow pathways in logging alleys. This is mostly relevant on a local scale.

Trends that reduce the water-related services of wetlands are (after Postel and Carpenter 1997) dike and levee construction, river diversions, draining and overharvesting. Other trends are climate change, deforestation and land use change (especially aquaculture).

Trends that reduce the ability of savannas and grasslands to provide water-related climate services are grazing intensity, land use change, changes in fire frequency and intensity, changes in composition of vegetation (trees / grasses). Sala and Paruelo (1997) state that moderately grazed natural grasslands ameliorate the climate in the Patagonian steppe. In the Sonoran desert, overgrazing on the Mexican side of the US-Mexican border leads to reduced precipitation compared to the US side of the desert (Sala and Paruelo 1997). This effect is due to changes in species composition and community structure depending on grazing intensity and coupled with energy balance and albedo effects that feed back on climate.

2.3 Energy budget and albedo

2.3.1 Functions and processes

The terrestrial vegetation influences the radiation and surface energy balance of the earth. Incoming solar radiation is absorbed by surfaces (soil and vegetation). The majority of the incoming energy is transferred back to the atmosphere as sensible heat (which leads to changes in surface temperatures) and latent heat (stored in water vapour). Vegetated terrestrial surfaces usually have a smaller albedo than bare ground and thus absorb more solar radiation. This leads to an increase in near-surface temperatures. The combined effects of the influence of vegetation on the water and energy balance of the earth have been explained in section 2.1.1 and are shown in Figure 4 (WBGU 2000). Under the conditions of a changing climate, increased leaf area index (LAI, equivalent to increased vegetation cover) leads to reductions in albedo and thus to a warming of the surface temperature. At the same time, the evaporation is increased and leads to a cooling effect (the process of evaporation is an energy-consuming process). The effect of the albedo-driven processes is more pronounced in regions with low vegetation cover and highly reflective land surfaces. In other regions, the vegetation evaporation effect dominates. Albedo effects, however, have a smaller effect on radiative forcing than greenhouse gases: While the well-mixed greenhouse gases lead to a radiative forcing of 2,43 Wm^{-1}, the cooling effect of albedo is only –0,2 Wm^{-1} (Clarke et al. 2001).

2.3.2 The role of biological units

Different vegetation types have different albedo and therefore have different effects on the global energy budget and radiation balance. Changes in cover, structure and vegetation type can therefore influence the global climate. Surface albedo values vary from as little as 8 % (northern conifer forests) to higher than 80 % (fresh snow over grassland) (Betts et al. 1996).

It is difficult to separate the albedo and the evapotranspiration effect of the vegetation. However, there are some regions where the albedo effect is more important than the evaporation effect.

Deserts, grasslands, agricultural lands and snow cover

Regions with sparse vegetation such as deserts, grasslands and agricultural lands are more reflective. The same applies to regions that are snow-covered part of the year (tundra). Table 9 shows albedo values for different vegetation types and a qualitative estimate of their significance for the global energy budget. The table shows that deserts and tundra have albedo values representing the highest reflection. It is important to note that the qualitative estimate refers to the current distribution of these vegetation types.

An important and well-studied region is the Sahel. The desertification mechanism in this region leads from reduced vegetation cover to reduced evapotranspiration, followed by reductions in precipitation, reduced soil moisture and further reductions in evapotranspiration. However, these effects are mainly regional and do not necessarily influence the global climate. The large-scale climatic relevance of this region seems to be more an effect of increased amounts of dust in the region than a surface albedo effect (Nicholson 2000).

Forests

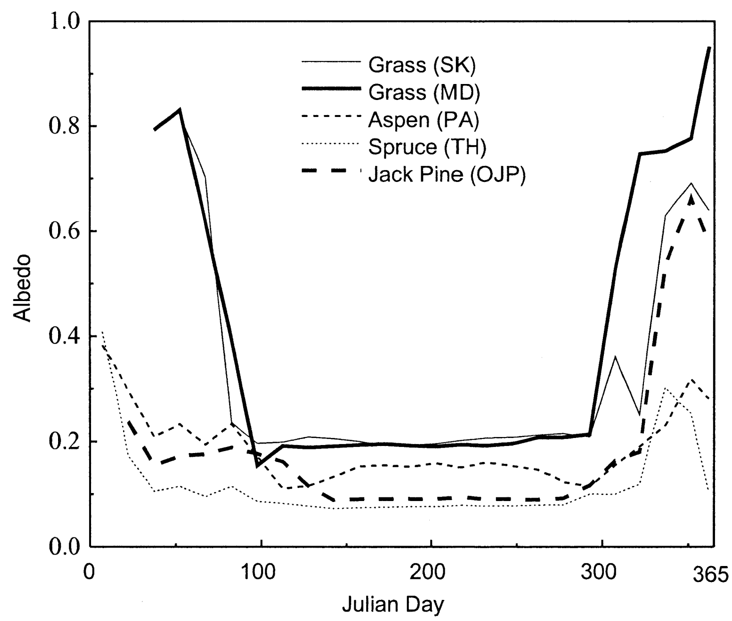
Regions with dense vegetation, especially forest areas are more absorbing and darker than other vegetation types like (snow-covered) tundra. Table 9 shows albedo values for different forest types and a qualitative estimate of their significance for the global energy budget. A study on different forest types in the boreal region has resulted in considerable differences between vegetation types (Figure 5).

Table 9 Values for albedo of different surfaces and their significance for the climate system

Vegetation type	Typical albedo value (in % of the incoming radiation)	Functional significance for global reflection of incoming radiation
Boreal forest	8 %*	very small
Temperate forest (broadleaf)	15 – 25 %	small
Tropical forest	10 – 12 %	small
Savanna	no quantitative data available	medium
Tundra	no quantitative data available	high
Desert	15 – 60 %	very high
Agricultural lands	15 – 30 %	
Marine biosphere	no quantitative data available	small

Source: WBGU 2000 and Höper 1998, * Betts et al. 1996

Figure 5 Seasonal differences in albedo values of typical boreal vegetation units



The abbreviations in the figure refer to different plots.

Source: Betts et al. 1996

A replacement of e.g. tundra (mainly (mainly herbaceous and grassy species and mosses) by forest can have serious implications for the climate because the influence of tundra on the energy balance during winter would be greatly reduced. Bonan et al. (1992) have shown that a poleward migration of boreal forest into tundra leads to a decrease in land surface albedo because the trees have a dark surface in winter compared to bright and reflecting snow-covered tundra, causing net increase in temperature. The same holds true for the possible impact of afforestations as a climate mitigation option north of 30 °N: The carbon sink effect of such afforestations will partly be offset by the changes in reflectivity that occur when dark trees replace lighter tundra land cover (Hadley Centre 2000).

An example for regional impacts is the interaction between the front system and forest in the boreal regions: The position of the polar front in summer along the northern edge of the boreal forest is probably caused by different heating over forest and tundra in summer (Pielke and Vidale 1995). The larger heating over forest vegetation in spring and summer is due to lower albedo from the forest which is not compensated by an increase in transpiration. In contrast to previous studies, Pielke and Vidale conclude that the boreal forest itself influences the position of the front and not vice-versa. This indicates that the distribution of tundra and boreal forest, especially in Siberia, plays an important role for albedo-driven climate effects.

2.3.3 Factors that influence energy budget and albedo

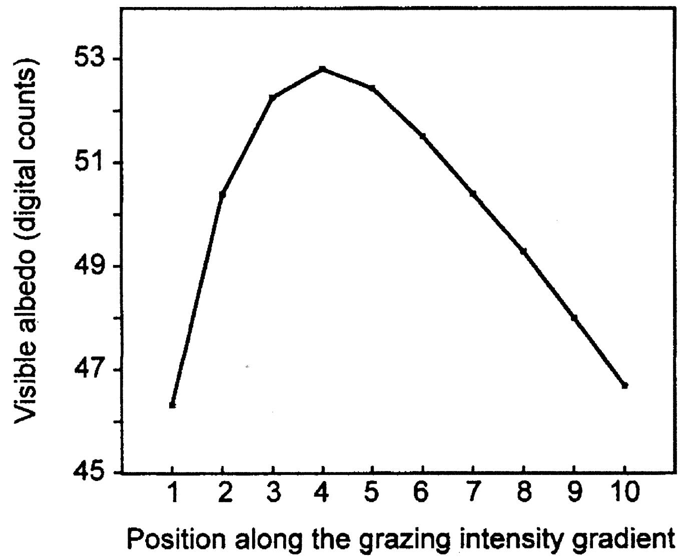
Land-use and land-use changes

Trends that affect the albedo of biological units are land use change, especially changes from forest to grassland or from grassland to desert with a higher percentage of bare soil. Hansen et al. (1998) show that land use changes between pre-industrial land cover and today have led to a reduction of radiative forcing by –0.2 +/- 0.2 Wm^{-2} which led to a cooling of 0.14 °C. Especially land use changes in Eurasia, North America and China in the past are responsible for this effect. These global estimates are confirmed by studies on the local and regional scale, where changes in vegetation cover due to land use change also showed influences on the weather and climate: Sala and Paruelo (1997) describe the effect that grazing intensity has on surface albedo on both sides of the US-Mexican border and on the Patagonian grassland. The greater loss of grass cover due to overgrazing results in a greater surface albedo and higher maximum summer air temperatures (Reynolds et al. 1996).

Species composition

Changes in species composition due to ecosystem alterations or species introduction can also influence the radiation budget of land surfaces. For example, the invasion of the shrub *Mulinium spinosum* in Patagonian grasslands (due to overgrazing) decreased surface albedo (Sala and Paruelo 1997, see Figure 6). From light to moderate grazing intensity, there is an increase in the amount of energy reflected which is related to a decrease in plant cover and an increase in bare soil. Further increases in grazing intensity result in the invasion of the shrub *Mulinum spinosum* with the resulting increase in cover and decrease in albedo.

Figure 6 Grazing intensity modifies the albedo of a Patagonian steppe.



1 means light grazing intensity, 10 means high grazing intensity,

Source: Sala and Paruelo 1997, in Daily 1997.

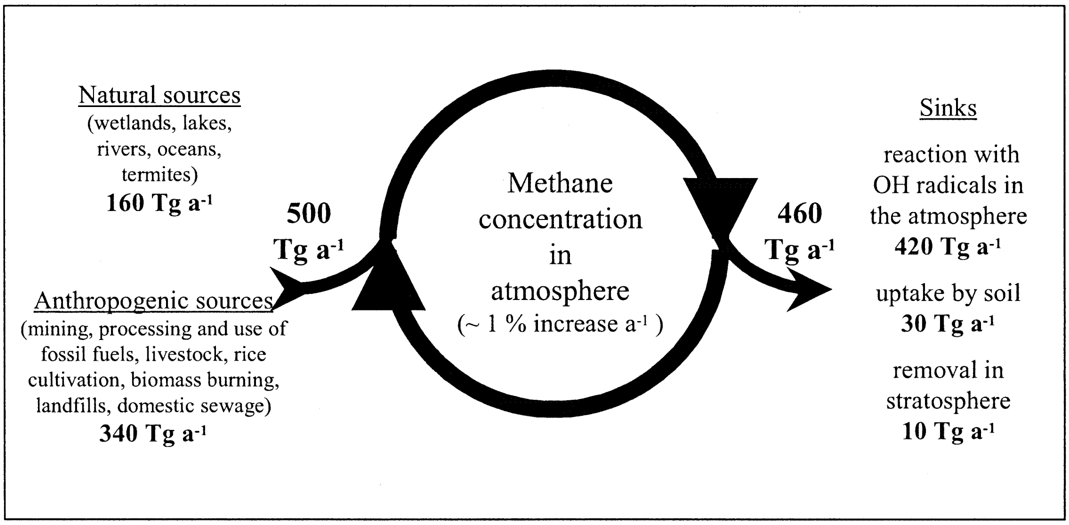
2.4 CH_4 Emissions

2.4.1 Functions and processes

Besides carbon dioxide and water vapour, methane is one of the most important greenhouse gases. Methane has a Global Warming Potential (GWP), which is 21 times higher than that of carbon dioxide. During the industrial era methane concentrations in the atmosphere have increased by about 150%. In the last two decades the increase has become slower for reasons that are not clear (IPCC 2000). Every year about 550 Mt methane are emitted into the atmosphere from various sources. Nearly the same amount of CH_4 is removed by chemical reaction with OH radicals in the atmosphere and an additional small amount is removed by uptake of soils. The small imbalance that exists in production and destruction of methane leads to an increase in the atmospheric concentration of about 13 ppbv a^{-1} in the early eighties. At the beginning of the nineties the increase dropped to 8 ppbv a^{-1} and is now (1996) at a rate of 4 ppbv a^{-1}. Although the total amount of methane emissions is well known, the shares of the individual sources are uncertain (IPCC 2000).

Wetlands are currently the primary source of methane emissions from natural sources. Methane is generated in moist, oxygen-depleted, wetland soil by bacteria, as they decompose dead plant material. Apart from being an important greenhouse gas, methane affects the atmospheric chemistry and oxidation capacity. It influences concentrations of tropospheric ozone, hydroxyl radicals, and carbon monoxide and in the stratosphere it is a source for water vapour and hydrogen, but a sink for chlorine (Neue 1993).

Figure 7 Sources and sinks of methane



Source: Neue 1993

2.4.2 The role of biological units

Methane's increasing atmospheric concentration is largely correlated with increasing human population. Human-related activities such as fossil fuel production, transportation, animal husbandry, rice cultivation, and waste management release significant quantities of methane, and all of these activities are expanding with industrialization and population growth. It is well established that these sources currently represent about 70 percent of total annual emissions. Natural sources account for the remaining 30 percent of methane emissions.

2.4.2.1 Natural sources and sinks

In pre-industrial times atmospheric methane was controlled by wetlands[4], termites, wild animals, oceans and gas hydrates. Table 10 provides an overview on natural sources of methane.

Table 10 Natural sources of atmospheric methane

Emission sources	**Emission estimates** - Tg CH_4 a^{-1} -	**Range of emissions** - Tg CH_4 a^{-1} -
Wetlands	109	70-170
Termites	20	10-50
Oceans	10	5-20
Freshwater	5	1-25
Gas Hydrates	5	0-5
Permafrost	0	?
Total for Natural Sources	150	100-300
Total Methane Emissions	505	400-610

Source: EPA 2000

Wetlands[5]

Wetlands are the most important sources of natural methane emissions. About 109-115 Mt methane per year are emitted from natural wetlands. This corresponds to nearly one quarter (24 %) of the total methane emissions. The share in natural CH_4 emissions sums to three thirds. Table 11 shows the different amounts of CH_4 emissions from wetlands in the tropics and in boreal or temperate climate.

Table 11 Methane emissions of natural wetlands

	Methane emissions - Mg CH_4 $ha^{-1}a^{-1}$ -	**CO_2-equivalents*** - Mg CO_2equiv. $ha^{-1}a^{-1}$ -	**% of total CH_4 emissions**
Global wetlands	0.05 – 0.21	1.1 – 4.4	
Tropical wetlands	0.26 – 0.28	5.5 – 5.9	60%
Boreal/temperate wetlands	0.08 – 0.15	0.5 – 1.0	boreal: 35% temperate: 5%

* GWP (Methane, 100a): 21

Source: WBGU 1998a, p. 54, EPA 2000

Recent research from wetland studies changed the contribution to global emissions from each region compared with previous studies. 60 % of wetland emissions are estimated to be from tropical systems, whereas previously tropical wetlands were only estimated to

4 Bogs at high northern latitudes and swamps in the tropics

5 see also chapter 8

contribute 29 % to 54 % of the total. Systems in the northern latitudes now represent a smaller portion (35 %) than in the past (31 % to 58 %), and temperate wetlands continue to represent a small portion (5%) of the total (EPA 2000). In general, the emission rate from wetlands is sensitive to a number of variables including:

- the temperature, since methane-producing bacteria are generally more active as temperature increases;
- the level of the water table, as the area must be sufficiently flooded to maintain anaerobic conditions; and
- the plant community, as the plants affect the availability of carbon for decomposition, in addition to the transport of methane from the anaerobic zone to the atmosphere.

Wetlands plants play an important role in the production, transport and emission of methane to the atmosphere (Roura-Carol and Freeman 1999). Plants may enhance methane production by supplying litter and root exudates as substrates for methanogenic bacteria. The methane is evolved under anaerobic conditions and would normally be susceptible to oxidation in the aerobic zone lying between the anaerobic zone and the atmosphere. However, oxidation of methane can be avoided if the methane flows through the aerenchyma of wetland plants either by passive moleculare diffusion, active pressurized flow or effusion (Roura-Carol and Freeman 1999). Thus, plants promote methane emissions both by stimulating production, and by minimising oxidative losses (see also section 3.2). There is research evidence that different plants influence wetland methane emissions, but there are no results, which indicate the quantitative influences of plants at an ecosystem level or on larger areas. Existing scientific knowledge and investigation refer to single processes or individual species. From these results, it is not possible to develop general recommendations with regard to activities or mitigation potentials. In the total balance of CH_4 emissions, emissions from natural wetlands are small compared with emissions from agricultural activities (see Figure 3); therefore the focus has been on mitigation potentials in the agricultural practices.

Lakes and rivers

Lakes and rivers have a share of approximately four percent of the total methane emissions to the atmosphere. Neue (1993) gives 10 Mt per year as total amount. Methane is emitted from inland water sediments during spring and fall. These methane releases, especially from the littoral zone, can be significant in lakes and reservoirs (Dentener et al. 2001).

Oceans

Oceans are reported to have a share of two percent in total methane emissions (10 Tg per year). In marine sediments large quantities of methane are stored as methane hydrates[6], which are dense combinations of methane and water molecules located deep

[6] Methane hydrate: Methane hydrates (also called methane clathrate) are nonstoichiometric compounds with structures consisting of a network of H_2O molecules hydrogen-bonded together

under the ground and beneath the ocean floor. An immense quantity of methane is trapped in both oceanic and continental gas hydrates, with estimates ranging from millions to billions of teragrams. The exact quantity of these methane reservoirs is uncertain. Studies show variations in the methane amount stored in the sediments by a factor of three (Holbrook et al. 1996;). The stability of hydrates decreases with reduced pressure and increased temperature, and it is assumed that they played a role in past rapid climate changes (Dentener et al. 2001). Drops in sea level and ocean warming can affect the stability of these methane hydrates stored in sediments. Calculations show that a relatively small amount of methane - 3 to 5 Tg per year - may be escaping to the atmosphere from this region (EPA 2000).

Termites

Termites have a share of two percent in total methane emissions (10 Tg a^{-1}) (Neue 1993). Methane is produced by the digestive system of the termites that is able – as it is by ruminants – to digest cellulose by the aid of protozoa and bacteria[7].

Soils

A small amount of CH_4 (estimates vary between 10 – 44 Tg CH_4 a^{-1}) is removed from the atmosphere by uptake of soils.

Permafrost

Permafrost is ground, usually consisting of soil and ice, that remains frozen throughout the year for at least two consecutive years. Research has shown that CH_4 is trapped in permafrost in small concentrations. Due to the large amount of permafrost that exists on earth, the total amount of CH_4 stored in this form could be quite high, possibly several thousand teragrams (EPA 2000). While it has been proven that permafrost is melting in certain locations, no estimates have been made for current emissions from this source.

2.4.2.2 Anthropogenic sources related to biological processes

The rise in methane emissions is correlated with the increase in world population because of the increasing importance of rice cultivation, of domestic livestock, of methane emissions from coal, oil and gas industry, from waste disposal sites and from biomass burning (Enquete 1988). This section will only highlight the anthropogenic sources related to biological units. Sources for anthropogenic methane emissions are rice cultivation, cattle breeding, biomass burning, waste treatment[8] and the use of fossil fuels[9] (IPCC 2000).

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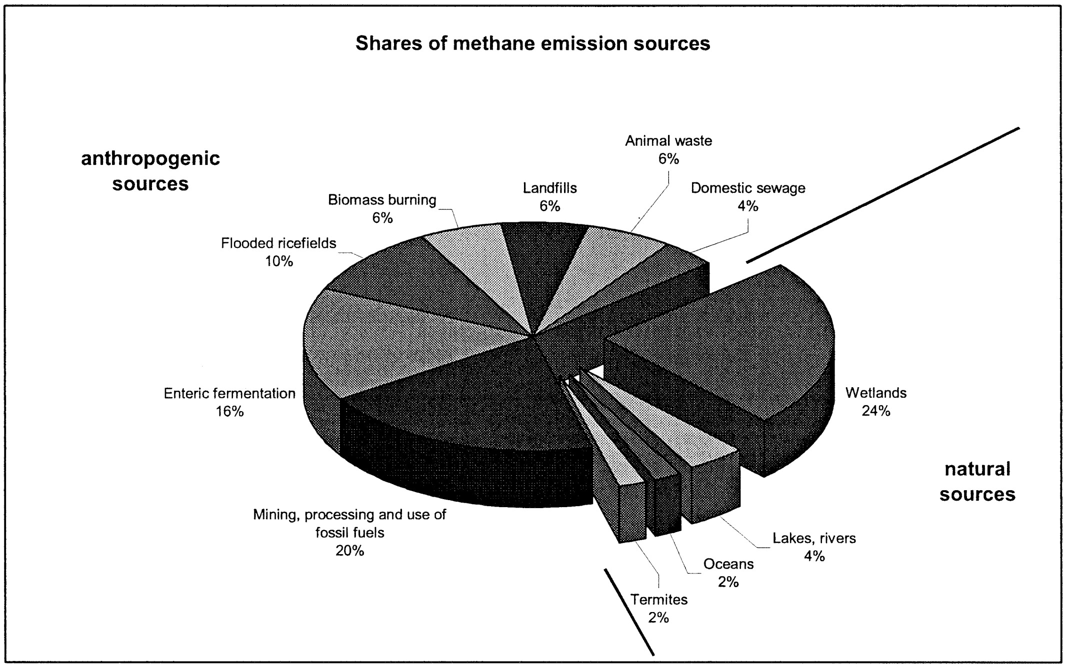
like ice ancaging molecules of methane. The ideal stochiometric composition of methane hydrate is CH_4 * 5.75 H_2O, constructed from 46 H_2O molecules with eight cavities available for CH_4 gas molecules (Stern et al. 1996).

7 New studies show that the digestive system of termites (in difference to that of ruminants) is not only an anoxic fermentation system, but also an oxic fermenting system (Brune 1998).

8 Landfills, sewage and animal waste

9 Mainly natural gas and coal extraction and petroleum industries activities in general.

Figure 8 Shares of different sources in total methane emissions



Source: Neue 1993

Rice cultivation

Flooded rice paddies are an important source for methane emissions. About 60 Mt (20 – 100 Mt a^{-1}) CH_4 are emitted per year. This means that more than ten percent of total CH_4 emissions are resulting from rice cultivation. By flooding a rice field the oxygen supply from the atmosphere to the soil is cut off. The result is – as in natural wetlands - anaerobic fermentation of soil organic matter, of which methane is a major end product.

Enteric fermentation and animal waste

The enteric fermentation of carbohydrates by herbivores produces about 80 Mt methane per year (Neue 1993). This corresponds to a share of 16% of the total methane emissions (Figure 8). Some animals, mainly ruminant animals (such as cattle and sheep), produce methane as one digestive product. With the aid of microorganisms carbohydrates, that the digestive system of mammals cannot utilise (mainly cellulose), are broken down into simple molecules for the absorption into the bloodstream. Methane emissions, which are caused by decomposition of animal waste under anaerobic conditions, are about 30 Mt CH_4 per year or six percent of the total methane emissions. In total methane production by livestock is at about 110 Mt per year or 22%.

Storage dams, reservoirs and lakes

The emission of greenhouse gases from reservoirs due to rotting vegetation and carbon inflows from the catchments is a recently identified ecosystem impact (on climate) of storage dams, but also of natural lakes. A first estimate suggests that the gross emissions from reservoirs may account for between 1 % and 28 % of the global warming potential of GHG emissions (World Commission on Dams 2000).

Biomass burning

Biomass burning produces methane as a result of incomplete combustion. About 30 Mt methane (or 6%) are produced every year by burning of agricultural residues or savannas. Biomass burning reduces organic matter stored in the soil with possible reductions in soil fauna.

2.4.3 Factors affecting CH_4 emissions

Land use and land use change

Table 12 shows the recent sources of methane emissions, which are influenced by land-use change activities. The likely changes in these methane sources caused by land use change and other terrestrial ecosystem modifications are uncertain.

Table 12 Recent sources of methane emissions that are influenced by land use activities

CH_4 sources	CH_4 emissions	
	- Mt CH_4 a^{-1} -	- Gt C-eq a^{-1} [a,b] -
Livestock (enteric fermentation and animal waste)	110 (85 – 130)	0.6 (0.5 – 0.7)
Rice Paddies	60 (20 – 100)	0.3 (0.1 – 0.6)
Biomass burning	40 (20 – 80)	0.2 (0.1 – 0.5)
Natural Wetlands	115 (55 – 150)	0.7 (0.3 – 0.9)
Total	**325 (180 – 460)**	**1.8 (1.0 – 2.7)**

a 12 Gt C-equivalents = 44 Gt CO_2-equivalents
b Carbon equivalent emissions based on CH_4 GWP of 21
Source: IPCC 2000, Table 1-3

The main changes in land use in tropical wetlands are conversions of wetlands in rice cultivation areas. Apart from consequences for biodiversity, methane emissions from rice cultivation could be much higher than from natural tropical wetlands. The range of methane emissions in rice cultivation areas is from 0.13 tC ha-1a-1 to 0.89 tC ha-1a-1, compared with 0.26 tC ha-1a-1 to 0.28 tC ha-1a-1 from natural tropical wetlands (WBGU 1998a). This means that methane emissions caused by rice cultivation could be more than three times higher than natural ones, on an average they are about double of the natural ones. Accordingly high is the contribution of rice cultivation to the greenhouse effect. Therefore the protection of natural wetlands – both in the tropics and in temperate or boreal climate – can make a considerable contribution to the protection of the climate (see also section 2.1.2).

Livestock management

As shown above livestock is one of the important anthropogenic methane sources, mainly by enteric fermentation. Many opportunities exist for reducing methane emissions from ruminant animals by improving animal productivity and reducing methane emissions per unit of product (e.g., methane emissions per kilogram (kg) of milk produced). This leads to smaller size herds required to produce the same amount of product. US EPA estimates that with adequate resources, current and potential future technologies and management practices can technically reduce methane emissions per unit product by 25 to 75 percent in many animal management systems (EPA 2000b). The US "Ruminant Livestock Efficiency Program" lists many different management practices, which can improve a livestock operation's production efficiency and reduce greenhouse gas emissions. Some of the most effective practices include:

- *Improved Nutrition Through Mechanical & Chemical Feed Processing*: Improved nutrition reduces methane emissions per unit product by enhancing animal performance, including weight gain, milk production, work production, and reproductive performance. Mechanical and chemical feed processing options include wrapping and preserving rice straw to enhance digestibility, chopping straw to enhance animal intake, and alkali treatment of low digestible straws to enhance digestibility. These options are applicable to accessible ruminant animals with limited or poor quality feed, and may decrease methane emissions per unit product on the order of 10 to 25% (assuming feed digestibility is increased by 5%), depending on animal management practices.
- *Improved Nutrition Through Strategic Supplementation*: Strategic supplementation provides critical nutrients such as nitrogen and important minerals to animals on low quality feeds. Additionally, it may include providing microbial and/or bypass protein to the animal. Methane emissions per unit product may be reduced by 25 to 75% due to substantial increases in animal productivity, depending on animal management practices.
- *Production Enhancing Agents*: Certain agents can act directly to improve productivity. These agents are generally most applicable to large-scale commercial systems with well-developed markets. Emissions reductions per unit product of 5 to 15% have been demonstrated. Additional reductions may be achieved by shifts in rumen microbial patterns. Options include the use of bovine somatotropin (bST) and anabolic steroids.
- *Improved Production Through Improved Genetic Characteristics*: Genetic characteristics are limiting factors mainly in intensive production systems. Continued improvements in genetic potential will increase productivity, and thereby reduce methane emissions per unit product. Emissions reductions from these options remain to be quantified.
- *Improved Production Efficiency Through Improved Reproduction*: Large portions of the herd of large ruminants are maintained for the purpose of producing offspring. Methane emissions per unit product can be significantly reduced if reproductive

efficiency is increased and fewer animals are required to provide the desired number of offspring. Options such as artificial insemination, twinning, and embryo transplants address reproduction directly. The nutritional options described above can also improve reproduction.

- *Other Techniques*: Additional options include disease control and the control of product markets and prices in countries with surplus dairy products, the improvement of grazing management and the provision of appropriate water sources and protection of water quality.

Possible consequences of these management options on biodiversity are described in section 4.1.10.

Livestock manure management

Methane emissions from anaerobic digestion constitute a wasted energy resource, which can be recovered by adapting manure management and treatment practices to facilitate methane collection. This methane can be used directly for on-farm energy, or to generate electricity for on-farm use or for sale. The other products of anaerobic digestion, contained in the slurry effluent, can be utilised in a number of ways, depending on local needs and resources. In addition to biogas use, other mitigation options include the treatment of manure in lagoons, which is associated with relatively large-scale intensive farm operations. Manure solids are washed out of the livestock housing facilities with large quantities of water, and the resulting slurry flows into primary lagoons. The anaerobic conditions treat manure and usually result in significant methane emissions, provided temperatures remain high enough. Placing an impermeable floating cover over the lagoon and applying negative pressure effectively recovers methane. Possible consequences of these management options on biodiversity are described in section 4.1.10.

Rice cultivation management

According to the IPCC (IPCC 2000d) management effects on methane emissions in rice fields are often more relevant for climate protection than those on carbon storage. According to the IPCC (IPCC 2000d) methane emissions can be suppressed to some extent by soil amendments, altered tillage practices, water management, crop rotation, and cultivar selection. It is unclear how different rice management systems affect biodiversity within these systems.

Storage dams

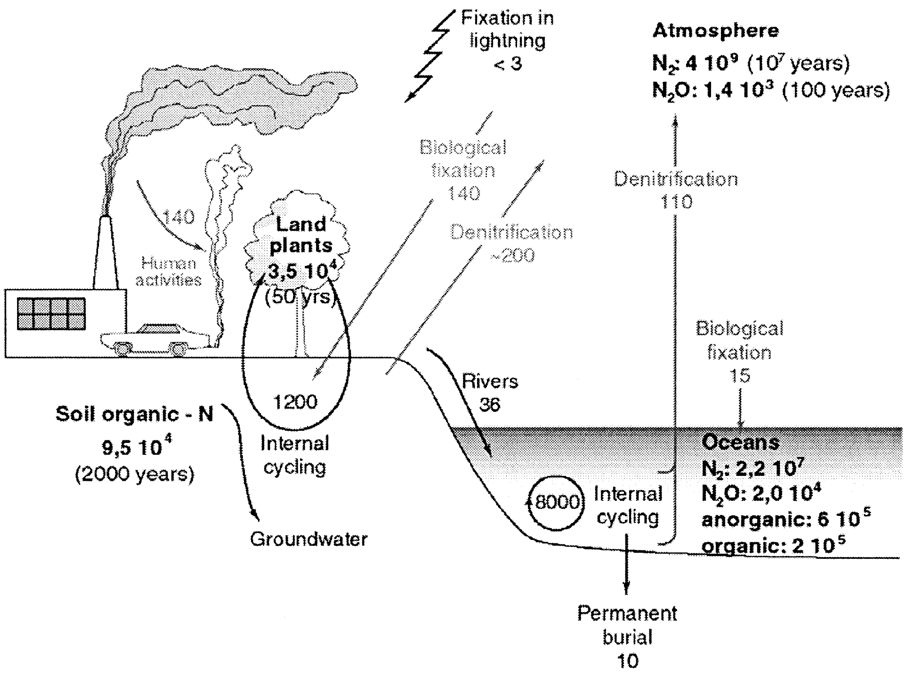
The emissions from storage dams may change significantly over time as the biomass decays within the reservoir during the first few years of impoundment. In some cases, the emissions may depend more on carbon inflows from the catchments in the longer term and have greater stability over time, subject to catchments conditions. Recent monitoring results of a large reservoir in Brazil (Tucuri) shows that greenhouse gas emissions are highly variable from year to year. Values in 1998 exceeded those measured in 1999 by more than a factor of 10 for methane and a factor of 65% for CO_2 (World Commission on Dams 2000). There seems to be rather limited knowledge with regard to the different factors that determine GHG emissions from reservoirs. Further research is needed to establish relationships between emissions and reservoir characteristics.

2.5 N_2O emissions

2.5.1 Functions and processes

Total global emissions of the greenhouse gas N_2O are estimated to be 14 Tg N a^{-1} (Prasad 1997) or, according to a more recent estimate, 16.4 Tg N a^{-1} (Dentener et al. 2001). About half of this amount is derived from natural sources, mostly from soils and land surfaces, the other half from anthropogenic sources like combustion or biomass burning (IPCC 2000). Figure 9 shows the major sources and sinks within the global nitrogen cycle. The main processes for the formation of nitrous oxide are denitrification and to a smaller extent also nitrification. Both processes occur in both soils and water. Ammonia (NH_4) and nitrite (NO_2^-) are the source substrates for nitrification. Nitrification happens under aerobic conditions, but also under waterlogged conditions, some bacteria are able to reduce NO_3^- to NO and N_2O. Denitrification is the process that returns soil N to the atmosphere as N_2 and N_2O. Denitrification takes place under anaerobic conditions. Soils with anaerobic sites are thus important sources for N_2O.

Figure 9 The global nitrogen cycle [in Tg N (bold) and Tg N a^{-1}]



Source: Schulze 2000, after Schlesinger 1997

There are no or only small terrestrial sinks for N_2O; most nitrous oxide is destroyed photochemically in the stratosphere (Schlesinger 1997)

2.5.2 The role of biological units

Table 13 provides a summary of global annual N_2O emissions from different sources.

Table 13 Sources and sinks of N_2O emissions

Sources and sinks	N_2O emissions - Tg N a^{-1} -
Sources	
Ocean	3.0 (1-5)
Tropical soils	
Wet forests	3.0 (2.2 – 3.7)
Dry savannas	1.0 (0.5 – 2.0)
Temperate soils	
Forests	1.0 (0.1 – 2.0)
Grasslands	1.0 (0.5 – 2.0)
All soils	
Natural subtotal	**9.0 (4.3 – 14,7)**
Agricultural soils	4.2 (0.6 – 14.8)
Biomass burning	0.5 (0.2 – 1.0)
Industrial sources	1.3 (0.7 – 1.8)
Cattle and feedlots	2.1 (0.6 – 3.1)
Anthropogenic subtotal	**7.2 (2.1 – 19. 7)**
Total sources	**16.2 (6.4 – 34.4)**
Sinks	
Atmospheric increase	3.9 (3.1 – 4.7)
Soils	?
Stratospheric Sink	12.3 (9 – 6)
Total sinks	**16.2**

Source: Mosier and Kroetze 1998

There are large uncertainties in the global estimates of these sources and sinks. The total emissions of N_2O as calculated by Mosier and Kroetze (1998) are 16,2 Tg N a^{-1}. About half of this amount is from natural and from anthropogenic sources. The most important sources and units are explained in more detail:

Tropical wet soils

Of natural sources, tropical wet soils are the most important single source of nitrous oxide. This is due to a combination of several factors including climatic and soil properties and rapid nitrogen cycling in these soils (Hall and Matson 1999). These factors favour N_2O formation and emission. Further increases from this source are expected from increased atmospheric nitrogen deposition (see section 2.5.3).

***Ocean**s*

The ocean is a source of nitrous oxide. It is expected that these emissions will increase in the future by anthropogenic inputs of nitrogen into coastal waters. The extension of hypoxic zones (areas depleted in oxygen) due to eutrophication will also favour conditions for increased N_2O production (Naqvi et al 2000). Kroeze and Seitzinger (1998) estimate that by the year 2050 global N_2O emissions from rivers, estuaries and continental shelves will have doubled due to increases in N inputs from the atmosphere and from fertilizer. This will result in an increase of emissions from continental shelves of 12.5 %. Seitzinger and Kroeze (1998) have calculated global emissions from rivers (55 %), estuaries (11 %) and continental shelves (33 %) to be 1.9 Tg N a^{-1}. A regional analysis based on a combination of measurements, calculation of gas transfer coefficients and extrapolation to global ocean waters results in a total oceanic N_2O source of 4 Tg N a^{-1}. Areas with high emissions are a latitudinal band from 40 to 60 degrees South, the northern Pacific, the equatorial upwelling zone and coastal upwelling zones in the tropical northern hemisphere (Nevison et al. 1995).

Agricultural soils

Microbial processes like denitrification and to a smaller extent also nitrification are sources for N_2O emissions from soils. Agricultural soils are the most important single terrestrial source of nitrous oxide. They emit 4.2 Tg N a^{-1}, with a range from 0.6 to 14.8 Tg N. Increases in mineral N in soils lead to increased N_2O formation, so that fertilizer inputs lead to enhanced emissions (see section 2.5.3).

Cattle and livestock

N_2O from livestock can derive from two types of sources: (i) animal production systems where the animals are kept in stacks and (ii) pasture systems where the animal dung and urine is deposited on the soil by the grazing animals.

2.5.3 Factors affecting N_2O emissions from biological units

Land use and land use change

Land use and land use changes have a large influence on N_2O emissions: After conversion of natural forest to pasture or agricultural soil, increased emissions of N_2O have been reported in experimental and modelling studies (Matson and Vitousek 1990, Keller and Reiners 1994, Liu et al 1999). In a tropical secondary forest, forest clearing doubled N_2O fluxes immediately and resulted in short-term peaks following biomass burning by a factor of 80 (see Table 14). Adjacent unfertilized agricultural soils had emissions of 3.9 ng N $cm^{-1}h^{-1}$ (Weitz et al. 1998). This increased N_2O flux is probably a result of increased nitrogen availability and cycling after clearing, and of higher gaseous diffusion in drying soils. Compaction of clay-rich soils may also be a factor that increases emissions of nitrous oxide as a result of anaerobic conditions in compacted microsites (Keller 1994). Management and land-use change also have a large influence on N_2O emissions from grasslands: US grasslands emit 0.067 Mt N_2O-N a^{-1} according to a modelling study (Mummey et al. 2000). Conversion from grassland to cropland leads to an increased N_2O flux from the soil that still remains high three years after conversion (Mosier et al. 1997). However, a reversion of cropland to grassland did not result in decreased N_2O emissions in a former wheat field in the same study. Application of fertilizer and manure can increase emissions (Kammann et al. 1998, Chang et al. 1998).

Table 14 Sequence of N_2O emissions after clearing of a tropical secondary forest

Time / status	N_2O fluxes - ng N cm^{-1} h^{-1} -
Before clearing	1.5
After clearing	2.7
After biomass burning (3 days)	123
Average post-burn flux (3-4 months)	17.5

Source: Weitz et al. 1998

Reduced tillage and pasture improvement by fertilization or legumes also increased N_2O emissions (Mummey et al. 1998, Plant and Bouman 1999). This is especially relevant because pasture improvements have often been recommended to increase the sustainability of pastures.

Fertilization

N additions like fertilizer or atmospheric N deposition increase N_2O fluxes from soils both in temperate (Aber et al. 1989) and tropical forests (Hall and Matson 1999). As most humid tropical soils are considered to be more limited by phosphorous than by nitrogen, future increases in nitrogen inputs may lead to high N_2O losses from tropical soils. Nitrogen inputs in tropical systems may even lead to reduced carbon storage because the increased leaching of nitrate also enhances cation leaching, thus reducing nutrient availability and plant growth (Matson et al. 1999).

2.6 Summary of relevant functions of biological units

This chapter summarizes the relevant functions by biological units. Table 15 shows the relative importance of these units for the climate system:

Table 15 Qualitative estimates of the functional significance of biological units for climate-relevant cycles and processes

Process	Forest			Grassland		Desert	Marine biota
	Tropical	Temperate	Boreal	Savanna	Tundra		
Albedo	-	-	--	0	+	++	-
Water cycling	++	+	-	-	?	--	-
NPP	++	++	+	0	-	--	-
Carbon storage	++	+	+	0	+	-	++

++: very high, +: high, 0: medium, -: small, --: very small, ? uncertain.

Source: WBGU 2000

The table shows that all biological units have some significance for the climate system. In forest ecosystem, carbon storage and water cycling are important functions, especially in tropical forests. The albedo effect of forests is usually low: Forests absorb more radiation than grassland ecosystems or bare ground, especially in high latitudes with temporal snow cover. So the albedo effect is mainly attributed to grassland ecosystems. However, changes from grassland to forest or vice-versa can significantly change the albedo of a given landscape. For methane emissions, wetlands, agricultural sites (rice cultivation) and enteric fermentation are the most important sources. These cannot be attributed to single ecosystem types. However, tropical wetlands have the highest emissions of the natural sources, and upland tropical soils can be significant methane sinks. Emissions of nitrous oxide from natural sources are mostly derived from tropical wet soils. Soils can also be sinks for nitrous oxide (Dentener et al. 2001) but the sequestered amounts are not significant and already included into net emission rates. Agroecosystems are mainly significant as emission sources of greenhouse gases.

2.7 Knowledge gaps and research recommendations

Carbon cycle

The role of the biosphere for the carbon cycle has been subject to many studies in the past, but it still remains difficult to estimate the changes in carbon stocks and sequestration rates for specific stands and management systems over time. Especially forests and grasslands and estimates of the soil carbon pools are lacking. There are also methodological problems associated with the estimation of carbon processes in ecosystems. The estimates of carbon storage in terrestrial ecosystems vary worldwide, especially for grassland soils.

Water cycling

The influences of the biosphere on water cycling processes that influence the climate system are not well understood. Pitmann et al. (1998) state that the time-scales of most studies on the influence of surface vegetation on climate and weather are too short. Assumed perturbations of ecosystems used to determine the influence of vegetation are too large-scale to be realistic (e.g. deforestation of the whole Amazon forests as a modelling scenario). They call for long-term measurements over large spatial scales. One important aspect for future research is that the role of biological units and geographical regions has not been studied as detailed and systematically as the changing carbon cycle. The question how local and regional effects add up to global effects is still unanswered. The relationships between forest cover, forests type, and hydrological regimes are still poorly understood. With respect to management options, the evaporative characteristics of different tree species are still unclear, and thus also the influence of large-scale reforestation / afforestation on the water cycle.

Energy balance

The same holds true for the influence of the biosphere on the albedo and energy balance of the land surface. Experimental and modelling studies have concentrated on either a global evaluation or an evaluation of processes in some key regions (Sahel, boreal forests). Most modelling studies on land-use change operate with very drastic effects (replacement of the whole Amazonian forest by grassland). The effect of smaller-scale changes is not yet quantified. It is also unclear how small-scale effects add up to global effects. Many studies in desert and savanna ecosystems are often performed under the aspect of desertification, therefore they lack conclusions about links with global climate change. It is thus recommended to extend studies on albedo, surface effects and radiation budgets to other regions and to include the aspect of global climate effects in desertification studies.

Methane

The generation, storage, transport, and release of biogenic methane are highly complex and variable processes. Scientists have only recently begun to understand the mechanisms of these processes and the potential for a natural methane feedback to climate change. Significant uncertainty surrounds many of the results. With additional research in the field of natural methane emissions, this uncertainty could be reduced.

An important factor contributing to uncertainty in current emissions estimates is the wide variety of wetland types and the variability within each type. Understanding the magnitude and dynamics of methane emissions at one site of a certain type, does not necessarily transfer to other types or even other sites of the same general "type" that are geographically remote. While several independent studies have arrived at similar global methane emissions estimates despite the existing uncertainties, more field research could further reduce these uncertainties. This research should focus on systems not previously measured, in addition to developing better information on areas of different ecosystem types and periods of inundation. Great uncertainty exists in the future wetland emission scenarios. Not only are the relationships between methane emissions and environmental variables (e.g., precipitation, temperature, actual evapotranspiration, plant community, human impacts, sea level change) not well known, but also how these environmental variables will change in the future is also uncertain.

Nitrous oxide

Generally, there are large uncertainties in the correct estimation of global emissions of N_2O from different sources (IPCC 2000). A better understanding at the process level and better availability of global data for different sources is needed to arrive at a more accurate estimate.

3 Biodiversity and the climate system

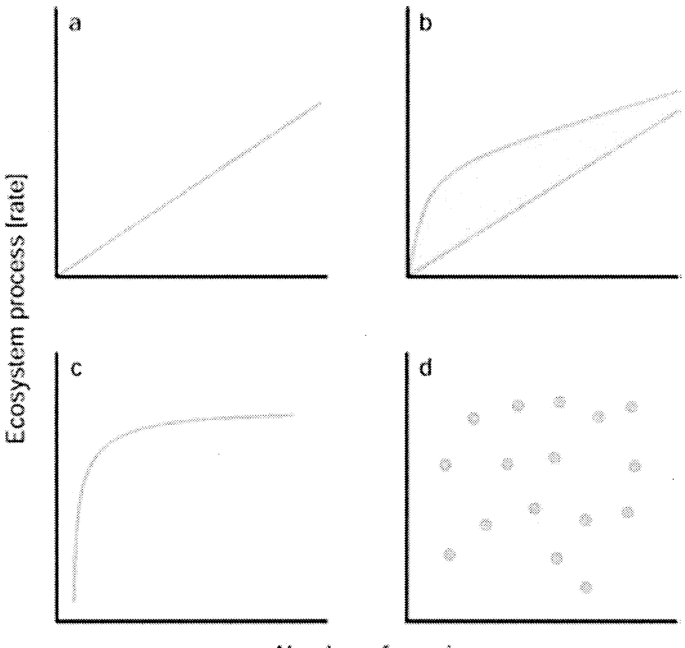
3.1 Biodiversity definition and relationship to ecosystem functions

Biodiversity is defined as

> *„the variability among living organisms from all sources, including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems“ (Norse et al. 1986).*

Studies on the relationship between biodiversity and ecosystem functions have focused on the stability of ecosystems and indicate that diversity within an ecosystem tends to be positively correlated with stability (reviewed by McCann 2000). Different hypotheses about the type of correlation have been suggested

Figure 10 Different hypotheses explaining the correlation between biodiversity (here: number of species) and ecosystem function within a given guild of organisms



(a) diversity-stability hypothesis, (b) rivet hypothesis, (c) redundant species hypothesis, (d) idiosyncratic response hypothesis. Explanations see text

Source: WBGU 2000

Figure 10 represents examples of hypothetical curves between a given ecosystem function or process (e.g. primary production or pollination) as a function of species diversity within an ecosystem. It is important to note that these curves only describe the functional relationships within one guild, i.e. one group of organisms that performs this ecosystem function. The diversity-stability hypothesis (a) states that each species matters, and that each reduction in species numbers leads to a loss in ecosystem performance. The rivet hypothesis (b) is similar to the first hypothesis, but at a certain level of species loss, the system can collapse completely. Another view is expressed by the redundant species hypothesis (c): here, ecosystem functions are performed by only a few species, the other existing species within these ecosystems are redundant and do not contribute to the ecosystem process. Thus, their loss would go unnoticed. Finally, the idiosyncratic response hypothesis (d) states that the relations between species are so complex that a prediction of possible responses to species loss is impossible.

The different definitions and aspects of biodiversity make it difficult to arrive at a comprehensive evaluation. The term "biodiversity" typically refers to ecosystem, species, or genetic diversity. Maintaining desired diversity at one level will have very different requirements than conserving it at another. Conservation priorities, measures and activities are different if one is trying to sustain the population of a specific species or if the aim is to sustain the ecological benefits such as the carbon storage function contributed by species or ecosystem processes. These different goals of the CBD with the resulting differences in priorities and activities complicate the analysis and the implementation of effective supporting linkages between the two conventions.

Useful approaches have started to identify regions with significance for both biodiversity and the climate system and to create maps for both thematic areas and combine these maps in a second step. A preliminary approach has been performed by WBGU (2000), who stresses that further research in this area is needed to arrive at a valuation of the different functions of the biosphere, biodiversity and its components. The approaches to identify the relevant regions for biodiversity and the climate system are described separately in section 4.2.

The consequences of declining biodiversity are yet unclear, but many studies suggest that these alterations are able to change biogeochemical cycles in a way that climatic processes and functions are influenced and modified. The following chapter will describe these effects and will outline research gaps.

3.2 Relationship and impacts between biodiversity and climate system

The following section – as well as the whole study – concentrates only on the goods services that are relevant for the climate. The most important functions of the biosphere within the climate system are the cycles of carbon (CO_2 and CH_4), Nitrogen (N_2O), water and the energy balance of the surface. Some of these functions have been shown to correlate with biodiversity. Some are not directly correlated to biodiversity of species, but to structural and functional traits of biotic units. Many studies contain evidence that biodiversity plays an important role for processes that have an influence on the climate. The following section will show examples of these interactions.

Effects of species richness

Many experimental studies in grasslands found a positive correlation between plant species number and productivity. (Tilman et al 1996, Hector et al. 1999). The European project BIODEPTH (Biodiversity and Ecosystem Processes in Terrestrial Herbaceous Ecosystems) was carried out over three years on eight grassland sites along a European transect (Greece, Portugal, France, Switzerland, Germany, Ireland, United Kingdom). The experimental design included plots that contained different number of plant species – ranging from monocultures up to 32 species in a plot. In spite of different soil and climatic conditions, a general observation was that the harvest yield of these plots decreased with decreasing species number (Hector et al. 1999). Soil respiration, soil microbial biomass and functional diversity of bacteria also decreased with reduced species number, which is a hint that the potential for carbon sequestration in grasslands can be negatively affected in biodiversity-poor sites. The team of investigators, led by Peter Reich at the University of Minnesota, found that more diverse plant ecosystems are better able to absorb CO_2 and nitrogen and concluded that biodiversity is an important factor regulating how ecosystems will respond to increasing atmospheric $_{CO2}$ (ENN 2001). This study was performed in a grassland environment. WBGU (2000) concludes that in many cases, the effect of such studies is not necessarily an effect of species richness per se, but also due to the fact that in plots with higher species number, more functional groups of plants are present (e.g. grasses, herbaceous species, legumes).

The experiments by Tilman et al. (1996) and Hector et al (1999) have raised a scientific debate whether the perceived effects of biodiversity on ecosystem functions are a mere sampling artefact (more species present on a plot increase the probability that a highly productive species is present) or a real effect of biodiversity. The debate is reviewed by Wardle et al. (2000). Further experiments are certainly needed to examine various hypotheses and effects on the correlation between biodiversity and ecosystem functioning. But so far, there has been no experimental proof that biodiversity loss does not have a negative impact on ecosystem processes (WBGU 2000).

Effects of single species

Experiences with invasive species can be used to highlight the effects of single species or species composition on ecosystem functions. Invasive species can significantly alter carbon cycling or the disturbance regime (all examples from Chapin et al. 2000). The perennial tussock grass *Agropyron cristatum* has been shown to reduce carbon levels by 25 % compared to native soils in North America, which resulted in emissions of 480 Mt C from these soils (Christian and Wilson 1999). This example shows that even changes in one specie can have significant changes on biogeochemical cycles in ecosystems. Many introduced grass species can increase the fire frequency and thus lead to increased emissions of greenhouse gases. In Hawaii, an introduced grass species has increased fire frequency by a factor of 300; in North America grasslands invaded by *Bromus tectorum* show increased fire frequency by a factor of ten in 40 Mio. ha of land. But also indigenous grasses like *Imperata cylindrica* can lead to higher fire frequency if they invade former forest lands that have been cleared for agriculture. Imperata grasslands are monocultures that cover 4 % of the land area in Asia (WBGU 1998). The research related to invasive species shows that individual species can have an important impact on ecosystems, their functions or processes related to ecosystems. A systematic review of the effects of species invasions on climate-relevant processes would be helpful to assess the role of such invasions for the global biogeochemical cycles.

Albedo / energy balance

The mosses in boreal forests insulate and thus stabilize the permafrost layer in the ground. Removal of the moss layer could cause a destabilization of the permafrost layer with possible changes in emissions of methane or CO_2 (VanKleve et al. 1991).

Water cycling

The replacement of deep-rooted trees by shallow-rooted pasture can lead to reductions in evapotranspiration and to warmer, drier climates in tropical regions like the Amazon. (Shukla et al. 1990) (see also chapter 2.2).

Methane emissions

Mooney et al. (1995) state that there are no studies that relate biodiversity directly to methane emissions. However, as already mentioned in section 2.4.2.1, some studies indicate influences of single species on CH_4 production of wetlands (Roura-Carol and Freeman 1999). The methane is evolved under anaerobic conditions and would normally be susceptible to oxidation in the aerobic zone lying between the anaerobic zone and the atmosphere. However, oxidation of methane can be avoided if the methane flows through the aerenchyma of wetland plants either by passive moleculare diffusion, active pressurized flow or effusion (Roura-Carol and Freeman 1999). The pathway and quantity of methane emitted through plants varies according to the characteristics of the species present. In species such as *Typha* CH_4 release is associated with stomata control. In other species, CH_4 is released through micropores such as in *Peltandra*, *Cladium* and rice. Chanton et al. (1993) found *Typha*, a plant with pressurized ventilation, exhibited higher CH_4 emissions rates by area than *Cladium*, a plant that solely uses molecular diffusion. Roura-Carol and Freeman (1999) found CH_4 release higher in the order of bare soils < plots with *Juncus* < plots with *Sphagnum*. This was explained with the availability of a pathway for transporting oxygen into the soil and the root zone with *Juncus* species, which is absent for Sphagnum. The input of oxygen into the rizosphere by this transport system (consisting of aerenchyma tissues and ventilation systems) is detrimental to methane production in the peat. Thus, there is research evidence that different varieties of plant structure influence wetland methane emissions, but there are no results, which indicate the quantitative influences of plants at an ecosystem level or on larger areas. Existing scientific knowledge and investigation refer to single processes or individual species.

Nitrous oxide emissions

There are no studies that relate nitrous oxide emissions directly to biodiversity. However, the case of nitrogen saturation of forest ecosystems is an example that shows that nitrogen inputs result both in increased N_2O emissions and in a complete change of function from a forest to mixed forest-grassland landscapes (Schulze et al. 1999). Scherer-Lorenzen (1999) found that in an experimental study in a grassland ecosystem where biodiversity of plots was manipulated from monocultures up to 32 species,

species-poor plots showed higher nitrate losses below the rooting zone. Increased availability of nitrate can increase N_2O emissions, especially if nitrate is washed out into oxygen-depleted sites.

These examples show that the replacement of single species or whole vegetation types can lead to significant changes in climate-relevant cycles. However, most studies are either case studies that examine a single specie (like *Agropyron cristatum*) or a single process (like plant productivity). It is difficult to generalize these results for ecosystem types, and there is no quantification of the contribution of single processes (e.g., species invasions) on climate-relevant cycles. There are no studies that look at possible influences of genetic diversity on climate-relevant processes. Genetic diversity of wildlife populations is very relevant for conservation-related questions, but it is difficult to relate genetic impoverishment of populations to losses in functional performance of ecosystems. At the ecosystem level, a SCOPE study lead by Mooney et al. (1996) tried to assess the role biodiversity plays in different biomes for ecosystem functions and services, among them climate stabilization. The results of these reviews are presented here for the most relevant biomes:

Arctic and alpine ecosystems

Relatively few species are responsible for nutrient cycling, so that these systems are probably characterized by a low degree of redundancy. Structural traits of species are important; changes like the replacement of tundra by trees may not only alter albedo but also the proportion of latent and sensible heat flux and thus change the regional climate. Therefore in the Arctic, changes in the extent and the boundaries of forests, grassland, shrubland or wetland could enhance projected regional warming (Gitay et al. 2001).

Boreal regions

Boreal regions are characterized by low redundancy in each functional group and by large oscillations of population dynamics by insect pest invasions and fire. The impact of removal of one species can be high.

Temperate deciduous broad-leafed forests

Responses to species loss would potentially be strongest in species-poor regions like Europe. Tree and shrub species richness declines from East Asia (876), East North America (157), Europe (106) to South America (47). There seems to be no great effect of forest species diversity on productivity. Acid rain and air pollution have resulted in a community-shift from forest to grass-woodland. Land-use conversions and management also have effects on ecosystem functions: changes from broadleaved forest to coniferous plantation result in nutrient depletion, soil acidification, loss of understory species and changes of the water balance (drier soils).

Arid ecosystems

In semi-arid or arid areas, evapotranspiration and the albedo affect the local hydrologic cycle and thus a reduction in vegetative cover could lead to reduced precipitation at local/regional scale and change the frequency and persistence of droughts (Gitay et al. 2001). In arid ecosystems, the elimination of a group of plants actively using soil water at a particular season or from a particular depth in the soil could lead to a decrease in productivity if that water is lost from the system. Arid lands are significant determinants of the earth's albedo. This is influenced by total plant cover, but also by the different properties of woody plants versus herbaceous plant cover.

Grasslands

Temperate grasslands are the ecosystem type where several experimental studies on the influence of species diversity on functions have been completed (reviewed in Tilman 1999). These studies suggest that diversity is positively correlated with productivity. No studies exist that correlate diversity with atmospheric properties. However, natural grasslands that have been converted to pastures or cropland have both experienced losses of species and reductions in the carbon pool.

Tropical savannas

High species diversity, uneven and unpredictable productivity and strong effects of large herbivores and fire that regulate carbon cycling characterize savanna ecosystems. Australian and American savannas are invaded by African species that have higher photosynthetic rates at favourable conditions but smaller photosynthetic activity at bad soil conditions. These invaders can change physicochemical properties in these ecosystems. Fire has a large impact on the distribution of woody and herbaceous plants and on productivity.

Tropical forests

The function of the enormous diversity of tropical forests for biogeochemical cycles is still unclear. Primary productivity of tropical forests is only affected by plant species richness at levels far below those that characterize most mainland tropical forests. In contrast, after a disturbance, the rate of biomass accumulation may be influenced by species richness, and variability in rates of photosynthesis may be lower in ecosystems with high species richness. Losses in microbial species could be severe for tropical forests because the diversity of endomycorrhizal species is much lower than in temperate forests. Generally, many atmosphere-biosphere linkages at the landscape level are influenced by vegetation cover, but probably not influenced by species richness per se. Plant species richness has no effect on carbon sequestration rates.

It is not known how emission rates of methane and other chemicals vary with biodiversity. The same holds true for the cycling of water.

4 Linkages between the Convention on Biological Diversity and the Framework Convention on Climate Change

4.1 Functional synergies and conflicts

This chapter describes the activities that are discussed under the Kyoto Protocol (e.g. sequestration activities under Articles 3.3 (afforestation, reforestation, deforestation) and 3.4 (additional activities)[10] or adaptation measures and their possible influences on biodiversity conservation.

4.1.1 Conservation of natural forests

Synergies

Natural forests are important carbon pools as already discussed in section 2.1.2 therefore conservation of natural forests is essential to safeguard existing carbon sinks. Compared to secondary forests or plantations, tropical natural forests contain 25 – 50 % more carbon than forests plantations (WBGU 1998a). In the temperate zone, forest biomass in managed forests is reduced by 40 – 50 % compared with pristine forest (WBGU 1998a). Forest conservation also helps to balance the water cycle, especially in mountain areas where they can prevent floods. Natural forests also contribute to precipitation recycling in some regions.

With regard to biodiversity, the most beneficial result generally can be achieved where deforestation can be prevented or slowed. Natural forests have the highest species diversity with species numbers declining from tropical over temperate to boreal forests. Tropical forests alone harbour 15 of 25 recently described biodiversity hotspots (Myers et al. 2000), which are priority areas for biodiversity conservation. Conservation of natural forests can thus be regarded as an important activity to protect both biodiversity and the climate.

Brown (1998) gives a ranking for several countries according to their significance for carbon sequestration and plant biodiversity (Table 16). All countries included in the ranking contain tropical forest. According to such rankings, there seems to be a temptation to prioritise tropical forests in the conservation activities under both conventions. Such an approach would not take into account neither the complete objectives of the CBD, which are not limited to species richness, nor other climate protection functions of ecosystems besides carbon sequestration as explained in previous chapters.

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[10] Article 3.3 includes the accounting of emissions or removals of greenhouse gas from afforestation, reforestation and deforestation on the quantitative emission reduction or limitation objective of Parties. Article 3.4 broadens the scope of activities that are eligible for accounting under the Kyoto Protocol. COP 6.5 decided to include emissions and removals from forest management, cropland management, grazing land management and revegetation as additional activities under Article 3.4 (see FCCC/CP/2001/L.7)

Table 16 Ranking of countries by plant biodiversity and carbon sequestration

Plant Biodiversity Rank	Country	Carbon Rank
1	Brazil	1
2	Colombia	8
3	Indonesia	2
4	Venezuela	16
5	Peru	15
6	Ecuador	19
7	Bolivia	Unranked
8	Mexico	6
9	Malaysia	5
10	Papua New Guinea	10

Source: Brown 1998

Conflicts

At the functional level there seem to be not many direct conflicts between the objectives of the CBD and the FCCC with regard to conservation of natural forests. However, priorities for conservation can differ under the different objectives. Fearnside and Ferraz (1995) for example report for Brazil that the most threatened natural forest types are along the southern boundary of Amazonia where establishment of protected areas is relatively expensive and where forests contain less biomass than in other areas and therefore offer less carbon removals.

However, even in a situation where major conflicts do not occur at the functional level, the accounting of forest conservation activities under the KP is an issue of very controversial debate at the political level, especially the inclusion of forest conservation as eligible activity under the CDM.[11] This debate is not related to biodiversity issues, but to effective incentive structures under the Kyoto Protocol that provide for real and additional crediting of activities. Often these concerns are summarized under the term "ecological integrity" of the KP. One of the political arguments is that the lack of limitation or reduction commitments for developing countries under the FCCC creates an imbalance because deforestation is not negatively accounted in developing countries, whereas forest conservation would be credited. Another argument is that forest conservation projects do not address underlying causes of deforestation. In such a situation, environmentally acceptable sink projects such as conservation of threatened forest areas in one region may increase pressure on land in another region (WWF 2000). Crediting of forest and land use conservation as such implies the acceptance of at least partial destruction under a "business as usual scenario". WWF fears that this *"undermines national forest protection policies and rewards forest terrorism - 'Give me credits for conservation or I cut the forests down."* whereas developing countries, that

[11] The decisions from COP 6.5 (FCCC) do not include forest conservation under the CDM, but limit eligible land-use change and forestry activities to afforestation and reforestation and request IPCC to further investigate other activities.

have undertaken efforts to conserve their forests are penalised as they will have unfavourable baselines which will result in less credits. Therefore according to the WWF, crediting of forest conservation under the KP *"seriously undermines the rationale for good housekeeping in developing countries and domestic nature conservation policies."* (WWF 2000)

4.1.2 Conservation and restoration of wetlands

Wetlands are sources for the greenhouse gas CH_4. At the same time, they are important carbon pools with the highest carbon densities of all ecosystem types. Section 2.4.2 has shown that the conversion of wetlands to agricultural lands leads to a net emission of greenhouse gases, even if methane emissions are reduced. Wetlands are also important areas for biodiversity conservation. Of the 233 ecoregions identified for conservation priority by Olson and Dinersteiner (1998), 36 are freshwater (lakes, rivers and streams) and 61 marine (coastal areas, mangroves, coral reefs and estuaries) ecosystems. Wetlands are often important resting areas for migratory birds and provide habitat and food for a diverse and unique flora and fauna. Conservation of wetlands thus provides a high potential for synergies between biodiversity conservation and climate change mitigation.

Restoration of wetlands that have formerly been drained for agricultural or other purposes is another option discussed under the Article 3.4 KP. Inundation of these lands would result in increased carbon storage, but also bear the potential of increased methane and N_2O emissions. In coastal wetlands, carbon storage will dominate over methane emissions (Bergkamp and Orlando 1999). Restoration of wetlands can lead to increases in biodiversity and are often carried out with the specific aim of biodiversity conservation. However, there are large uncertainties associated with the possible impacts of restoration on climate-relevant processes and the associated biodiversity impacts also remain unclear (IPCC 2000).

4.1.3 Afforestation and reforestation

Afforestation and reforestation are activities that have both potentials for synergies as well as for conflicts with the protection of biodiversity. In many regions of the world, plantations of single species are the most frequent form of afforestation and reforestation. Natural regeneration of forests is often used in Europe, but is more difficult in tropical areas because of the type of seeds (not wind-spread, but animal-distributed) and the light and temperature conditions needed to establish certain native species.

Synergies

Many authors and institutions already have acknowledged the large potential of synergies between the CBD and the FCCC through the enhancement of reforestation and afforestation. Afforestation can increase biodiversity where it replaces land cover that is species-poor (IPCC 2000). Synergies can be expected in regions where degraded pasture and agricultural sites are afforested. For example, Süßer (1997) found that *Pinus* *radiata* plantations increased the number of native plant species in former pasture whereas they decreased native species number in former stands of natural *Nothofagus* forest in Central Chile. According to WBGU (1998a), 90 Mha of degraded lands are globally available for afforestation, especially in Central America, Eastern Europe, Central Russia, India, Indochina and China.

When cultivated lands or soils that previously were low in organic matter are afforested or reforested, substantial increases in the amount of soil organic matter can occur (IPCC 2000). Trees also play an important role in maintaining favourable physical soil properties. Besides sequestering carbon, afforestations can help to prevent erosion on degrades sites, contribute to flood prevention and avoid siltation in inland waters. Biodiversity will also benefit from fertile soils with favourable physical soil properties except for habitat types that are specific for marginal habitat types. The plantation of windbreaks can reduce erosion and desertification. Forests also play an important role in improving water quality. As forests lower average water flows, they may reduce peak flows in heavy rain periods and increase flows during dry seasons because of their higher infiltration capacities and a high capacity to retain water.

Compared to simple vegetation types such as *Imperata* grassland, poor degraded savanna or rehabilitate denuded industrial waste or eroded land, plantations can lead to increased diversity: Plantations can provide a refugee for wildlife and can lead to their increase (leopard in Malawi, deer and jaguar in Venezuela). In Kenya and Tanzania the Sykes monkey has adapted to the cypress plantations and feeds on the bark in the tops of the trees. The increase in animal species resulted from the provision of shelter and refugee from man. Plantations are relatively unattractive for recreation and sometimes hunting is forbidden in plantation forests, which creates a new protection zone for mammals and birds. Plantation trees could flower profusely (e.g. Eucalyptus species) and provide rich nectar source.

Plantations typically do not reduce pressure on natural forests in the tropics because plantations provide other products (pulpwood, sawn wood) than those for which natural forests are cleared (agricultural area, fuel wood) (Kanowski et al. 1992 in IPCC 2000, Johns 1997 in IPCC 2000). However, Kanowski et al. (1992) suggest that fuel wood plantations might help to reduce pressure on natural woodlands in dry regions.

Conflicts

Afforestation and reforestation activities can have strong adverse impacts on biodiversity if they replace natural forests. Currently the expansion of industrial plantations is a significant driver of natural forest loss in some regions (Potter and Lee 1989 in IPCC 2000). Conversion of native natural woodlands, grasslands or wetlands to plantations is also likely to threaten biodiversity and native habitats. If afforestations are carried out in non-forest ecosystems of high importance for biodiversity, for examples, biodiversity hotspots like the South African Fynbos or Vavilov Centres (centres for crop diversity) where forest cover is only sparse and patchy landscapes have been under extensive agricultural use for a long time in the past, they could considerably threaten biodiversity conservation. Many grassland ecosystems are rich in endemic species. In

South Africa, the expansion of *Eucalyptus* and *Pinus* plantations has led to significant declines in several endemic and threatened species of grassland birds (Allen et al. 1997). Monoculture plantations also have negative impacts on biodiversity if they are planted in areas where natural (or assisted) regeneration of indigenous forest would occur in the absence of the plantations.

For forest plantations, conflicts with biodiversity conservation are largely discussed in scientific literature. Tradeoffs between carbon storage and maintenance of biodiversity can occur if large areas are re- or afforested with monoculture plantations of exotic species. High productive wood monocultures demand high light interception, which suppresses native ground flora and limits other life forms (Hill and Wallace 1989). Virtually no other plants may exist if canopy cover in plantations is dense such as in younger stands of pines, some eucalyptus, and teak before thinning (Sawyer 1993 in Cavalier et al. 1998). Plantations with single tree species have a considerably reduced flora and fauna than natural forest stands. Habitats typical for recovery periods after natural disturbance are generally lacking. Harvesting at the point of time with maximum timber yield prevents the development of typical habitats that occur in old-growth forests (Bull and Meslow 1977). Large-scale forest plantations are managed to avoid natural mortality, decay, disease, and insect infestation (Nilsson and Schopfhauser 1995). Consequently, dead wood is lacking which is an important habitat for many species. For larger animals plantations often do not provide adequate protection and shelter. Monocultures with exotic species also threaten biodiversity conservation if they show invasive traits. Plantations are also lacking food sources for animal diversity, e.g. *Eucalyptus* plantations with their small hard fruits and seeds are poor food for birds and the *Eucalyptus* foliage is unpalatable for many species.

Monoculture plantations may not provide the benefits with regard to soil fertility and favourable physical soil conditions as described above for afforestations and reforestations. Short rotations and intensive harvesting methods can considerably increase nutrient losses from the site by removal in the wood and other losses. Where successive rotations are grown, the necessary harvesting operations could lead to gradual deterioration of the soil by compacting it and altering bulk density (Evans 1992) which reduces infiltration rates and enhance erosion. Forests generally use more water than crops, grass or shrubs because trees can access water at greater depth and evaporate more intercepted water (IPCC 2000). Extensive afforestations in the dry tropics therefore can have serious impacts on supplies of groundwater and river flows (IPCC 2000). Vincent (1995 in IPCC 2000) found that establishing high water-demanding species of pines to restore degraded watersheds in Thailand considerably reduced dry-season streamflows.

An important question is if afforestations in one place can lead to deforestations in other places. Careful assessments that include socio-economic analyses should be carried out to determine the potential for possible off-site effects („leakage“). Another problem is that commercial plantation forestry seldom meets the local population's needs (Trexler and Haugen 1995).

Conditions that influence biodiversity of afforestations and reforestations

The previous section already showed that the contribution of afforestations and reforestations to biodiversity conservation largely depends on the conditions under which they are established. The conditions are summarized in four categories, the type of land chosen, the type of afforestation/reforestation chosen, the management option chosen and the scale of the activity. Afforestations and plantations would be beneficial to biodiversity conservation

Type of land

- if they replace previous, non-sustainable land-uses, especially if the landscape to be restored is severely degraded and unproductive. This means that reforestation which per definition occurs on previously forested areas is more likely to threaten biodiversity than afforestation, especially if reforestations are established on areas of natural forests that have been cleared for the plantations.
- if they lead to long-term reductions of pressure on adjacent natural forests and if negative impacts on local agricultural production, land-use conflicts between local residents and outside interests do not occur (Trexler and Haugen 1995).

Type of afforestation/reforestation

- if natural regeneration is preferentially used where possible.
- if preferentially native species are used in mixed stands and if forested lands are created that reflect the typical species composition and functional / structural properties of forests in the surrounding area.

Type of management

- if plantation forests consist of many age-classes, ranging from newly planted to mature stands, containing approximately equal areas of all ages classes.
- if clearance of pre-existing vegetation is avoided and thinning of dead and dying trees is minimized.
- if benchmark reserves and islands with natural forest are left (If 10 % of pre-existing vegetation is retained it is likely that about half of the naturally occurring tree species are conserved (Evans 1992)).
- if unplanted areas and gaps and their edge vegetation exist (e.g. firebreak, gullies, streams and rocky areas) (In a fully stocked forest, these unplanted areas consist of about one-fifth of the total areas).
- if weed control and the use of chemical is minimized.
- if rotation length is extended.
- if some trees are left on site after clearing and if dead wood is left on site.
- if tree density allows more open conditions after initial growth stage and near maturity.

- if low-impact harvesting methods are applied.

Scale

- if large-scale monocultures and monostructures are avoided in favour of structures with small-scale variations.

Besides the functional level, there are institutional, social and political circumstances which also determine the success of afforestation or reforestation activities, including a country's history of establishing and maintaining plantations, projected future demands for wood and wood products, the current area of natural forest against which plantations would compete, institutional capacity in the forest sector for maintenance, care of planted areas and local infrastructural capacities (Trexler and Haugan 1995).

Table 17 compares the conditions mentioned above with the priorities under the FCCC and the KP and the related incentive structures.

Table 17 Priorities related to afforestation and reforestation under the CBD compared with incentive structures under the FCCC and the KP

Conditions for afforestation/reforestation to ensure biodiversity conservation	Results from the perspective of carbon storage/ incentive structure under the KP
Type of land	
Afforestation and reforestation of marginal degraded lands where agricultural or grazing use is no longer possible	• Afforestation and reforestation activities will only sequester small amounts of carbon • High risk of failure on degraded and marginal sites
Type of afforestation/ reforestation activity	
Promotion of natural forest regeneration (or assisted regeneration) where possible	• Harvesting more difficult, but at the same time less maintenance work needed • Higher C storage if all C pools are accounted (understorey vegetation) • The proof of the additionality condition under the provisions of Art. 12 KP is more difficult (CDM criteria state that only projects are eligible that do not occur in the absence of the project activity. Natural regeneration might occur without human involvement) • Timber value reduced compared with commercial plantations because of smaller number of species with high value whereas other services e.g. watershed protection are improved.

Conditions for afforestation/reforestation to ensure biodiversity conservation	Results from the perspective of carbon storage/ incentive structure under the KP
Use of native tree species, mixed stands, genetic diverse stands	• Often few experiences with native species and mixed stands, • lack of seedlings can occur, • potentially less productive than some fast-growing species and in consequence potentially lower carbon sequestration • higher stability
Management options	
Longer rotation types	• Higher carbon storage • More expensive as harvesting does no longer occur when maximum timber yield is achieved. (Could be potentially compensated by higher carbon storage in an international carbon market)
No measures to clear understorey vegetation	• Loss in timber productivity • Reduced cost for maintenance work • Higher carbon storage
More open conditions after initial growth stage and near maturity	• Reduced density is equivalent to reduced timber growth
Minimization of chemical input	• Decrease in timber productivity • Higher risk of long-term carbon sequestration
Scale	
Large scale plantations should de avoided	Economies of scale are reduced with small-scale afforestation/ reforestation activities

Source: Öko-Institut

The comparison shows that there are considerable discrepancies between the priorities under biodiversity aspects and under maximum timber yield. If the objective of carbon storage is added, in some areas the new potentials of an international carbon market could possibly compensate for existing disadvantages of biodiversity-friendly options. It is difficult to assess the effects on carbon storage in some areas, as this effect would also depend on the accounting rules that are established. The consequent consideration of biodiversity aspects with the implementation of the Kyoto Protocol would therefore imply that appropriate provisions and instruments are developed and implemented for all afforestation and reforestation activities accounted for under the different provisions of the KP which allow direct choices at all four levels, i.e. with regard to the type of land afforested, the type of afforestation/ reforestation, the management options as well as with regard to the scale of the afforestation activities in a way that they are consistent with biodiversity conservation. The following chapter 5 analyses whether the work under the CBD provides for such provisions and instruments that could be used to direct afforestation and reforestation activities in a sustainable direction.

With regard to management options, the analysis of linkages in the following chapters will also include the forest process under the UN and international work on sustainable forest management in chapter 6.

Many conflicts under the FCCC with regard to land-use, land-use change and forestry arise from the political implementation of incentives and not at the level of functional synergies. E.g. discussions on the accounting of additional activities under Article 3.4 of the KP are not controversial because of their environmental effects, but because of the implications of such an accounting on the overall limitation and reduction commitment for Annex I Parties under the KP and because of uncertainties with their precise measurement and estimation. The discussion in the following chapter 5 on improved linkages between the two conventions mainly address areas where functional synergies and conflicts exist and therefore do not highlight the complete discussion on the accounting of sink activities under the KP.

4.1.4 Restoration of degraded lands / ecosystems

Degraded lands include croplands, grazing lands, degraded forests, mining areas, polluted, salinized and eroded soils. The restoration of severely degraded land to crop-, grass-, or forestland is discussed as an option under the Article 3.4 of the Kyoto protocol. The area potential of such lands is estimated 2.77×10^8 ha (IPCC 2000), with 4 % in Annex I (industrialized) and 96 % in non-Annex I-countries (mostly developing countries). This is already a hint that this activity would be mostly carried out through the Clean Development Mechanism under the KP. However, the IPCC also states that of this area, only 20 – 40 % could be restored at a reasonable cost. The carbon sequestration potential of such activities is low (only 3 Mt C a^{-1} until 2010). A possible associated impact might be increased N_2O emissions if degraded lands are fertilized for a quick establishment of vegetation cover. The biodiversity impact of land regeneration can be ambivalent: In many cases, land degradation has also negative impacts on biodiversity and restoration of these lands could help to avoid negative off-site effects (e.g. siltation as a result of erosion) and to restore some of the biodiversity on this area. However, it is unclear, if the restoration of degraded lands really leads to significant increases in biodiversity. In temperate regions, abandoned mining sites, low-nutrient raw soils and other sites with extreme conditions can be valuable habitats for species adapted to extreme conditions (dry, warm, nutrient-poor sites). These habitats could be destroyed if they were restored.

4.1.5 Forest management

The different options for forest management have been described in section 2.1.3 of this study. Forest management options can have both positive and negative impacts on forest biodiversity.

Forest regeneration

Forest regeneration methods are particular relevant under the CBD. The choice of regeneration methods such as natural regeneration, artificial planting or seeding has strong impacts on species distribution and variety. Natural regeneration is preferable from the available options. Only a few studies exist on the relationship between forest regeneration and carbon sequestration, thus it is not completely clear if regeneration methods with the aim to maximize carbon sequestration would be in line with biodiversity conservation. If high tree densities are replanted, the rapid crown closure of the growing trees can lead to an impoverished understorey vegetation and reduced biodiversity in such stands.

Pest management

Pest management clearly concentrates on the damage that pest could create to the standing forest stocks and pest control strategies largely do not take into account effects of chemical use on other species. Therefore pest management with chemicals seems to conflict with biodiversity aims. But general statements are difficult as the impacts on biodiversity depend on the general type of forest management and pest impacts on the general ecosystem.

Fertilization

Forest fertilization with lime and Mg fertilizer has been studied on nutrient-poor soils that had become acidic after deposition of sulphuric acid in the 1980s. Fertilization of such impoverished soils usually leads to an increase in earthworm populations, plant diversity in understorey vegetation and soil fauna activity. On the other hand, forest fertilization bears the risk of increased N loads in seepage (Kilian et al. o.J.) Fertilization of naturally nutrient poor areas in order to increase plantation productivity can have adverse effects on biodiversity of the natural ecosystems.

Fire management

Fire management is an option that can have both positive and negative effects on biodiversity. Positive effects of fire management are to be expected in regions where fire frequency due to species invasions or other human-induced impacts are increased heavily beyond „typical“ background rates. Negative impacts are to be expected when natural fire regeneration cycles are interrupted by suppression of fires. Care has to be taken that the natural and typical fire dynamics within a given ecosystem are maintained as part of a reasonable fire management.

Harvesting

Extended rotation periods and low-impact harvesting are management options that can contribute to biodiversity conservation aims in these forests. WBGU (1998a) states that selective logging of forests instead of clear-cut techniques is the most efficient method for carbon storage in forest ecosystems (except for conservation of natural forests). Marshall (2000) found that extended rotation periods were the management option with the least impact (compared to clear-cutting and shelterwood systems) on biological processes and soil communities in forest soils in British Columbia. However, increasing the rotation time, lengthening the period between harvest operations, or reducing the volume extracted may lead to reduced growth rates of trees and reduced carbon sequestration (Row 1996 in IPCC 2000). Also harvesting methods can be another area where biodiversity priorities do not match the aim of maximum carbon storage. Additional research is needed to find out if extended rotation periods in industrialized countries could lead to increased demand for wood from unsustainable forestry in developing countries. Leakage[12] effects due to better forest management in industrialized countries should be considered. If forestry activities were shifted from industrialized to developing countries, this would lead to serious threats for biodiversity in countries where primary forests are logged. Synergies with regard to management options of forest plantations will be discussed in section 4.1.3.

4.1.6 Agroforestry

Agroforestry is a management type that uses a combination of crops associated with trees and is applied mainly in the tropics. It ranges from simple two-species systems that combine a crop with a tree cover (e.g. corn and a leguminous fast-growing tree) to multi-species gardens and mosaic landscapes that contain up to 300 plant species, combining a wide range of root and grain starch suppliers, vegetables, fruit trees, forage, fuel wood and medicinal plants. In these systems, a high level of biodiversity can be achieved or maintained – Gillison (1999) states that they are higher in biodiversity than grasslands, croplands or secondary fallows in the humid tropics.

The IPCC (2000) estimates that 391 Mt C a^{-1} could be sequestered globally until 2010 by the establishment of agroforestry systems in the tropics. Of all activities discussed under the Article 3.4 KP, agroforestry has the highest carbon sequestration potential and may even act as a sink for methane in some systems (IPCC 2000).

4.1.7 Cropland management

The application of management activities that aim at a higher carbon sequestration rate in croplands can have positive and negative consequences for biodiversity.

Reduced tillage

An intensively discussed topic is the application of reduced tillage as carbon sequestration activity (IPCC 2000). Reduced tillage decreases decomposition activities in soils and thus conserves soil organic matter. It is applicable in both tropical and temperate ecozones, although the carbon sequestration rates vary between ecozones. Together with fertility management, erosion control and irrigation management, reduced tillage may sequester 75 Mt C a^{-1} in Annex I and 50 Mt C a^{-1} in non-Annex I countries until 2010. A synergy with biodiversity is to be expected from the fact that soil fauna diversity usually increases with reduced tillage intensity. Almost all

[12] Leakage is defined as the unanticipated decrease or increase in GHG (greenhouse gas) benefits outside of the project's accounting boundary (the boundary defined for the purposes of estimating the project's net GHG impact) as a result of project activities (IPCC 2000)

biological functions and services provided by soil organisms are affected by tillage (Giller et al. 1997), especially earthworm communities. However, tillage has some purposes such as herb control. In many cases tillage reduction is accompanied by increased applications of herbicide and pesticides (especially nematizides and herbicides). One indicator for this link is the active promotion of reduced tillage for accreditation under the KP by large agrochemical enterprises. If this combination of reduced tillage and agrochemicals is promoted for enhanced carbon storage, there are clearly negative impacts on biodiversity, especially with regard to the composition and diversity of soil organisms and communities.

Increase of cropping intensity

The IPCC (2000) summarizes several management practices as part of an increase of cropping intensity: crop rotations, reduced bare fallow, cover crops, high yielding varieties, integrated pest management, adequate fertilization, organic amendments, irrigation, water table management. Some of these practices are likely to have positive effects on biodiversity within the agroecosystem, like cover crops, organic amendments and some systems of crop rotation – essentially all agricultural practices that increase the amount of organic carbon in the soil will also have positive impacts on soil biota. However, agricultural intensification usually leads to a reduced biodiversity in agroecosystems (Altieri 1999). Increases in cropping intensity can have significant negative impacts on on-site biodiversity if rates of fertilization or pesticide application are increased. Off-site effects like nutrient transport in adjacent natural systems (N and P in forests, grasslands and aquatic ecosystems) can lead to reductions in biodiversity in these systems. The use of high-yielding varieties can displace native crop varieties and lead to reductions in genetic diversity of crop plants. The question whether an increase of cropping intensity can have positive impacts on biodiversity can only be answered if off-site effects are also included into considerations. If pressure on natural ecosystems is reduced through intensification of agroecosystems, this will be the case. This question has been studied by Carpentier et al. (2000) who investigated four different intensification schemes for the Brazilian Amazon (no intensification, intensification of non-livestock activities on cleared land, intensification on all cleared land, and intensification on both cleared and forested land). Intensification of non-livestock activities on cleared land resulted in the largest deforestation rates. The authors conclude, *„under the current socio-economic and political setting existing intensification systems on the cleared land will not save the forest“* (Carpentier et al. 2000). This example shows that there is no simple relation between intensification of agriculture and reduced impact on natural, diverse ecosystems.

Fertilization

Reduction of N additions through fertilizer to soils will reduce N_2O emissions. There is a general synergy between climate change mitigation through reduction of N_2O emissions and the aims of biodiversity conservation as reduction of fertilizer inputs often helps to increase biodiversity in terrestrial ecosystems.

4.1.8 Grassland and pasture management

Grassland management comprises of three major activities: grazing management, fire management, fertilization, and species introduction. Species introduction is described in the following section.

Grazing management

Better grazing management with reduced stock numbers avoid overgrazing and the associated negative impacts of carbon loss, increased albedo and related meso-scale changes in weather and climate. Grazing management can also reduce emissions of methane and nitrous oxide (IPCC 2000). Synergies with biodiversity conservation are to be expected where natural grasslands can be established on formerly degraded sites. The sequestration potential of these activities is moderate to high with a potential of 93 (Annex I) and 168 (non-Annex I) Mt C a^{-1} until 2010. Grazing management is another management option where off-site effects have to be considered. Grazing management usually includes reduced stocking rates and thus avoids overgrazing by livestock. If grazing intensity is reduced on one site (with possible positive impacts for both biodiversity and climate), care has to be taken that this does not lead to increased demand for new grazing lands, possibly at the expanse of natural ecosystems. To answer this question, socio-economic considerations have to be included into assessments.

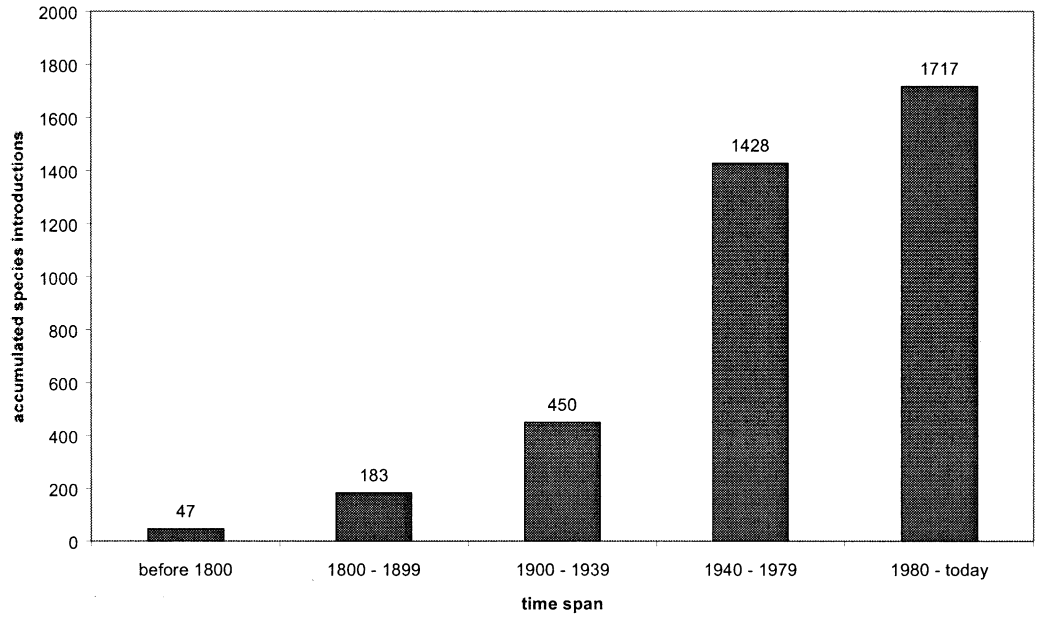
Fire management

Fire management is frequently applied in grasslands and savannas. It could lead to significant changes in structure and species composition due to tree thickening and will reduce the competitiveness of fire-adapted species in the grass layer (Mooney et al. 1995). It could lead to increased diversity of tree species. Negative impacts from fire management could arise if it is applied in ecosystems where the native vegetation is fire-adapted and where fire suppression either leads to large accumulations of fuel and fewer, but more severe fires or where the characteristic, fire-adapted plant communities are suppressed by ubiquist plant species. One example is South Africa where the native, fire-adapted fynbos vegetation is suppressed by invaders like the black wattle (*Acacia mearnsii*) or pine species. These invaders increase above-ground biomass of fynbos ecosystems by 50 – 1000 % (World Resources Institute 2000). A fire management policy that aims at maximization of carbon sequestration might lead to reduced biodiversity in this vegetation unit. A study on the impacts of low-intensity fires in Australian forest (Morrison et al. 1996) shows conflicts between the frequency of low-impact fires as a management option to avoid heavy fires and the fire frequency that would be required for biodiversity conservation.

4.1.9 Introduction of species

Species invasions are considered to be one of the most important threats to biodiversity (Sala et al. 2000), and the significance of this threat will increase in the future. Introductions of species can be intended (e.g. as a crop or hunting prey) or unintended (e.g. in the ballast water of ships). Worldwide, species invasions have increased during the last 200 years as a result of increased human traffic. Figure 11 shows the increase of species introductions in aquatic ecosystems during the last 200 years.

Figure 11 Accumulated number of introduced species in aquatic ecosystems since 1800



Source: *http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/sta_year.htm*

An evaluation of the effects of species introductions on climate-related processes has two main aspects. These are:

- Planned introduction of species as a climate change mitigation option
- Effects of introduced species on climate-relevant processes

The planned introduction of species as a climate change mitigation option has been discussed in the IPCC report on Land Use, Land use change and forestry (IPCC 2000, Fact sheet 4.8). The introduction of legumes and non-native grasses to pastures as well as fertilization with N and P can increase productivity and carbon storage in grasslands. For example, it is suggested to introduce deep-rooted African grasses to South American grasslands to increase their carbon sequestration potential. However, such intended introductions may have negative impacts on native species and thus on biodiversity. The planting of exotic grasses with high productivity in Australian and South American savannas has even led to reductions of yield, soil fertility and forage quality in the past (Mooney et al. 1995).

In Australia, pasture improvements and tree clearances have led to reductions in native herbaceous plant, bird and soil invertebrate species (Mooney et al. 1995). Mooney et al. (1995) also found that plant or animal introductions into grasslands have clear and negative effects on these ecosystems. In recent years, there have also been suggestions to improve pastures with native species (Crosthwaite et al. 1996). This approach should be preferred to the introduction of non-native species, especially if they are from similar habitats but different biogeographical regions (like neotropis / paleotropis). In a paper for the 6th SBSTTA meeting[13], a recent survey on invasive species reveals that currently most countries are not prepared to cope with the possible risks that may arise from species introductions. The Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species of SBSTTA[14] recommend avoiding species invasions wherever possible. It is at least recommendable to carry out impact assessments that include biodiversity aspects to avoid that introduced grasses and legumes lead to biodiversity losses in native grasslands and pastures. The example of the invaders *Pinus* and *Acacia* in South African fynbos shows more conflicts between biodiversity and carbon sequestration: These invasive tree species cover large areas of former fynbos shrublands and have increased productivity in these areas. These trees consume much more water than the native vegetation and lead to increased water scarcity in some regions. To counteract these reductions in water supply, programmes are carried out to remove them from these water catchments (World Resources Institute 2000). While this activity clearly favours the restoration of the native vegetation in the deforested areas, the carbon gains from fynbos may be smaller than that from the invasive trees.

Species invasions into other ecosystems have very often resulted in changes in carbon and nutrient cycling, water and albedo properties and changes in fire frequency (see chapter 3.1). Avoiding species introductions can thus help both to conserve biodiversity and reduce greenhouse gas emissions. However, it is difficult to predict how avoided species introductions may have changed (or: not changed) ecosystem processes or to quantify these effects. Removal of established invaders is difficult and expensive. In many cases, invasive species only can establish in ecosystems that are under pressure from other factors, e.g. by heavy grazing or land use changes; therefore removals of the invasive species will only be successful if these pressures are removed.

4.1.10 Livestock management

In section 2.4.2.2 the practices suggested for improvement of livestock system to reduce methane emissions from enteric fermentation have been summarized. The large-scale implementation of the practices described will have negative impacts on biodiversity compared with past industrialization of agriculture. Improvement of genetic characteristics with the aim to reduce CH_4 production is likely to reduce genetic variations and is likely to have negative impacts on genetic biodiversity of ruminants. Most of the chemical amendments, which are recommended to reduce CH_4 emissions, are not allowed in organic farming practices (Institut für Organischen Landbau 1994). Therefore their application will more likely have negative than positive impacts on biodiversity as it is associated to agricultural systems which do not take into account

13 UNEP/CBD/SBSTTA/6/6

14 UNEP/CBD/SBSTTA/5/5

overall negative impacts on the environment. It should also be noted that most of the mitigation practices for livestock management are only suitable for highly industrialized livestock management systems or their application will transform animal husbandry into highly productive and industrialized systems. Mitigation options related to manure management as discussed in chapter 2.4.2.2 do not seem to have negative impacts on biodiversity.

4.1.11 Storage dams

Energy related mitigation activities under the KP could also have impacts on biodiversity conservation. Large storage dams generally have extensive impacts on the biodiversity and species composition of terrestrial and aquatic ecosystems. The World Commission on Dams (2000) summarizes the main impacts as follows:

- loss of forest and wildlife habitat, loss of species populations and the degradation of upstream catchments areas due to inundation of the reservoir areas;
- loss of aquatic biodiversity, upstream and downstream fisheries and the services of wetlands and riverine estuaries and adjacent marine ecosystems;
- cumulative impacts on water quality, natural flooding, and species composition where a number of dams are sited on the same river.

These strongly negative impacts on biodiversity require further research and further work on principles and criteria for a more sustainable use of hydropower, which should be implemented in cooperation between the FCCC and the CBD. Such criteria and principles are especially relevant with regard to a possible inclusion of large storage dams under the CDM.

4.1.12 Biomass burning

Biomass burning reduces organic matter stored in the soil with possible reductions in soil fauna. Behavioural changes with regard to biomass burning could avoid greenhouse gas emissions. The impacts of such changes on biodiversity greatly depends on the specific circumstances and regions, e.g. if frequent fires are a natural component of savanna ecosystems.

4.1.13 Adaptation activities

A new generation of international activities is planned under the FCCC on adaptation to climate change in order to address the threats and negative impacts of climate change. Since the potential effects of climate change are pervasive, adaptation can include a wide range of responses and policies in all economic sectors and all regions. Human and natural systems will to some degree adapt autonomously which can be supplemented by planned adaptation. Planned adaptation includes economic, legal, institutional and technological approaches. Some of the planned adaptation approaches, especially technological approaches, have potential negative impacts on biological diversity. Table 18 summarizes some of the examples.

Table 18 Examples of planned adaptation opportunities to climate change impacts

Response strategy	Adaptation options	Possible impact on biodiversity
Agriculture		
Change land topography to reduce runoff, improve water uptake and reduce wind erosion	• Land levelling • Bench terracing • Deep ploughing • Roughen land surface • Use windbreaks	- - - - +
Introduce artificial systems to improve water use and availability	• Pumps and irrigation systems	?
Change farming practices to conserve soil moisture and reduce runoff	• Bare fallow • Mulching • Minimum tillage • Contour cropping • Lower planting densities	- + ? ? +
Use different crops or varieties to match changing water supply and temperature conditions	• Research on new crop varieties • Biotechnology to produce crops that are able to cope with heat stress and droughts	+ ?
Coastal zones – adaptation to sea-level rise		
Protection of coastal zones	• Dikes, levees and floodwalls • Floodgates and tidal barriers • Dune restoration • Wetland creation • Afforestation	- - + + ?
Prevention of saltwater intrusion in coastal estuaries and groundwater aquifers	• Build barriers across rivers • Tune discharge of rivers to keep the salt wedge at the river mouth in dynamic equilibrium • Build sluices to allow outflow but not inflow • Switch to salt-resistant crops • Move freshwater inlets further upstream	- ? ? ? -
Floods		
Flood protection	• Rehabilitation of natural wetlands • Floodgates and reservoirs • Afforestation of catchments areas	+ - +

+ signifies positive, - signifies negative impact, ? signifies unclear impact or dependent on management option chosen. Categories are very broad and should only highlight where further conflicts may arise.

Source: compilation based on FCCC/TP/1997/3: Klein, R.J.T, Tol, R.S.J. 1997: Adaptation to climate change: options and technologies. Technical paper.

The list of examples in Table 18 shows that options to adapt to climate change could yield non-climatic, secondary benefits for biodiversity such as for example the restoration of natural wetlands and that climate protection could profit from activities implemented under the CBD to conserve biodiversity. Other options, especially "hard" protection structures could have negative impacts on biodiversity such as land levelling, the change of river discharge systems or flows or new genetic plant varieties that reduce genetic variety to few genotypes. IPCC's third assessment report states that adaptation strategies for coastal zones have shifted emphasis away from hard protection structures toward soft protection measures, managed retreat and enhances resilience of biophysical and socio-economic systems in coastal regions (McLean et al. 2001). IPCC also recommends incorporating options for coastal management with policies in other areas such as land-use plans. IPCC's third assessment report presents a number of potential adaptation options that can contribute to the conservation and sustainable use of biological diversity (IPPC 2001d). These include: :

- designing terrestrial and marine multiple-use reserves and protected area which incorporate corridors that would allow for migration or organism as a response to climate change;
- expanding aquaculture to relieve stress on natural fisheries;
- specific management in some ecosystems could reduce pressures on biodiversity and even enhance biodiversity, e.g., in the Arctic, economic diversification could reduce the pressure on wildlife, multiple cropping in some agroecosystems could enhance biodiversity, rotational cropping and decreased use of marginal lands in semi-arid areas could reduce biodiversity loss;
- integrated land, water and marine area management with the aim of reducing non-climate stresses could be beneficial to biodiversity, e.g., reduction of fragmentation of land and water systems, reduction of land-based pollution into marine systems such as coral reefs;
- efficient use of natural resources, small-scale restoration of inland wetlands, restoration of degraded soils especially in rangelands, adjustment in the timing and intensity of livestock grazing.

Implementation of adaptation activities should concentrate on such activities that provide mutual benefits to both conventions as there seem to be large potentials.

4.1.14 Summary of synergies and conflicts

Table 19 summarizes the possible synergies and conflicts between climate change mitigation and biodiversity conservation. The previous elaborations and the table clearly show that only few activities discussed under the FCCC are clearly positive or negative, with the exception of the conservation of natural ecosystems. Whether impacts of activities are positive or negative for biodiversity depend on

- the selection of practices within the activity,

- the management options related to the activity,
- biological and physical conditions of the area where the activity takes place,
- Socio-economic conditions of the region where the activity takes place.

Table 19 Summary of possible impacts on biodiversity of land use activities considered under the Kyoto Protocol

Possible land use activities	**Circumstances for positive impacts on biodiversity**	**Circumstances for negative impacts on biodiversity**
Conservation of natural forests	General positive	Priority areas for conservation could be different under both conventions
Conservation and restoration of wetlands	Conservation general positive, further research needs	Restoration positive for biodiversity, but could result in increase in CH_4 and N_2O emissions
Afforestation and reforestation	• On degraded pasture and agricultural sites • If natural regeneration and native species are used that reflect structural properties of surrounding forest, • If mixed age classes stands are established • If clearing of pre-existing vegetation and thinning is minimized • If chemical use is minimized • If areas for habitats for different species are considered • If rotation length is extended • If tree density respects biodiversity needs • If low-impact harvesting methods are used	• On areas where natural ecosystems are destroyed for the activities • If monocultures of exotic species are used on large areas • If single age-class stands are established • If other vegetation is completely cleared before and during the activity • If chemicals are used abundantly • If no habitats are created • If short rotation periods are used • If tree density is very high • If harvesting operation clear complete vegetation • If sites with special significance for the in-situ conservation for agrobio-diversity are afforested
Restoration of degraded lands/ ecosystems	• Often positive because restoration increases species richness • Positive effect will depend on the definition of "degraded"	• If habitats of species that are adapted to extreme conditions are destroyed • Possible increase on N_2O emissions because of fertilizer use

Possible land use activities	**Circumstances for positive impacts on biodiversity**	**Circumstances for negative impacts on biodiversity**
Forest management	• If natural forest regeneration occurs • If use of chemicals is minimized • If fire management respects natural fire regeneration cycles • If low-impact harvesting and extended rotation periods occur	• If monocultures of exotic species are planted and natural regeneration suppressed • If abundant chemical use occurs • If fire management disrupts natural fire regeneration cycles • If clear-felling occurs
Agroforestry	Mainly positive if not established on areas of natural ecosystems	Negative if natural forests or other natural ecosystems are replaced
Cropland management	• If reduced tillage is used without increased chemical application	• If reduced tillage is used with increased application of herbicides and pesticides • Increase in cropping intensity has mainly negative impacts • If established on areas of natural ecosystems
Grassland and pasture management	• Mainly positive if no natural areas are destroyed for the purpose • If no exotic species are used • If fire management respects natural fire regeneration cycles	• If established on areas that previously contained natural ecosystems • If non-native species are introduced
Introduction of species	If species are known as non-invasive in the affected ecosystem, restore natural ecosystems and provide habitat for other native species	Mainly negative
Storage dams	-	Large storage dams are mainly negative
Adaptation activities	Adaptation activities that conserve or restore natural ecosystems are generally positive	Adaptation activities that use hard technologies and that strongly change natural ecosystems are generally negative

Source: Öko-Institut

Because of this situation, few unambiguous generalizations can be drawn with regard to recommendations for the eligibility of activities under the FCCC. Eligibility of activities that are compatible with the objectives of the CBD depends on the following circumstances:

- whether activities eligible for accounting can be defined in such a way that practices and related management options with negative impacts on biodiversity can be excluded,
- whether adequate rules and criteria are developed for the implementation of eligible activities that ensure that adverse impacts on biodiversity are avoided,
- whether functioning tools and instruments are developed at the global and the national level that ensure the consideration of adverse impacts on biodiversity with the implementation of activities,
- whether appropriate monitoring and controls are established that ensure with and after the implementation that negative impacts are avoided and minimized.

The following chapter 5 will analyse whether and how the work under the CBD is able to contribute to address these needs.

4.1.15 Knowledge gaps and research recommendations

In the past, research has mainly concentrated on either biodiversity or climate change. Thus the number of studies that reveal information about the linkages and interactions between them remains very limited. There are still large knowledge gaps around the questions:

- Which ecosystems are important for climate processes and biodiversity conservation?
- Which management / mitigation options favour both climate protection and biodiversity conservation in different ecosystem types?

Many studies are now undertaken that examine the carbon sequestration potential of different ecosystem types or management options with respect to the Kyoto Protocol. Studies of that kind should generally look at the role of biodiversity within these systems, and how different management options affect biodiversity. There are also field studies available that relate N_2O emissions to changes in land use or management. However, biodiversity considerations have only rarely been part of such studies.

4.2 Regions with special significance for biodiversity

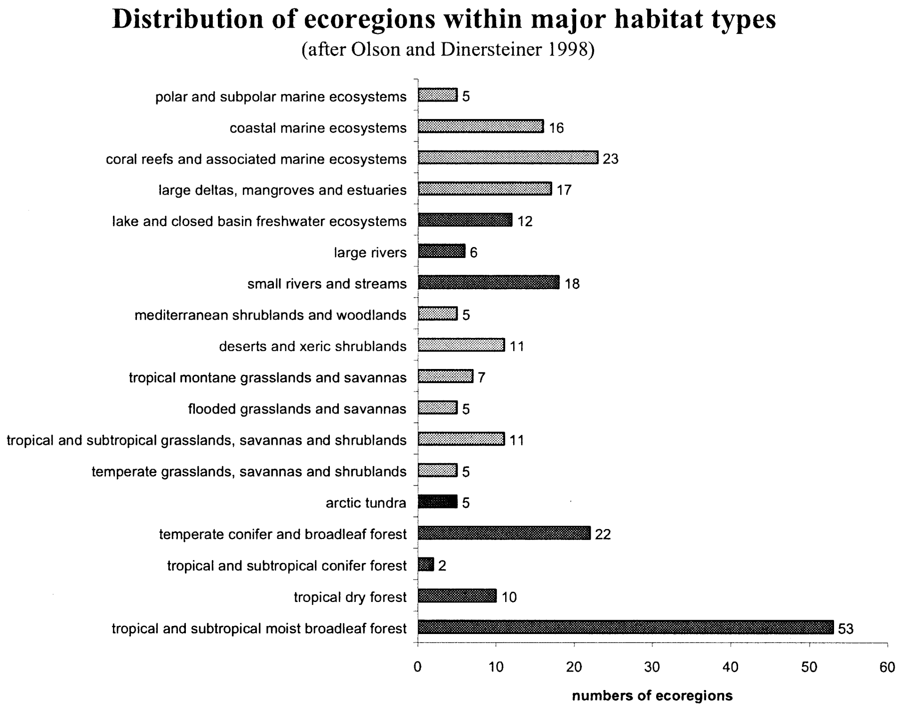
The previous sections have shown that biological and physical conditions of the areas in which adaptation or mitigation activities take place, as well as the socio-economic conditions of the region, are important determinants whether synergies or conflicts with the objective of biodiversity conservation occur. This section analyses existing work on priority areas for biodiversity conservation in order to assess whether such approaches could be used either to promote cooperative activities between FCCC and CBD in specific areas or to separate certain areas where mitigation or adaptation activities should either be avoided or should only be implemented under stringent conditions in order to avoid damage to biodiversity.

The selection of priority regions for biodiversity conservation depends largely on the examined aspect of biodiversity. Here we present three approaches that reflect the three levels of biodiversity (ecosystem, species and genetic). The approaches are not always strictly separated between each other.

4.2.1 Ecosystem / landscape level

Ecoregions are defined as relatively large units of land or water containing a characteristic set of natural communities that share a large majority of their species, dynamics, and environmental conditions (Dinerstein et al. 1995). In an approach to identify priority areas for conservation, Olson and Dinersteiner (1998) have identified 200 ecoregions that represent most of the world's biomes and ecosystem types. The ecoregional approach tries to integrate the goal of protecting species and the goal of maintaining distinct ecosystems and ecological processes.

Figure 12 Distribution of ecoregions among major habitat types



Source: Olson and Dinersteiner 1998

The criteria that led to the choice of these ecoregions are:

- Species richness
- Endemism

- Higher taxonomic uniqueness (genera, family or relict species)
- Unusual ecological or evolutionary phenomena
- Global rarity of the major habitat type regarded (Olson and Dinersteiner identified 12 major habitat types that describe different areas of the world that share similar environmental conditions, for example freshwater communities or arctic tundra)

The ecoregions chosen by Olson and Dinersteiner (1998) are distributed as follows among major habitat types: Tropical forest regions are the major habitat type that contains the most ecoregions of all habitat types. Conservation of these units would thus lead to general benefits for the climate system, too, because these forests are important for the storage of carbon, the water cycle and because they are the largest current source for carbon emissions from land-use changes.

4.2.2 Species level

At the species level, areas with high levels of species richness and / or high endemism of species are priority areas for conservation. Myers (1990) has combined these features in the „hotspot approach“ that also includes some measure of threat of these regions. In a recent study, Myers et al. (2000) identified 25 hotspots with high numbers of endemics for conservation priorities. These areas contain 44 % of all vascular plant species and 35 % of all species in 4 vertebrate groups on only 1.4 % of the earth's surface. Figure 13 shows a map of these regions. 15 of these areas are found in tropical forests and another five are Mediterranean-type zones, including the South African fynbos.

The most diverse of these hotspots with respect to plant diversity are the Tropical Andes, Sundaland, Madagascar, Brazil's Atlantic Forest and the Caribbean. Like the ecoregional approach, the hotspot analysis results in a bias for conservation of tropical forests. These ecosystem types are also crucial for the global climate. However, conflicts are possible where hotspots like the Brazilian Cerrado or the South African Fynbos are subject to carbon mitigation activities like pasture amendments with non-native species or afforestations in regions where the natural and diverse herbaceous vegetation cover is replaced by (non-native) trees. The hotspot approach could be used under the FCCC in a way to separate areas where conservation of existing ecosystems has the highest priority and where natural ecosystems should not be converted to other uses, even if these uses would imply increased carbon storage.

to clarify the actions required. Article 2 (qualitative commitments) of the Kyoto Protocol (KP) also requests Annex I-Parties to promote sustainable development in achieving its qualified emission limitation and reduction commitments. Article 12 of the FCCC mentions the contribution of projects to reduce greenhouse gas emissions in non-Annex I Parties as a contribution to sustainable development. The sustainable use of the components of biological diversity is one of the major objectives in Article 1 (objectives) of the CBD.

Accounting of sinks

The accounting of carbon sequestration by biological sinks in Articles 3.3 (accounting of afforestation, reforestation and deforestation), 3.4 (accounting of additional land-use, land-use change and forestry activities) and 3.7 (accounting rules) of the KP with regard to the quantified limitation and reduction commitments of Annex I Parties has implications on the CBD, because the practical consequences of these provisions in the areas of forestry and land use can have considerable impacts on biodiversity. Under the CBD the discussion process on forest and agricultural biodiversity is of special relevance[15]. The synergies and conflicts between both conventions are also addressed in the IPCC Special Report on Land-use, Land-use Change and Forestry (IPCC 2000), unfortunately the report addresses the work, proposals and decisions performed under the CBD only in a very general way.

For activities under Articles 3.3 (afforestation, reforestation and deforestation) and 3.4 (additional activities) of the KP, the definition of accountable activities and the selection of categories that are allowed for accounting are the key determinants to be considered at the global level. Monitoring and review under KP will not include an analysis of the way how accountable activities have been implemented but will mainly focus on the accounted sequestration effects of these activities. The KP provides the possibility to include or exclude activities for accounting but does not address any further elaboration of instruments that should be in place with their implementation. At the national level, Parties have larger discretion to decide on further rules, guidelines, criteria or instruments to ensure appropriate consideration of biodiversity with the implementation of activities under Articles 3.3 and 3.4.

Projects to reduce greenhouse gas emissions

Article 6 (Joint Implementation) KP creates the possibility of projects to gain emission credits in the area of land-use change and forestry between Annex I-Parties. COP 6.5 decided that afforestation and reforestation are included in CDM project activities under Article 12 (Clean Development Mechanism) KP between Annex I and non-Annex I-Parties[16]. These Articles are linked with Article 8 CBD (In-situ conservation) which deals with the establishment of protected areas and measures for biodiversity

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15 See decision III/11 and Annex , COP3 under CBD

16 Germany and the EU rejected the inclusion of land-use change and forestry projects under Article12 KP (Clean development mechanism) whereas other Parties, especially the umbrella group wanted to include sink projects.

conservation. There are other linkages to the discussions on the implementation of Article 8.j (acknowledgment of indigenous and local communities) as well as to Article 11 CBD (incentive measures) addressing incentive measures for the conservation and sustainable use of components of biological diversity. JI and CDM under the KP are also new incentive measures to enhance the implementation of greenhouse gas reduction projects.

For project based activities under Articles 6 (Joint Implementation) and 12 (Clean Development Mechanism) KP detailed procedures and project cycles will be established (even if they are not yet fully agreed) that encompass processes of national approval, as well as validation, certification, monitoring and verification at the international level. Especially the processes of national approval, international validation and verification are the appropriate stages where further rules, guidance, criteria, instruments and tools to safeguard biodiversity conservation could be included. Besides the international level, of course Parties could design respective provisions at the national level.

Adaptation measures

Article 4.1.b FCCC establishes the commitment for all Parties to formulate and implement measures to facilitate adequate adaptation to climate change. Article 4.4 FCCC requests developed countries to assist developing countries in meeting costs of adaptation to adverse effects. Article 12.8 of the KP also addresses adaptation costs and outlines that a share of proceeds from CDM projects should be used to assist developing country Parties to meet the costs of adaptation. Decision 5/CP.6 adopted at COP 6.5 in July 2001 that establishes a special climate change fund to finance activities, programmes and measures related to climate change.[17] One of the areas included in this new fund is adaptation. In addition, a separate adaptation fund shall be established according to the same decision *"to finance concrete adaptation projects and programmes in developing country Parties"*. The adaptation fund shall be financed from the share of proceeds on the clean development mechanism project activities. The third fund established at COP 6.5 is a fund for least developed countries to support a work programme that also includes national adaptation programmes of action.

With regard to implementation of adaptation measures, the negotiation text[18] for COP6.5 requested:[19]

- Promoting the transfer of adaptation technologies;
- Establishing pilot or demonstration projects to show how adaptation planning and assessment can be practically translated into projects that will provide real benefits, and may be integrated into national policy and sustainable development planning;
- Starting the implementation of adaptation activities where sufficient information is

17 FCCC/CP/2001/L.7

18 FCCC/CP/2001/2/Add.1

19 Decision at this level of implementation have been postponed to COP 7, thus there is still no agreed decision on the implementation of adaptation measures under the KP.

available to warrant such activities, inter alia, in the areas of water resources management, land management, agriculture, health, infrastructure development, fragile ecosystems, and integrated coastal zone management;

- Implementing measures regarding forest conservation, rehabilitation of degraded land, and combating desertification, particularly in Africa.

Recent decisions on the one hand specify the areas of adaptation measures and on the other hand provide new funding for such activities. The above mentioned areas, such as water resources management, land management, agriculture, health, infrastructure development, fragile ecosystems, and integrated coastal zone management are also relevant under the CBD. Therefore possibilities for collaborative and coordinated actions between CBD and FCCC are the development of coordinated approaches to elaborate, select and implement adaptation measures under the FCCC and the Kyoto Protocol. Whereas sustainability of adaptation activities is addressed in several parts of the negotiating texts, no specific reference to the CBD or biodiversity considerations are contained.

Plans, programs, policies and measures

Article 6 and Article 10 CBD request Parties to integrate the conservation and sustainable use of biological diversity in relevant strategies, plans or programs. Article 8 CBD (in-situ conservation) requests Parties to establish a system of protected areas and to develop guidelines for the selection, establishment and management of protected areas. The promotion of protected areas is linked with the land-use, land-use change and forestry activities under the KP and with the development of effective adaptation strategies under the KP.

Environmental impact assessments

Environmental impact assessments (EIA) are mentioned in both conventions, in Article 4.1.f FCCC and in Article 14 CBD. Article 14 requests EIAs of proposed projects in order to avoid or minimize adverse effects on biological diversity and to allow public participation in such procedures. Similar provisions could be adopted under the KP in order to avoid negative impacts on biodiversity from land-use change and forestry projects.

Monitoring

Article 7 CBD on identification and monitoring requires Parties to identify and monitor the components of biodiversity, processes and categories of activities having adverse impacts on the conservation and sustainable use of biodiversity. These processes shall be identified and monitored. The provisions under Article 7 are relevant with regard to impacts of climate protection measures and adaptation measures under the KP as well as for the design of monitoring of project activities under Articles 6 and 12 KP.

Financial resources and transfer / GEF

Both conventions are linked through the financial mechanisms of the Global Environmental Facility (GEF). GEF provides financial resources for projects to reduce greenhouse gas emissions as well as for projects to conserve and sustainable use of biodiversity in developing countries.

Research, training, education, and public awareness

Article 12 und 13 CBD address research, training, public education and awareness. These topics have correspondent articles under the FCCC (Articles 5 and 6). Under both conventions programmes for capacity building have been initiated which could have synergetic effects.

Technology transfer

Another interface of both conventions are the provisions on transfer of technology (CBD Article 16 and KP Article 4).

Table 21 Overview on interfaces between the FCCC, the KP and the CBD

Topic	Framework Convention on Climate Change / Kyoto-Protocol	Convention on Biological Diversity
Sustainable forestry	FCCC Art. 4.1.d KP Art. 3.3, 3.4, 3.7	CBD Art. 10
Adaptation measures	FCCC Art. 4.1.b, 4.4 KP Art. 12.8	-
Plans, programmes, policies and measures	FCCC Art 4.1.b, Art. 4.2.a KP Art. 2	CBD Art 6, 11
Monitoring	FCCC Art. 4.1.a, KP Art. 5, 7 and provisions under Art. 6, 12	CBD Art. 7
Environmental impact assessment	FCCC Art. 4.1.f,	CBD Art. 14
Financial mechanism	FCCC Art. 11, 4.3, KP Art. 11	CBD Art. 20, 21
Technology transfer	FCCC Art. 4.1.c, 4.5, 4.8, 4.9 KP Art. 10.c	CBD Art. 16
Research and training	FCCC Art. 4.1.g, 5, 6 KP Art. 10.d	CBD Art. 12
Education and public awareness	FCCC Art. 4.1.i, 6 KP Art. 10.e	CBD Art. 13
Forestry and agriculture	Projects in the area of land-use change and forestry FCCC Art. 4.1.d, KP Art. 3.3, 3.4, 6,. 12	Thematic programmes (forest and agriculture biodiversity)

Source: Öko-Institut

5.2 Approaches to promote the cooperation between CBD and FCCC

Mainly during the recent meetings and conferences, the bodies under the CBD increased their initiatives to enhance the cooperation between both conventions.

The COP 5 to CBD considered the interactions between climate change and the conservation and sustainable use of biological diversity in a number of thematic and cross-cutting areas, including coral bleaching, forest biodiversity and incentive measures, and urged strengthened cooperation with the FCCC[20]. Specifically, the SBSTTA was requested to consider the impact of climatic change on forest biological diversity[21] and to prepare scientific advice in order to integrate biodiversity considerations into the implementation of the FCCC and its Kyoto Protocol.[22] In both cases the COP to the CBD called for this work to be carried out in collaboration with the appropriate bodies of the FCCC and the IPCC.

The Executive Secretary of the CBD made available a discussion note to the SBSTA 13 (FCCC) on the interaction between climate change and biological diversity.[23] The SBSTA invited Parties to the FCCC to submit views on the discussion note.[24] Few (only three Parties) submissions were received which expressed divergent views.

Also COP 6 of the CBD addressed the issue of biological diversity and climate change. The Executive Secretary of the CBD prepared a note,[25] providing a progress report on activities, including collaboration between the CBD, the FCCC and the IPCC, and identifying relevant areas of scientific guidance. At the same meeting, the SBSTTA of the CBD, agreed to undertake a pilot assessment to prepare scientific advice to integrate biodiversity considerations into the implementation of the FCCC and its Kyoto Protocol. For this purpose, the SBSTTA established an ad hoc technical expert group. The pilot assessment will address the following issues:

(a) The impacts of climate change on biological diversity and the impacts of biodiversity loss on climate change;

(b) The potential impact on biological diversity of mitigation measures that may be carried out under the FCCC and its Kyoto Protocol, and identification of potential mitigation measures that also contribute to the conservation and sustainable use of biological diversity;

(c) The potential for the conservation and sustainable use of biological diversity to contribute to climate adaptation measures.

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20 Decisions V/3, V/4, V/15 and V/21

21 Decision V/4, para. 11.

22 Decision V/4, para. 18.

23 UNEP/CBD/SBSTTA/6/11, annex I.

24 The secretariat received four such submissions from Parties; these are contained in document FCCC/SBSTA/2001/MISC.3.

25 UNEP/CBD/SBSTTA/6/11

The SBSTTA invited the FCCC and other relevant organizations to contribute to this assessment. It further invited the IPCC to contribute by preparing a technical paper and by identifying experts[26].[27]. In response to the request by the SBSTTA, the IPCC agreed to prepare a scoping paper[28] in time for the fourteenth session of the SBSTA (FCCC).

The SBSTTA (CBD) further requested the Executive Secretary of the CBD, in consultation with the secretariat of the UNFCCC, to explore the formation of a joint liaison group between the bureau members of the relevant subsidiary bodies of the FCCC and the CBD, and their respective secretariats.[29] The SBSTA (FCCC), at its 14th session, endorsed the formation of a joint liaison group and requested to invite the secretariat of the United Nations Convention to Combat Desertification to participate in this liaison group in order:

(a) To enhance coordination between the three conventions including the exchange of relevant information;

(b) To explore options for further cooperation between the three conventions, including a possibility of a joint workplan and/or a workshop.[30]

This means that recent decisions under both conventions have established new institutional structures aiming at closer cooperation. Work in some important areas was already started. These approaches are first steps to use synergies and should continue.

5.3 Thematic areas for cooperation between CBD and FCCC

The following sections provide a further assessment of some of the linkages described in the overview in section 5.1. The analysis is mainly performed from the point of view of the CBD and evaluates whether and how the work under specific articles of the CBD could provide inputs to the FCCC and the KP in order to enhance synergies and to avoid adverse impacts as described in the previous chapter. The analysis concentrates

- on *monitoring and reporting* as appropriate data and information is the fundamental prerequisite for a successful cooperation,
- on the *ecosystem approach* as one of the key frameworks developed under the CBD which is promoted as the framework to be used by other conventions,
- on *in-situ conservation* and the potential relevance of areas of special relevance to the CBD and their possible use for the purposes of the FCCC as already discussed in chapter 4.2,

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26 UNEP/CBD/COP/6/3, paras. 5-9)

27 Recommendation VI/7

28 The IPCC secretariat has indicated that the scoping paper will be available at the fourteenth session of the SBSTA.

29 Further information is available on the CBD web site at http://www.biodiv.org/cross-cutting/climate

30 FCCC/SBSTA/2001/L.3

- on *instruments* such as *EIA* as the application of established instruments across conventions could provide an integrated approach for conflict resolution,
- on the *financial mechanism* as the FCCC and CBD are linked through the use of the Global Environment Facility (GEF) so that GEF provides for experiences in integrating aspects of both conventions.

5.3.1 Ecosystem approach

At COP 2 in 1995 under the CBD, the COP adopted the ecosystem approach as the primary framework for action under the Convention, and subsequently has referred to the ecosystem approach in the elaboration and implementation of the various thematic and cross-cutting issues work programmes under the Convention.[31] At its fourth meeting in Bratislava in May 1998, the COP acknowledged the need for a workable description and further elaboration of the ecosystems approach, and requested the SBSTTA to develop principles and other guidance on the ecosystem approach..[32] The ecosystem approach has been discussed in a number of workshops and promoted through a range of initiatives, which, together, provide a wide range of technical views and different geographical perspectives. The COP 5 CBD endorsed the description of the ecosystem approach and operational guidance and recommended the application of the principles and other guidance on the ecosystem approach.[33]

The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems. The term "ecosystem" does not, necessarily, correspond to the terms "biome" or "ecological zone", but can refer to any functioning unit at any scale. The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Management must be adaptive in order to be able to respond to such uncertainties and contain elements of "learning-by-doing" or research feedback. Measures may need to be taken even when some cause-and-effect relationships are not yet fully established scientifically. The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations.

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[31] Decision II/8 CBD

[32] Decision IV/1.B CBD

[33] Decision V/6 CBD, The preliminary approach will be tested with case studies and will be reviewed at a later stage.

IUCN promotes to adopt and to integrate the ecosystem approach in the context of the FCCC and the KP (IUCN 2000). In the view of the Conservation Union the approach could contribute because the ecological complexity of forests is recognized, deforestation is avoided, the limits of carbon management are recognized, the ecological and social benefits from projects are maximized and the costs minimized by following the ecosystem approach. The following section will provide a more detailed analysis of the operational guidance for the ecosystem approach in order to justify these promises.

Operational guidance for the ecosystem approach recommends the use of so-called adaptive management practices. Implementation programmes should be designed to adjust to the unexpected, rather than to act on the basis of a belief in certainties. According to the guidance, there is a need for flexibility in policy-making and implementation. Long-term, inflexible decisions are likely to be inadequate or even destructive. Ecosystem management should be envisaged as a long-term experiment that builds on its results as it progresses. This "learning-by-doing" will also serve as an important source of information to gain knowledge of how best to monitor the results of management and evaluate whether established goals are being attained. Following this guidance under the KP could be interpreted in a way that flexible provisions instead of stringent guidelines and criteria for land-use change and forestry projects and activities should be agreed with a view to modify them if concerns related to the dangers of such projects are really met. Parts of the negotiating parties under the FCCC (at least the EU) are calling for the implementation of the precautionary principle that avoids negative consequences before any implementation started. This does not seem to be fully consistent with the recommendation of adaptive management practices under the ecosystem approach. This guiding principle also implies that adaptation of management practices is still possible during the implementation of activities, which is not the case for land use changes.

The forth operational guiding principle developed under the ecosystem approach recommends carrying out management actions at the scale appropriate for the issue being addressed, with decentralization to the lowest level, as appropriate. And it is added, that this approach will imply decentralization to the level of local communities. Where common property resources are involved, the most appropriate scale for management decisions and actions would necessarily be large enough to encompass the effects of practices by all relevant stakeholders. Appropriate institutions would be required for such decision-making and, where necessary, for conflict resolution. With a view of the potential conflicts between FCCC and CBD which mainly arise at the management level and the level of implementation of projects and activities, this guidance principle could be interpreted in the way that conflicts between both conventions should be resolved at the national or regional scale involving the relevant stakeholders, and that no further rules and guidance are necessary at the global level under the KP. Many NGOs and several Parties do not trust in the national capacities to address and resolve the conflicts in a way that minimizes the damages to biodiversity. Therefore they favour stricter rules and guidelines at the international level. The operational guidance of the ecosystem approach does not support the Parties favouring stricter international guidance, but those Parties that believe that Parties can adequately deal with any conflicts at the national level.

5.3.1.1 Conclusions and recommendations

A more detailed look at the principles and the operational guidance for the ecosystem approach leaves some doubts if the approach is really able to contribute significantly to resolve the problems under the KP. At least some of the operational principles could be read in a way that no further action under the KP is needed and that stakeholders at the national or regional level should deal with potential conflicts and adverse impacts. However, the ecosystem approach could provide useful guidance in other areas than those described above, but it clearly does not yet provide the adequate means to balance climate change, biodiversity and social objectives at the implementation level for project activities or concrete adaptation measures.

5.3.2 General measures for conservation and sustainable use (Article 6 CBD) and sustainable use of components of biological diversity (Article 10 CBD)

The concept of sustainable use of biodiversity is currently being discussed under the CBD and is related to the three major goals of the CBD. It is defined as *"...the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations"*[34]. The SBSTTA also stresses the importance that the use of the goods and services from biological diversity provides an incentive for its conservation. The services mentioned in a provisional classification in this paper range from pollination to flood control and crop and livestock productions. The only directly climate-related service mentioned in this classification is carbon sequestration.

The ecosystems for which SBSTTA has developed recommendations on the sustainable use are agroecosystems and coastal and marine biodiversity. There are no recommendations for the sustainable use of forests or grasslands. Thus with regard to one of the key areas for synergies with the FCCC, specific work under the CBD is still lacking.

5.3.2.1 Conclusions and recommendations

The ecosystem services discussed under the CBD related to climate protection should be extended to other services than carbon storages such as discussed in this report (service with regard to water cycle, energy budget and albedo, radiation).

Recommendations with regard to sustainable use of forests and grasslands should be developed under the CBD.

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[34] UNEP/CBD/SBSTTA/5/13

5.3.3 Identification and Monitoring (Article 7 CBD)

Article 7 CBD on identification and monitoring requires Parties to

- Identify components of biodiversity important for conservation and sustainable use;
- Monitor the components of biological diversity;
- Identify and monitor processes and categories of activities having or likely to have significant adverse impacts on the conservation and sustainable use of biodiversity, and;
- To maintain and organize data derived from identification and monitoring activities.

Article 7 CBD is a key Article for the integration of both conventions as only the information and data on important components of biodiversity identification allows adequate measures for conservation when greenhouse gas mitigation or adaptation activities are implemented. Article 7.c on the monitoring of activities with adverse impacts could be read in a way that the CBD already implemented the commitment to monitor land-use change and forestry projects and activities under the KP with potential negative impacts on biodiversity. The proper maintenance and organization of data will provide a useful tool for all project developers and project managers as such databases would clearly show areas where special care needs to be taken with regard to biodiversity aspects.

If biodiversity aspects should be considered and respected with the implementation of mitigation measures under Articles 3.3 and 3.4 of the KP or in forest or agriculture project activities, it is important that the respective country has in place a system of identification and monitoring of biodiversity. The usefulness of principles, rules and criteria at the international level that require Parties to minimize and avoid adverse impacts of climate related projects on biodiversity would be considerably reduced for those Parties where such identification and monitoring systems are absent at all or are at a very incomplete and limited stage.

5.3.3.1 Work progress on monitoring under the CBD

In the following section the actual progress on identification and monitoring under the CBD and the potential application under the FCCC is analysed. At its 2nd meeting SBSTTA presented a document on identification, monitoring and assessments of components of biological diversity and processes, which have adverse impacts.[35] The paper states that the Convention and indicative guidelines, however, do not provide much guidance because they us terms that are open to extremely broad interpretation and because there appears to be a need for more specific guidance to enable the Parties to develop their priorities for identification, monitoring and assessment. In the document SBSTTA provided further guidance in relation to the interpretation of Annex I of the CBD. A similar conclusion is drawn for the identification and

[35] UNEP/CBD/SBSTTA/2/3

monitoring of adverse impacts where the note states:

> *"Neither Article 7, Annex I, nor the Convention itself provide much by way of guidance as to how the COP might start the process of identifying activities that have or might have an adverse impact on biological diversity. While recognising that many such activities are dependent upon local conditions, it seems that the Parties would nonetheless benefit from some general guidance as to what types of activities are generally acknowledged as falling within the meaning of Article 7(c) so as to begin the process of identification, monitoring and assessment in a manner that allows them to better contribute to the aims of the Convention. In order to meet the aims of the Convention with limited resources, the Parties will again need to set priorities. For this reason, the Parties will need an understanding of the relative importance of the different activities that have or may have an adverse impact on biological diversity."*[36]

In the same document SBSTTA tried to provide further guidance to Parties in deciding which aspects of biological diversity should be considered important and tries to clarify Annex I of the CBD. The document also identifies categories of human activity that may lead to the proximate threats. From the proposed categories several are relevant for the discussion under the FCCC. These are:

- deliberate introduction of exotic species,
- conversion of land to settled agriculture,
- shifting cultivation on too short a cycle,
- accidental or deliberate burning, or change in natural fire regime,
- dam construction,
- canalisation and
- drainage of wetlands.

SBSTTA proposed three complementary approaches for the monitoring of threats to biodiversity: extensive monitoring, usually using remote sensing or aerial photography; detailed sampling of particular sites; and the use of pressure indicators to predict areas or ecosystems that may be expected to be under adverse influence. One of the key problems for the monitoring of threat is that the understanding of the impacts of the threatening activities on biological diversity is still limited. SBSTTA noted an urgent need to develop a programme of further study directly linking pressures to the assessment of the state of biological diversity.

Until COP 5 under the CBD there was not much progress related to the implementation of biodiversity monitoring. Decision V/7 on identification, monitoring and assessment, and indicators requests to

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36 UNEP/CBD/SBSTTA/2/3

> *"develop a set of principles for designing national-level monitoring programmes and indicators and a key set of standard questions and a list of available and potential indicators, covering the ecosystem, species and genetic levels, taking into account the ecosystem approach, that may be used by Parties at their national level and in national reporting and that also allow for regional and global overviews on the state and trends of biodiversity and, if possible and appropriate, any responses from policy measures."*[37]

Therefore at the national level, which is important for sequestration or adaptation activities under the FCCC and the KP, there is still a lack of standardized monitoring programmes for biodiversity issues. This fact complicates considerably the integration of biodiversity issues in the implementation of activities or projects as well as the formulation of principles and criteria for such integration at the international level. The work under the CDB on monitoring issues should be strengthened and promoted to establish an adequate knowledge base for cross-conventional problems.

5.3.3.2 Progress on monitoring at the national level

The second national reports from Parties under the CBD provide information on the existing monitoring systems, more specifically they provide country-specific information

- whether biodiversity is monitored,
- which type of monitoring data exists,
- on the geographical and taxonomic coverage of monitoring,
- on the focus of monitoring (e.g. rare species, ecosystems, threatened species etc.),
- on the scale of monitoring and the level of disaggregation of monitoring data,
- and on the availability and accessibility of monitoring data.

Thus, with the data presented in second national reports it could be assessed whether and to which degree present monitoring activities in different countries match with the need to monitor adverse impacts of forest related mitigation measures and projects.

Second national reports report severe limitations with the implementation of monitoring provisions at the national level:

- Argentina reports to have very limited capacities for monitoring and that there is no program at national level that covers all taxonomic groups, but only certain groups of species while other species are almost not considered at all. In addition there are some specialized monitoring programs but no systematic approach.
- Niger also reports severe resource limitations related to biodiversity monitoring. Only 6% of the national territories are classified at all. Monitoring or inventories are

[37] UNEP/CBD/COP/5/23, Annex III

only conducted for some species (mainly animals) for which international funding is provided.

- Thailand as well reports severely limited resources for monitoring and minimal activities established.
- Bulgaria reports considerably monitoring activities at the level of key plant and animal groups and threats but also has not yet established a systematic and integrated biodiversity monitoring system.
- Even Norway reports that despite the fact that plans for identification, monitoring and assessment activities are fairly advanced, more extensive measures to follow up the plans are limited due to budget restraints.
- Finland reports that the Ministry of Agriculture and Forestry is monitoring the sustainability of the use of natural resources and attempting to guide agriculture, fisheries, game management, reindeer husbandry and the use of water resources in the right direction through a series of indicators. The Ministry of the Environment published a series of indicators of sustainable development in April 2000. The publication on sustainable development indicators for Finland includes some preliminary indicators for biodiversity. Suitable species and habitat data were available, but not interpretations on their relationship with biodiversity overall, or on questions of scale. Indicators for whole ecosystems or for genetic diversity have not yet been sufficiently elaborated. Through these indicators it is possible to gather nationally reliable data on biodiversity resources and obtain information on pressures and threats, including on qualitative and quantitative future trends for the resources. There are few indicators, which try to describe the change of biodiversity in agriculture.

A more complete assessment of national reports (when more second national reports are available) could provide useful input to more specific discussion on the monitoring of CDM and JI projects or on the specific rules for activities under Articles 3.3 and 3.4. If information from second national reports shows that biodiversity monitoring is very limited or inexistent in a country, a more careful or intensive approach with regard to project validation and monitoring could be required under the FCCC. An assessment of the existing progress on monitoring of biodiversity could also provide useful information for the scientific discussions on monitoring, accounting and eligibility under the FCCC.

5.3.3.3 Organization and management of monitoring data

Article 7.d CBD addresses the organization and management of monitoring data. Easy accessible biodiversity data would also be an important pre-requisite for an adequate integration of biodiversity aspects with mitigation or adaptation activities under the FCCC and the KP. This is also an area where further progress is needed. Glowka et al. (1996) describe that in the 1980s many complex database systems have proved unworkable in practice and have been abandoned and that the development of an effective data capture network has proved extremely difficult at the global level. One of the recent approaches is the development of the Global Biodiversity Information Facility (GBIF). The GBIF is an interoperable network of biodiversity databases (taxonomy) and information technology tools that will enable users to use biodiversity information for national, economic, environmental and social benefits. The purpose of establishing GBIF has been to promote, co-ordinate, design and implement the compilation, linking, standardization, digitalization and global dissemination of biodiversity data. Despite the past problems, it is essential that databases work with agreed standards and transfer formats and that they are compatible with each other.

Several countries report in their national reports activities for a more systematic recording of species distributions and biodiversity components. UK, for example, recently developed a 'Sampling Framework', and related improvements to biological recording, both locally and nationally, within the UK 'National Biodiversity Network'. The UK 'Sampling Framework', which started in 2000, is intended to provide the co-ordination umbrella that focuses data collection activities on information requirements so providing the wider-countryside complement to monitoring systems for designated areas. Initial work has focussed on mammals and threatened plants. One of the key tasks in the UK Biodiversity Action Plan is to improve the accessibility and co-ordination of biological data sets in the UK and is developing an internet based data exchange system.

5.3.3.4 Biodiversity indicators

Indicators for the conservation and sustainable use of biological diversity summarize data on complex environmental issues and serve to indicate the overall status and trends of biodiversity as well as being a means to assess national performance and to signal key issues to be addressed through policy interventions and other actions. In the framework of the CBD indicators have been defined as quantitative measures, which *"imply a metric (i.e. distance from a goal, target, threshold, benchmark, etc.) against which some aspects of policy performance can be measured".* Once indicators are selected, they give direction to monitoring and verification programmes.

The current work under the CBD on biodiversity indicators mainly aims to provide an overall assessment of biodiversity of a country or of biodiversity of certain ecosystems over time. The perspective under the FCCC and the Kyoto Protocol is different as the focus is on potentially negative impacts of activities under the Protocol on biodiversity. The negative impacts that should be avoided depend inter alia on the activity and on the habitat / ecosystem where the activity takes place. In such a complex situation, general indicators may not be appropriate and ecosystem-specific or management-related indicators may be necessary which is more complex to develop at the international level. This dilemma was also recently acknowledged by SBSTTA under the CBD:

> *"Biological diversity criteria and indicators have essentially the same drawbacks as large scale satellite surveys: they do not assess directly biological diversity but rather processes that maintain and generate biological diversity. Monitoring of specific indicators may provide useful information on trends of the status of forest ecosystems and potential early*

> *warning signals. [...] However, indicators may be most useful at the site level and their usefulness for overall forest management may be limited. It should also be noted that most site level surveys are likely to be too detailed for the current needs of the Convention, but are essential in providing ground-truth data for validating national and regional surveys."*[38]

The CBD is providing work on biodiversity indicators at the global level, which has to be rather general, abstract and aggregated to be globally applicable. For the resolution of conflicts between mitigation or adaptation activities under the FCCC and the CBD and biological diversity in many cases concrete, specific, regional or site-specific biodiversity indicators would be most useful and would guarantee to be appropriate and applicable to the specific problem. This means that there is a clear gap between the progress that can be achieved under the CBD and the factual need under the FCCC and the KP.

The Secretariat under the CBD is currently assessing experiences gained in the implementation of national and regional processes and identifying common elements and gaps in the existing initiatives with regard to indicators for forest biological diversity, including the processes of Helsinki, Montreal, Tarapoto and others[39]. Forest biodiversity will be substantially reviewed at the seventh meeting of the subsidiary body. These initiatives should be further analysed with regard to useful inputs to the FCCC and the KP. Nevertheless, the gap between the needs at project and at global level will remain.

5.3.3.5 Conclusions and recommendations

Article 7 CBD is a key article for the integration of both conventions as only the information and data on important components of biodiversity allow adequate measures for conservation when mitigation or adaptation activities are implemented. Further work on identification and monitoring is needed under the CBD, such as a programme to further study the direct links between the pressures on and the state of biological diversity. At the implementation level, which is important for activities under the FCCC and the KP, there is still a lack of standardized monitoring programme for biodiversity issues. This fact complicates considerably the integration of biodiversity issues in the implementation of activities or projects. The work under the CDB on monitoring issues should be strengthened and promoted to establish an adequate knowledge base for cross-conventional problems. Easy accessible biodiversity data would also be an important pre-requisite for an adequate integration of biodiversity aspects with mitigation or adaptation activities under the FCCC and the KP. The global accessibility of monitoring data is also an area where further progress is needed.

The information from Parties presented in second national reports is very valuable to assess whether and to which degree present monitoring activities in different countries

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38 UNEP/CBD/SBSTTA/5/8, p. 6

39 UNEP/CBD/COP/5/10

match with the need to monitor adverse impacts of forest related mitigation measures and projects. Currently only few second national reports are available. Therefore a more complete assessment at a later stage should be conducted. If information from second national reports shows that biodiversity monitoring is very limited or inexistent in a country, a more careful or intensive approach with regard to project validation and monitoring could be required under the FCCC. A more thorough assessment of the existing progress on monitoring of biodiversity could also provide useful information for the scientific discussions on monitoring, accounting and eligibility under the FCCC.

The CBD is providing work on biodiversity indicators at the global level, which has to be rather general, abstract and aggregated to be globally applicable. For the resolution of conflicts between mitigation or adaptation activities under the FCCC and the CBD and biological diversity concrete, specific, regional or site-specific biodiversity indicators would be most useful in many cases and would guarantee to be appropriate and applicable to the specific problem. This means that there is a clear gap between the progress that can be achieved under the CBD on biodiversity indicators and the factual need under the FCCC and the KP.

The Secretariat under the CBD is currently assessing experiences gained in the implementation of national and regional processes with indicators for forest biodiversity. This issue will be substantially reviewed at the seventh meeting of the subsidiary body. Any future initiatives should be further analysed with regard to possible contributions to the FCCC and the KP. Nevertheless, the gap between the needs at project and at global level will remain.

5.3.4 In-situ conservation – protected areas (Article 8.a-c CBD)

Previous section 4.2 (regions with special significance for biodiversity and climate change) has already highlighted possible synergies between the two conventions with regard to areas that should be protected because of their important value under the conventions. Therefore in this section the work process under the CBD is analysed in order to assess whether besides the general possibilities for cooperation with regard to protected areas, more specific results from the CBD process could be used under the FCCC.

5.3.4.1 Protected areas

Article 8 CBD provides the main set of convention obligations to conserve biological diversity and requires Parties to establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity (Articles 8.a, 8.b)). Implementing of paragraphs (a) and (b) requires a firm legal base under which government authorities can establish and manage protected areas. The COP 5 under the CBD has decided that protected areas should be one of three items for in-depth consideration at its seventh meeting[40], and has commended protected areas as one of

[40] decision IV/16, Annex II

four specific themes for the compilation and dissemination of information on the implementation of Articles 6 and 8[41]. The COP has also emphasised the importance of protected areas in the work programmes on forest biological diversity, marine and coastal biological diversity, inland water biological diversity and biological diversity of dry and sub-humid lands.

This means that Articles 8.a and 8.b theoretically provide the legal basis for protected areas but more specific work with regard to the key ecosystems that are important for the linkages between the conventions (forests, wetlands) is still outstanding. Therefore it is recommended to promote this work, but it is too early to assess possible linkages at a more detailed level. It would be helpful to have a clear list that identifies sites of high interest for biodiversity. For such sites, coordinated and mutually supportive approaches could be developed between activities under both Conventions. With the implementation of LULUCF activities at the regional level, project developers could more easily be aware of sites where thorough consideration of biological diversity is needed. At present such work is not yet available under the CBD.

5.3.4.2 General provisions for biodiversity conservation

Article 8.c CBD obliges each Party to ensure that biological resources important for the conservation of biological diversity are conserved and sustainably used by regulating or managing them. This obligation applies to all areas within a Party's jurisdiction, not only within protected areas. The scope of this paragraph is potentially broad. In the same way also paragraph (d) refers to all areas and requires each Party to promote ecosystem and species protection. Effective regulatory or management actions will very often depend on creating an effective legal framework. This is acknowledged in paragraph (k), which obliges Parties to develop and maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations. Since the requirement includes populations, paragraph (k) includes habitat protection. Parties will have to develop provisions to comply with this requirement including the use of incentives and planning constraints or land-use controls, as, in most cases, it is not possible to declare all areas with threatened species into a protected area.

Many countries have legislation in place on conservation of vertebrate animal species. At the global level, legislation to protect invertebrates, plants or microorganisms is less common. In many countries, plants are treated as private property and can be freely removed by landowners. In others they are treated as free products of nature, which can be collected or used by anyone almost anywhere. Legislation to protect individual habitat types and ecosystems is not common either (Glowka et al. 1996).

While Article 7(c) requires Parties to identify the processes and categories of activities which have or are likely to have significant adverse impacts on the conservation of biological diversity, Article 8(l) then obliges them to *"regulate and manage the relevant processes and categories of activities"*.

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[41] decision III/9 paragraph 9

Articles 8.c, 8.d, 8.k and 8.l. are key articles for the linkages between the two conventions because they apply to all areas within a Party's jurisdiction and because they present the basis for an effective legal framework for biodiversity protection at the national level. If such legal frameworks exist, they will provide adequate guidance at the national level to minimize or eliminate potential negative impacts of activities under the FCCC and the KP. However, the previous section already described areas where reality is quite far away from an effective implementation of these provisions. Therefore implementation of these provisions should be promoted and objective assessments of the actual implementation progress are needed. The results of such assessments could determine the need for further actions at the global level.

5.3.4.3 Rehabilitation and restoration of degraded ecosystems

Article 8.d CBD requires Parties to rehabilitate and restore degraded ecosystems and to promote the recovery of threatened species, through the development and implementation of plans or other management strategies. Rehabilitation and restoring ecosystems is a fairly new discipline which relies on natural succession and/or active human intervention, such as planting trees, removing introduced species, using controlled burns, apply certain traditional land-use practices. Rehabilitation and restoration have been implemented on a small-scale for mines, landfills, temperate forests or wetlands. Larger scale applications are fewer in number (Glowka et al. 1996).

Previous chapters have already shown the functional linkages in the area of rehabilitation and restoration. Especially with regard to adaptation activities under the FCCC cooperation between both conventions in this area should be enhanced.

5.3.4.4 Conclusions and recommendations

It would be helpful to have a clear list from the CBD that identifies sites of high interest for biodiversity. For such sites, coordinated and mutually supportive approaches could be developed between activities under both Conventions and LULUCF activities. Project developers at the regional level could more easily be aware of sites where thorough consideration of biological diversity is needed. According to decision III/12 under the CBD, methodologies for identification of such sites will be developed. Methodological work on such lists should be completed as soon as possible in order to start practical work on such lists.

Articles 8.c, 8.d, 8.k and 8.l are key articles for the linkages between the two conventions because they apply to all areas within a Party's jurisdiction and because they present the basis for an effective legal framework for biodiversity protection at the national level. If such legal frameworks exist, they will provide adequate guidance at the national level to minimize or eliminate potential negative impacts of activities under the FCCC and the KP. Therefore implementation of these provisions should be promoted and objective assessments of the actual implementation progress by Parties are needed. The results of such assessments could determine the need for further actions at the global level either under the FCCC or the CBD.

5.3.5 Impact assessment and Minimizing of Adverse Impacts (Article 14 CBD)

Article 14 CBD deals with impact assessment and minimization of adverse impacts. Paragraphs (a) and (b) concern EIA of a Party's proposed projects, programs and policies. Paragraphs 1.c and 1.d deal with transfrontier cooperation. Emergency planning, including international cooperation is addressed in paragraph 1.e. The goal of the Article is to use EIA to avoid or minimize significant adverse effects on biological diversity in all Parties as it requests to introduce appropriate procedures requiring EIA if such procedures have not yet been implemented.

EIAs are most often used for specific projects, but could be used and adapted for plans in forestry, land-use or agriculture. EIAs are frequently regarded as a screening tool for biodiversity considerations that should be applied to LULUCF activities (Arts. 3.3 and 3.4), and projects (Arts. 6 and 12) under the KP for example in the note by the Executive Secretary of the CBD on climate change and biological diversity (CBD 2000):

> *"Whether or not a proposed activity has positive effects on biological diversity may depend on the specific characteristics of the case concerned. In some cases, a proposed activity may have positive impacts on some components of biological diversity, or at certain levels, but negative impacts on others. Further, they may be other non-carbon impacts on sustainable development, besides impacts on biodiversity, that may need to be taken into account. Impact assessments may be necessary to determine likely impacts in some cases."*

In this regard Article 14 CBD is one of the most important Articles of the CBD in relation to the FCCC as it provides an already agreed, established and implemented tool to address the concerns related to possible negative effects of forestry and land-use activities under the FCCC. Thus, it needs to be analysed how powerful this tool is in relation to land-use, land-use change and forestry activities.

5.3.5.1 Work progress on EIAs and SEAs under the CBD

EIAs should be introduced for a Party's projects, but paragraph 14.1.a CBD leaves a wide discretion to the Parties in determining which projects – whether public, private or both – require EIA. This is somewhat compensated in paragraph 1.b which requires the introduction of appropriate arrangements at the level of programmes and policies and therefore broadens the scope of the article considerably. But paragraph 1.b only addresses "appropriate arrangements" and does not address EIA at the level of programmes and policies; and it is not completely clear whether this requirement calls for the same substantial procedures. Up to now few countries (e.g. Canada, the Netherlands and the United States) have started to conduct EIA on individual government sponsored projects (Glowka et al. 1996). In the EU, a directive on impact assessment of strategies and plans was adopted in 2001.[42]

The article addresses the *"appropriate"* procedures requiring EIA and the *"appropriate"* arrangements to ensure that the environmental consequences of programs and policies are *"duly"* taken into account" (Article 14.1(a) and 14.1(b)). This means that Parties have considerable discretion what they consider as appropriate. This lack of preciseness considerably weakens the comparable implementation of the article. In this regard it should be considered whether some minimal implementation of procedures and arrangements could be developed to ensure some basic standards across Parties. A similar framework approach was adopted with the EU council directives 97/11/EC and 85/337/EEC on the assessment of the effects of certain public and private projects on the environment. With regard to the application of Article 14 under the FCCC it is important that such minimal EIA provisions cover forest and agricultural projects. Any more specific development of such a framework with minimum standards at international levels goes beyond this report.

Decision V/18 CBD on impact assessment, liability and redress invites Parties, to address loss of biological diversity when carrying out environmental impact assessments, to consider biological diversity concerns from the early stages of the drafting process, when developing new legislative and regulatory frameworks; and to ensure the involvement of interested and affected stakeholders in a participatory approach to all stages of the assessment process. It also encourages Parties to use strategic environmental assessments to assess not only the impact of individual projects, but also their cumulative and global effects, incorporating biological diversity considerations at the decision-making and/or environmental planning level and to include the development of alternatives, mitigation measures and consideration of the elaboration of compensation measures in environmental impact assessment. Thus with this decision it is aimed to reduce the amount of discretion left to the Parties by Article 14 and to provide more specific guidance on some of the key issues raised above. However, the language ("invites" and "encourages") is not very binding.

Decision V/18 and recommendation IV/6 request the SBSTTA to further develop guidelines on the incorporation of biodiversity-related issues into legislation and/or processes on environmental impact assessment. Such guidelines seem to be necessary to reduce the large amount of discretion with regard to the implementation of Article 14. With a view to the interlinkages to the FCCC, any guidelines that are developed should consider the use of EIAs for forest projects.

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42 Directive 2001/42/EC from 27.06.2001.

5.3.5.2 Problems with comparability of EIAs across countries

National legislation is needed to implement Article 14 CBD, which can vary significantly with regard to different aspects, such as:

1. the type of projects subjected to EIA

   Not all countries may include forestry or other land-use activities under the projects that are subject to an EIA. In addition, the size and type of such projects may differ. At present, EIA in many countries do not or only partly include land use, land use change and forestry activities or specific management practices. E.g. in the European legislation agriculture or silviculture activities are only subject to an assessment whether a case-by-case examination provides the recommendation that an EIA should be performed or whether certain thresholds or criteria set by Member States are met. Agriculture and silviculture activities do not cover the whole range of potential land-use, land-use change and forestry activities, but only the conversion of natural or uncultivated lands to intensive agricultural purposes, afforestation and deforestation, but not reforestation. EIAs as a general requirement under the FCCC for project activities therefore would require that the list of activities for which EIAs are mandatory needs to be enlarged in many countries by additional types of activities and subsequently procedures and guidelines for the EIA for these activities would need to be adopted. This means, that the general use of EIAs for land-use, land-use change and forestry project activities will take considerable time to be fully implemented across countries.

2. The existence of strategic impact assessment for national programs and policies

   EIA aims to assess the effects of public or private projects on the environment. In this regard EIA could be an instrument for the assessment of effects of project activities under the Kyoto Protocol. However, it seems less adequate for the assessment of activities under Article 3.3 and 3.4 because those represent national policies or programs. Those would be candidates for Strategic Environmental Assessment (SEA). The purpose of SEAs is to ensure that environmental consequences of certain policies, plans and programmes are identified and assessed during their preparation and before their adoption. In this regard, SEAs could be appropriate tools for activities under Articles 3.3 and 3.4. However the implementation of SEAs as a political instrument is much less developed internationally than the use of EIAs for projects, thus only in some countries necessary domestic legislation, guidance and procedures are established which present a considerable problem for their use under international Conventions. In those countries where SEAs are implemented, they are not necessarily applied to all activities that are covered under Articles 3.3 and 3.4 with potential negative effects on biodiversity.

3. the procedures to be followed, including for what design phase an EIA is required

   The procedures used during EIA can vary significantly between countries and an EIA can be conducted at different project design phases such as project identification, pre-feasibility study, feasibility study, appraisal and approval. In the past the tendency has been to complete EIA late in the design process after the main project plans have been developed. This is often a time where it is considered to be too expensive to reject the entire project. For example for a large hydroelectric dam project, an EIA at a late stage would only explore possibilities to reduce negative impacts, an EIA at an early stage would also consider alternative options for electricity generation or alternative project sites.

4. the relevant biodiversity aspects and parameters considered

   An impact assessment with regard to biodiversity issues would require a clear indication of the relevant biodiversity aspects and parameters. The strength of the relationship between the activity and the change in biodiversity needs to be clearly definable, significance of impacts needs to be defined and criteria and thresholds for judgements are needed. These aspects are more difficult to define for LULUCF activities than for industrial projects that clearly replace natural areas by built-up land.

5. who is required to undertake the EIA

   EIA can be conducted by the project proponent or by independent (possibly certified) organizations.

6. the assessment criteria to be used to determine significant adverse effects on biodiversity

   The assessment criteria used in an EIA with regard to impacts on biodiversity will depend on biodiversity criteria and indicators already established in a country against which the significance of impacts is evaluated. The criteria and procedures for determining whether an activity is likely to significantly affect biodiversity can be defined in different ways, for example in lists of categories with

   - activities that by their nature are or are not likely to have significant effects (positive or negative lists).
   - areas that are of special importance or sensitivity, so that activities affecting such areas are likely to have significant effects,
   - environmental problems, which are of special concern, so that an increase of such as problem is likely to be significant.

7. the form and level of public participation

   The form and level of participation can be related to project circumstances such as project size. It can also differ with regard to the stakeholder groups or individuals whose opinions are considered.

8. the effects of the EIA results on the project approval procedure.

   At present, negative impacts identified in EIAs often do not result in a non-eligibility of an activity but in measures that aim to mitigate impacts or in measures that aim to compensate for lost ecosystem and biodiversity resources, or that replace lost productive use. It is questionable whether compensation approaches or mitigation approaches would be effective for LULUCF activities. On the one hand LULUCF activities with clear negative impacts on biodiversity (e.g. the conversion of primary forests to plantations) involve a destruction of an ecosystem in a large area[43], which is hardly compensable. One the other hand forestry and land use activities themselves are often used as compensation measures as a result of EIAs. EIAs for LULUCF activities should be performed at an early planning stage with the aim to permit an informed decision on whether the project shall be implemented or not and to influence the design from the beginning.

This analysis demonstrates that the considerable difference with regard to the implementation of EIAs and SEAs at the national level provide the possibility that the assessments are powerful tools to integrate biodiversity aspects in national planning and decision making. At the same time a less stringent implementation will considerably weaken the practical usefulness of these instruments. At present, no general basic standards have been discussed or agreed at a global level, which considerably reduces the usefulness to ensure an appropriate implementation of critical activities under the FCCC and the KP across all Parties.

5.3.5.3 Progress with the implementation of Article 14 CBD at the national level

In its decision IV/10 C, the COP under the CBD invited governments and organizations to transmit reports and case studies relating to environmental impact assessment. Only five Parties and three organizations submitted information to the Executive Secretary. Both in number and in the level of detail, these submissions did not constitute a sufficient sample to reach any definitive conclusions about the present status of incorporation of biodiversity considerations into environmental impact assessment procedures.[44]

The reporting in the few second national reports on the implementation of Article 14 yet available under the CBD confirm the analysis of considerably differences in implementation. Developing countries mostly report that resources for implementation of this obligation are severely limited (e.g. Armenia, Argentina, Madagascar, Mali, Niger). Even Norway reports severely limited resources for the implementation.

Establishment of legislation is often not yet sufficient to implement EIAs in practice. Armenia reports on *"the absence of several sub-laws and other normative regulations necessary to ensure the proper functioning of the law"*. Also Argentina explains that abundant legislation exists without correspondent appliance in practice and that there is a big openness to sign agreements, but a very limited openness to apply them and to devote resources.

Developing countries often report that the public participation is rather limited. Armenia

[43] Already in the AIJ pilot phase plantation projects encompass areas of several 10,000 ha.

[44] UNEP/CBD/COP/5/13

reports that there is no public participation as one of the regulations not yet approved is the "Order of implementation of public hearings related to Environmental Impact Expertise (Assessment)" (Armenia). Argentina explains that only the first steps to implement public participation have been met.

Another barrier for appropriate implementation is the lack of expertise. Armenia reports that "No institute of public ecological expertise, which could conduct independent ecological assessments, exists in Armenia." Also Mali considers the lack of technical expertise to conduct EIAs as the most important problem for the implementation.

Very few countries have SEAs in place. One of the countries that reports established SEA especially with regard to forestry activities is Finland. The Ministry of the Environment has issued general guidelines for SEA by the authority given in the Act. Significant SEAs have been carried out (e.g. Finland's Natura 2000 network proposal, the National Forest Programme for 2010, SEAs in the transport sector). A monitoring system programme has been developed to follow-up actual impacts of the National Forest Programme. Prior to the implementation of the National Forest Programme 2010 detailed estimation of its environmental impact was made.

5.3.5.4 Conclusions and recommendations

Since EIAs require national legislation, the specific implementation of the general rules provided in Article 14 CBD can vary significantly. This may substantially reduce the value of the instrument if no comparable implementation can be achieved across Parties. The considerable discretion left to Parties in relation to "appropriate" procedures and arrangements under Article 14 CBD should be reduced. This lack of preciseness considerably weakens the comparable implementation of the Article. In this regard the development of guidelines on the incorporation of biodiversity-related issues into legislation and/or processes on environmental impact assessment should be supported and it should be ensured that the development process considers the use of these guidelines for projects in forestry and agriculture. The guidelines should elaborate some minimal standards for implementation of procedures and arrangements to ensure some basic standards across Parties. A similar framework approach was adopted with the EU council directives 97/11/EC and 85/337/EEC on the assessment of the effects of certain public and private projects on the environment. A more specific development of such a framework with minimum standards at international levels goes beyond this report. However, the political willingness to implement such minimum standards for EIAs is lacking at least in some countries. The submissions from Parties on cooperation between the CBD and the FCCC[45] showed very divergent views with regard to the development of screening tools. Australia and Japan highlighted that the eligibility of specific projects, their consistence with biodiversity objectives and screening criteria should be left to each Party's discretion. Whereas the European Union stressed the importance o policy tools such as EIA and the need of international screening criteria.

45 FCCC/SBSTA/2001/MISC.3

In developing countries adequate planning processes are often lacking as well as capacities for ecological assessments. Financial and human resources and political support are also limited. Even if the concrete implementation of EIA under the CBD varies considerably between countries, it can strengthen the importance of adequate planning processes considering ecological impacts. In this regard Article 14 CBD has a strong potential to promote effective planning systems and an enhanced importance for strategic planning in developing countries. This process will also be useful in the case of any project activities under the CDM in developing countries. It is important that the appropriate application of instruments and tools such as EIA are promoted by the financial mechanisms of the conventions as the capacities to apply such tools ensure the implementation of the objectives under both conventions.

Decision III/2 CBD identified as a research priority, inter alia, the scientific analysis of the ways in which human activities, in particular forest management practices, influence biodiversity and the assessment of ways to minimize or mitigate negative influences. A closer analysis of EIA legislation and procedures in different countries is needed in order to provide a clearer view on the usefulness and the problems of the practical implementation of EIAs as a general tool to harmonize objectives of CBD with objectives of FCCC in relation to LULUCF activities.

With regard to Articles 3.3 (accounting of afforestation, reforestation and deforestation) and 3.4 (accounting of additional LULUCF activities) it should be evaluated whether EIAs and SEAs are the most appropriate instruments to integrate biodiversity aspects into forest policies. In general SEAs and EIAs are less focused on forestry activities as many countries have chosen a different approach that establishes binding principles and criteria for forest management in the framework of the national forest policy which also has the objective to avoid negative environmental effects without using the instruments of EIAs or SEAs. Further analysis on the mutual usefulness, or contradiction between EIAs/SEAs and criteria and principles for sustainable forest management should be conducted.

Assessments of EIAs or guidelines for EIAs developed under the CBD, especially if the topics forests and agriculture are included, should be exchanged with the bodies under the FCCC to increase the mutual understanding and to create the possibilities that such approaches are also taken into account under the FCCC.

5.3.6 Other possible instruments and tools

5.3.6.1 Participation - Methodologies to ensure involvement of indigenous and local communities

Standard EIA procedures would allow for public participation and comments both at an early stage of the assessment, and after an initial draft of the assessment has been prepared. With Article 8 and 14, the CBD acknowledges the key role of public participation for the implementation of the Convention. The Convention of Biological Diversity (CBD) also highlights the importance of indigenous and local communities to the conservation and sustainable use of biological diversity. The paragraph (j) of Article 8 of the CBD is regarded as the core, or most important provision, with regard to the recognition and protection of the interests of indigenous and local communities. The CBD also recognizes the links between conservation of biological diversity and cultural diversity, and the dependence of such communities on the continuation of their traditional access to biological resources. In this regard, the CBD goes beyond the general requirements of public participation as explained above and as discussed currently under the FCCC. The implementation of paragraph (j) of Article 8 of the CBD is subject to national legislation, and allows for the Parties to develop a legal framework and to take the necessary administrative measures to respect, preserve, maintain the knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant to the conservation and sustainable use of biological diversity. In this regard any mechanisms developed under the CBD Article 8(j) would also be applicable for potential CDM projects. Such national frameworks, developed under the CBD, could be very useful for the consideration of project activities under the CDM.

Rules under the Kyoto Protocol for the Clean Development Mechanism (CDM) and Joint Implementation (JI) should incorporate the principles of public participation as already implemented under the CBD or as affirmed in recent international environmental agreements, including the Rio Declaration and the UNECE Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters, known as the Aarhus Convention. Involvement of civil society can ensure that the CDM and JI contribute to an overall program of sustainable development and assist in verifying that standards and criteria for projects at the national or international level are met. In this regard involvement of indigenous and local communities is a general requirement that CDM and/or JI projects should fulfil and should include biodiversity issues but should not be limited to such aspects.

5.3.6.2 Conclusions and recommendations

At present activities addressing local participation and participation of indigenous and local communities to the conservation and sustainable use of biological diversity as developed under the CBD are not acknowledged in discussion on forest activities under the FCCC and relevant information does not reach the bodies under the FCCC.

National legal frameworks and necessary administrative measures to respect, preserve, maintain the knowledge, innovations and practices of indigenous and local communities relevant to the conservation and sustainable use of biological diversity should be further supported. Such a legal status would facilitate the consideration of these issues in the project validation phase under the KP.

5.3.6.3 Negative and positive lists

If an activity under the FCCC would always have negative impacts on biodiversity, it would be most appropriate to add this activity to a negative list that excludes this activity from eligibility under the Protocol. In addition, a negative list follows the precautionary principle that excludes all activities with potential negative impacts and it is therefore a safeguard to avoid any negative impacts. The previous section 4.1 has shown that in most cases negative or positive impacts of land-use change and forestry or adaptation activities under the KP depend on certain conditions such as the regions where they are implemented or the specific management options applied. This means that the elaboration of a negative list seems to be complicated as the list would not contain specific activities but specific conditions for the implementation and would exclude activities on basis of such conditions.

A positive list would encompass activities that would always have clear positive impacts on biodiversity. A clear determination of such activities with clearly positive impacts is even more difficult than the compilation of activities with negative impacts (as already discussed in previous sections, see Table 18). In many areas, the type and the severity of impacts on biodiversity would depend on the local and regional circumstances, the way of implementation of a specific activity or on the management practices applied. In this regard it is considered to be difficult to elaborate a positive list.

5.3.6.4 Conclusions and recommendations

Decision III/2 under the CBD identified as a research priority, inter alia, the scientific analysis of the ways in which human activities, in particular forest management practices, influence biodiversity and the assessment of ways to minimize or mitigate negative influences. It would be useful for the discussions under the FCCC, if the CBD would help to identify elements for negative or positive lists as described above in relation to adverse impacts on biodiversity. For the identification of such lists, expertise under the FCCC does not seem to be appropriate. Any such tool can only be implemented for forest or land-use related activities under the FCCC if scientific guidance is provided under the CBD.

5.3.6.5 Rules and guidelines for management

As already addressed in previous sections, many negative impacts of LULUCF activities on biodiversity will not strictly depend on a certain type of activity, but how this activity is performed, i.e. on the way and the intensity of management of forests, cropland or grazing land. A tool, which addresses this situation, is the establishment of management rules and guidelines. Many countries already established and apply rules and guidelines for sustainable forest management in forestry practice. Such rules and guidelines should include biodiversity aspects.

Sustainable forest management is being discussed in a wide range of international fora, and numerous national policies in support of sustainable forest management have already been established (see also chapter 6). In this regard cooperation between Conventions should not only be promoted between CBD and FCCC, but also between FCCC and Intergovernmental Panel on Forests of the Commission On Sustainable Development, the Intergovernmental Forum on Forests and existing regional recommendations on sustainable forest management, such as the Paneuropean Criteria and Indicators for Sustainable Forest Management (see also section on interlinkages between UN forest process).

Despite the considerable work that was already performed in relation to sustainable forest management in these processes, there is still a lack of international agreement and wide applicability of rules, criteria and indicators for sustainable forest management. In this regard further scientific advice on criteria and indicators for the conservation and use of biological diversity as a component of sustainable forest management is needed. A proposal for such criteria, indicators in the framework of sustainable forest management should be established as soon as possible for instance by the expert group under the CBD compiling the pilot assessment suggested in UNEP/CBD/SBSTTA/6/11, Annex III.

5.3.6.6 Conclusions and recommendations

The instruments and tools presented above (EIA, SEA, management principles and criteria, participation or positive/ negative lists) are not exclusive but some of them complement each other, e.g. stakeholder participation and EIAs. Different instruments are developed under different conventions, e.g. CBD focuses on EIA and SEA, the Aarhus Convention on participation, the forest process on management rules and principles. All elements could contribute to an appropriate implementation of Articles related to forestry and agriculture under the KP. However, the success of such an approach will depend on the implementation and appropriate application across all Parties involved in those conventions. Such information is not easily available for discussion processes under the FCCC and improved exchange of actual progress of implementation and application of those instruments is recommended. Further research based on actual progress of implementation of these instruments is necessary to evaluate the usefulness and the possibilities of application of these instruments under the FCCC.

5.3.7 Reporting

5.3.7.1 Reporting under the FCCC

Biodiversity issues are not mentioned in the reporting guidelines for national communications under the FCCC[46]. Nevertheless many Parties are already reporting aspects related to biodiversity in their national communications and thus have established the linkages between both conventions even without formal requirements

[46] FCCC/CP/1999/7 UNFCCC guidelines for reporting and review, February 2000 and Decision 10/CP.2 Communications from Parties not included in Annex I to the Convention: guidelines, facilitation and process for consideration in FCCC/CP/1996/15/Add.1

under the FCCC. Biodiversity is addressed in the following parts of national communications[47]:

- National circumstances – forest and agricultural resources/ geography/ managing natural resources/ land-use/ legal framework (e.g. Australia, Bolivia, Cook Islands, Costa Rica, Indonesia, Ivory Coast, Malaysia, Mexico, Micronesia, Senegal)
- Impacts of climate change, vulnerability assessment on biodiversity (e.g. Armenia, Australia, Bolivia, Cook Islands, Costa Rica, Denmark, El Salvador, Estonia, Germany, Grenada, Ireland, Italy, Ivory Coast, Honduras, Lithuania, Malaysia, Mali, Mexico, Micronesia, Nauru, Philippines, Samoa, Thailand, Uruguay)
- Adaptation measures (e.g. Austria, Cook Islands, Czech Republic, El Salvador, Honduras, Kiribati, Mali, Netherlands, Norway, Vanuatu)
- Mitigation options, projections, plans and measures related to forestry or agriculture (e.g. Australia, Austria, Bolivia, Costa Rica, Czech Republic, Grenada, Hungary, Kiribati, Mexico, Norway, Senegal, Thailand)
- Systematic observation, education and public awareness (e.g. Bolivia, Costa Rica, Thailand)
- Research and research needs (e.g. Austria, Azerbaijan, Lithuania, Uruguay, France)
- Information and capacity building needs related to biodiversity (e.g. Cook Islands)
- AIJ forest projects and biodiversity (e.g. Czech Republic)

Sometimes, very specific impacts of climate change (especially storms and cyclones, temperature increase) on wildlife and nature are reported (e.g. national communication from Cook Islands, Italy, Samoa, Honduras) and detailed research and modelling results in relation to climate change impacts on biodiversity are presented (e.g. Costa Rica), specific adaptation projects and measures and their effects on biodiversity are described (e.g. Austria, Czech Republic, Mali) or efforts related to specific research projects on effects of climate change on ecosystems or biodiversity (e.g. Australia, France).

5.3.7.2 Conclusions and recommendations

This analysis shows that information is already provided in national communications that would also be relevant and useful under the CBD. Since presently biodiversity is not addressed in the UNFCCC reporting guidelines, the reporting is somewhat arbitrary and incidental, incomplete and scattered, very different in scope, extension and degree of detail, and spread in different parts of the national communications. This does not allow a systematic use of the reported information under the CBD, even if individual contributions are very valuable and informative. In two areas it seems especially relevant to improve the guidelines to encourage reporting on linkages between climate change and biodiversity. The first area is the reporting on mitigation policies and

[47] For Annex I Parties second national communications were analysed, for non-Annex I Parties initial national communications.

measures in the forest and agricultural sectors, the second area is the impacts of climate change on ecosystems and biodiversity, related research activities as well as the consideration of biodiversity aspects with the planning and implementation of adaptation measures. Country-specific experiences on these issues could enhance global understanding and formulation of adequate international policies.

It should also be considered how this information could and should be made available for the CBD process. One possibility could be a compilation and synthesis of biodiversity related information in national communications under the FCCC that is forwarded to the CBD. At present, information is too scattered for such a compilation, but improved and more structured reporting under the FCCC could provide a very valuable input to the CBD.

During the last revision of guidelines for national communications for Annex I Parties, the issue of reporting on biodiversity related aspects was not addressed at all by any Party and no changes in this respect were introduced. Future revisions of guidelines should consider this aspect and provide improvements in the relevant sections of the guidelines. These requirements should not be mandatory but encourage Parties to report in order to improve understanding and exchange of information.

The Consultative Group of Experts (CGE) on non-Annex I national communications[48] is currently developing proposals to improve guidelines for non-Annex I national communications. A report of the CGE will be presented in November at COP 7 (FCCC). In different regional and one global workshop many experts from non-Annex I Parties expressed the need to revise the section on vulnerability assessment, climate change impacts and adaptation in order to provide more specific and structured guidance to Parties how to report on these issues and which elements to include. However, neither the workshop reports nor the draft versions of reports developed by CGE experts address the issue of biodiversity. Thus, it is likely that any recommendations for the revision of the guidelines will not address an improved reporting on linkages between biodiversity and climate change. Therefore, also with regard to guidelines for non-Annex I Parties, further work is necessary to improve consistency of reporting in order to provide the CBD with relevant country-specific experiences on these issues.

There does not seem to be a general resistance or reluctance of Parties to provide this information in national communications which is proven by the frequency with which Parties addressed these issues without any formal requirements, but there seems to be a lack of awareness, that this information could be provided in a more systematic way and should be exchanged with the CBD. In this regard it is recommended to develop specific proposals how biodiversity issues could be integrated in the reporting guidelines for national communications under the FCCC.

[48] The Consultative Group of Experts (CGE) was established according to decision 8/CP.5

5.3.7.3 Reporting under the CBD

National reports

The objective of national reporting, as specified in Article 26 CBD is to provide information on measures taken for the implementation of the Convention and the effectiveness of these measures. COP 2 (Jakarta, November 1995) under the CBD decided that the first national reports should "*focus in so far as possible on the measures taken for the implementation of Article 6 (General measures for conservation and sustainable use) of the Convention, as well as the information available in national country studies on biological diversity*"[49]. COP 5 under the CBD endorsed guidelines for future national reporting that were developed by the secretariat through a pilot project for future national reporting.[50]

The new reporting format for the second national reports has the advantage that it aims to obtain comparable and clearly structured information on the implementation of all relevant Articles of the CBD. Thus, especially the information on those Articles with clear linkages to the FCCC as presented in previous sections could provide useful information for the discussions under the FCCC.

One example where information provided in the second national report would be useful under the FCCC is the information provided in relation to the implementation of Article 14 (EIA). The reporting format addresses the following questions:

- Is legislation in place requiring an environmental impact assessment of proposed projects likely to have adverse effects on biological diversity (question no. 194)?
- Do such environmental impact assessment procedures allow for public participation (question no. 195)?
- Does your country have mechanisms in place to ensure that the environmental consequences of national programmes and policies that are likely to have significant adverse impacts on biological diversity are duly taken into account (question no. 196)?
- Does your country ensure the involvement of all interested and affected stakeholders in a participatory approach to all stages of the assessment process (question no. 208)?
- Does your country use strategic environmental assessments to assess not only the impact of individual projects, but also their cumulative and global effects, and ensure the results are applied in the decision-making and planning processes (question no. 211)?
- Does your country require the inclusion of development of alternatives, mitigation measures and consideration of the elaboration of compensation measures in environmental impact assessment (question no. 212)?

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49 decision II/17

50 decision V/19

- Is national information available on the practices, systems, mechanisms and experiences in the area of strategic environmental assessment and impact assessment (question no. 213)?

Thus, the second national reports under the CBD provide country-specific information on the status of EIA in many countries. A deeper analysis of this material could provide closer insights on the use of EIA as a tool to prevent negative effects from forest related provisions under the Kyoto Protocol. It could also provide useful input to the advice by SBSTTA under the CBD on the questions addressed in the note on biodiversity. Such an analysis goes beyond the scope of this report and can not yet be provided as only few reports are yet available as Parties were requested to submit their second national reports by 15 May 2001 for consideration at the sixth meeting of the Conference of the Parties (April 2002). Until beginning of June, 24 Parties submitted the second national report; only 8 industrialized countries already submitted this report. A further deeper analysis is recommended when more reports are available.

On Article 11 (Incentive Measures) CBD, the reporting format contains two questions that are specific with regard to the linkages between CBD and FCCC:

- Question no. 171: Has your country reviewed the incentive measures promoted through the Kyoto Protocol to the UN Framework Convention on Climate Change?
- Question no. 172: Has your country explored possible ways and means by which these incentive measures can support the objectives of the Convention on Biological Diversity in your country?

However, the answer in the few existing reports do not provide very useful inputs to the FCCC or the CBD, as answers are very brief (yes, no or under consideration) and no further information was provided by most of Parties in relation to these questions.

This shows that there is also a potential to improve reporting formats under the CBD with regard to climate related issues in order to enhance the usefulness of the information provided by Parties for other Conventions such as FCCC and the Kyoto Protocol. Based on the possible conflicts between both conventions as addressed in previous sections of this report, some further requests of information under the CBD could be investigated.

An analysis with regard to the contribution to problems under the FCCC could also be conducted for other parts of the second national report under the CBD, such as the answers on Article 6 (general measures for conservation and sustainable use) and Article 8 (In-situ conservation).

In addition to the possibility that the information provided relevant to specific Articles of the CBD could be used under the FCCC, it also occurs that Parties reported on linkages between the two conventions without a specific question in the reporting format, e.g. UK informs under question 44 that it is collaborating with the Republic of Ireland in an assessment of inter-tidal biodiversity indicators for detection of climate change impacts.

As proposed in the previous section for the national communications under the FCCC it should be assessed whether a compilation and synthesis of climate-related information from the second national reports under the CBD would be feasible and useful for information exchange with the FCCC. This cannot be answered at present because of the limited availability of second national reports. This analysis only highlights some possible answers and results that a complete analysis of the second national reports could provide.

Thematic reports

Parties under the CBD were also invited to submit thematic reports on different issues to be considered in depth at meetings of the Conference of the Parties. In the case of the sixth meeting (COP-6), these are alien species, forest ecosystems and benefit sharing. Related to the FCCC, a preliminary analysis of reports on forest ecosystem was conducted. This analysis can only be preliminary as the deadline for the reports on forest ecosystems was 15 May 2001 and only 13 reports are available on the CBD homepage so far. For the thematic report on forest ecosystems a special questionnaire or reporting format was developed. Especially the answers to following questions are of relevance for the discussions on carbon sinks under the FCCC:

- Question no. 9: Has your country promoted activities for an enhanced understanding of positive and negative human influences on forest ecosystems by land-use managers, policy makers, scientists and other relevant stakeholders?
- Question no. 11: Has your country promoted activities with the aim of providing options to minimize or mitigate negative and to promote positive human influences on forest biological diversity?
- Question no. 13: Has your country identified means and mechanisms to improve the identification and prioritisation of research activities related to influences of human activities, in particular forest management practices, on forest biological diversity?

The understanding of positive and negative human influences on forest ecosystems as addressed in question 9 and 13 is key for the discussions of promoting carbon sinks under the KP. In the operationalization of the KP options to minimize negative and to promote positive influences as addressed in question 11 are highly relevant. However, from the few reports available only a small share provides useful information to the discussion as many of the reports are very brief and provide answers to the multiple choice questions but very limited explanatory information. Countries, which have chosen a more detailed approach, are Sweden and United Kingdom. Both reports also contain information that addresses climate issues:

- As well as an existing forest biological diversity research programme, a crosscutting multi-sectoral research agenda is being developed in UK as a result of a two-year series of workshops and consultancy review. This covers the direct and indirect influences of policies and trends such as climate change and also socio-economic issues.

- In Sweden in 1998-2000 the Analysis Department of the National Board of Forestry carried out an extensive Forest Impact Analysis, in co-operation with a number of other Swedish authorities. The impact analysis project aimed at estimating possible national changes in a number of variables over the next 100 years including; condition of forest, size and composition of the highest sustainable harvesting level, potential accessibility of forest fuel, environmental aspects and carbon and nutrient balances. This is done through extensive calculations based on specified alternatives for future forest management and environmental considerations.

Several developing countries report "minimal activities" for the three questions quoted above (e.g. Argentina, Central African Republic). This means that only minimal knowledge on human activities on forests ecosystems exist in those countries. Assessment of forest related projects under the FCCC would face considerable problems in those countries.

On the basis of the few reports available at present, no further conclusions are possible with regard to the usefulness of the information provided in the thematic reports on forest ecology for the discussions under the FCCC. Further analysis is needed when more reports are available.

5.3.7.4 Conclusions and recommendations

Profound analysis of materials useful

Many proposals under the FCCC that addressed possible ways to consider adverse effects of climate change related measures and projects on biodiversity, have been limited to very general recommendations and in most cases they have not been based on the analysis of country-specific information in relation to the tools or solutions presented (e.g. criteria and indicators, EIA, SIA etc.). In this regard analysis covering a broad range of countries and using country-specific information is lacking in the current discussion. The information already provided under the CBD in national reports and thematic reports should be assessed in a more comprehensive analysis as it could contribute significantly to fill this gap. Such an analysis could be one important step in the direction of a discussion on recommendations that base on country experiences and existing activities.

Revision of guidelines

Under both Conventions existing reporting guidelines and formats could be improved to enhance the mutual usefulness of the reported information. Cross-linkages are often not considered in the elaboration and revision of reporting guidelines and formats. Specific advice and textual proposals need to be developed under both Conventions. Under the FCCC this is of special relevance for the reporting on forest related mitigation measures and projects, vulnerability assessment, climate change impacts and adaptation in national communications.

Under the CBD it should be considered how Parties could be encouraged to provide more specific and detailed information if so available. If Parties only fill in the multiple choice formats without providing additional information in the respective boxes, the answers are not very helpful for any further analysis and assessment, as the most relevant information usually is contained in the comment boxes.

In the revision of guidelines and formats it should also be considered whether and how an improved mutual cooperation between the conventions could streamline reporting obligations and reduce reporting burdens of Parties. Recommendations should not only increase reporting requirements but also use existing linkages to avoid repeated reporting of similar issues in different reports.

5.3.7.5 Improving information exchange and harmonizing information management

The three Rio Conventions, Biodiversity, Climate Change, and Desertification carry out work in the area of information exchange and support to information needs of Parties. The programme approved by the XIXth Special Session of the UN- General Assembly (June 1997) for the further implementation of Agenda 21 gives special priority to collaboration among the Conventions and to the enhancement of information capacities as requisites for sustainable development. Responding to decision II/13 CBD, the five global biodiversity-related treaty secretariats and UNEP commissioned the World Conservation Monitoring Centre to undertake a Feasibility Study to identify opportunities for harmonising information management between CBD, Convention on Migratory Species, Convention on Trade in Endangered Species, Convention on Wetlands and World Heritage Convention. The secretariats of the Framework Convention on Climate Change and the Convention to Combat Desertification were invited to participate as observers. Despite the focus on biodiversity related agreements, the feasibility study also provides useful findings and recommendations for improved information exchange and information management between CBD and FCCC. Important findings, that are also valid for FCCC and CBD include that

- there is very little flow of scientific information between the conventions;
- information flow is hampered by lack of knowledge about the respective data holdings of the conventions;
- feedback of information to Parties should be improved, especially the dissemination of case studies and information on best practice;
- access to documents is difficult as in many cases they are neither indexed nor in digital form (Harrison and Collins 2000).

At the level of information preparation and dissemination Harrison and Collins (2000) recommend to develop a meta-database and an inter-convention web site and search engine in order to improve access to information across conventions. The authors also propose streamlining of reporting requirements of each convention and the identification of well-defined structured "modules" of information that avoid duplication of reporting. The third area where further work was requested in the feasibility study is the development of a lessons-learned network comprising an internal review in each secretariat to select appropriate material to be posted on a special section of the convention web site, an prototype lessons-learned web site as part of the inter-convention web site and the establishment of links to lessons learned of development agencies and national web-sites. All these recommendations – if implemented for the FCCC and the CBD – would also increase the exchange of relevant information between the two conventions.

5.3.7.6 Conclusions and recommendations

As proposed in the previous sections under both Conventions, ways to enhance the mutual information exchange should be explored. The analysis in previous sections shows that under the FCCC relevant information related to biodiversity issues is reported and vice versa under the CBD. But at present, few exchange of such information takes place. One option would be to produce specific compilation and synthesis reports or technical papers that summarize the reported information relevant under the other convention and that these compilation and synthesis reports are published under both conventions. Other ways and means for such information exchange exist, such as

- the development of a meta-database covering both conventions
- the development of an inter-convention web-site and search engine
- the development of a lessons-learned network
- joint working groups under both conventions

and should be further explored and promoted.

5.3.8 Financial Resources and financial mechanism

The FCCC and CBD are linked through the use of the Global Environment Facility (GEF) as their financial mechanism. The GEF is financing the incremental costs of country-driven projects in developing countries that provide global environmental benefits in the context of both conventions. The agreed incremental costs of activities concerning land degradation, primarily desertification and deforestation, as they relate to the four focal areas, are also eligible for funding.

GEF developed operational strategies for the different thematic areas such as biological diversity and climate change. Under the operational strategies operational program have been formulated. As of May 2000, there were 12 operational programs (OPs) through which the GEF provides grants. Eleven of these reflect GEF's primary focal areas: four in the biodiversity focal area, four in climate change, and three more in international waters. OP 12, Integrated Ecosystem Management, encompasses cross-sectoral projects.

5.3.8.1 Operational program 12: integrated ecosystem management

With the operational program on integrated ecosystem management, the GEF has taken into account the need to address the linkages between the FCCC and the CBD as well as the CCD. The program is based on the ecosystem approach; this means that from the point of view of the CBD, one of the most important advances in the work under the convention has been acknowledged. The operational program also specifically addressed the ecosystem services, including carbon storage:

> *"Ecological systems or ecosystems are responsible for life-supporting environmental services, such as the hydrological, nitrogen and carbon global cycles." (GEF 2000)*

Human-induced impacts on ecosystems are seen in a holistic way with their consequences with regard to the objectives for different conventions:

> *"Throughout the world, ecosystems are increasingly being subjected to human-induced impacts, such as overexploitation of forests, clearing of land for agriculture, infrastructure development, fossil fuel combustion, and burning of biomass that induce loss of biological diversity, land degradation, disruptions in water flow regimes and poor water quality, and increases in the concentration of atmospheric greenhouse gases." (GEF 2000)*

The objective of the operational program specifically addresses the cross-sectoral synergies:

> *"Traditional attempts to address these impacts and the management challenges they pose are invariably based on sector-by-sector approaches, which have resulted in fragmentation of policies, institutions, and interventions. Such approaches have not achieved optimum results because the linkages and interactions among natural systems as well as with people have been ignored or compromised. Consequently, there is an urgent need for the adoption of management systems embracing comprehensive and cross-sectoral approaches. A particularly useful system is integrated ecosystem management." (GEF 2000)*

Under this operational program, GEF also defined ineligible activities and that GEF will not support activities that may result in perverse incentives for integrated ecosystem management or may have negative environmental or social impacts. These activities may include:

- commercial logging in primary forests;
- conversion of natural landscapes into forest plantations or other monoculture systems ;
- introduction of alien species; and
- establishment of agricultural systems that displace affected communities to marginal lands.

With these provisions, the operational program explicitly addresses the major functional conflicts between the two conventions. Under this operational program GEF also aims at developing verifiable indicators to help evaluate implementation progress and to assess the extent to which it will meet and sustain the expected outcomes, including the global environmental benefits.

With this operational program GEF moved forward in the direction of using synergies and optimising strategies between the UN Conventions. The operational program on integrated ecosystem management is able to promote closer linkages between the two conventions. The program definition already takes into account the key areas of synergies and conflicts and the development of indicators measuring mutual benefits could be an important step in the development of an improved cooperation.

On the other hand, the holistic approach is only considered in one operational program out of twelve. Previous parts of this study showed that the linkages between CBD and FCCCC exist in forestry and agriculture activities or for adaptation measures, independent whether they are specifically addressed by a single program. In this regard it is essential that not only specific programs on cross-conventional issues are developed, but that the possible synergies and conflicts are addressed under each GEF operational program where such effects occur. Therefore the operational strategies on biological diversity and climate change are analysed in the following sections.

The GEF project performance reports as currently available do not provide an assessment for this operational program. Some quantitative information on distribution of projects across operational programs is included in GEF's annual project implementation reports, but the report for 2000 is not yet available. Since the operational program on integrated ecosystem management was only introduced in 2000, earlier reports do not provide information on this program. Therefore no further information with regard to the actual role of integrated approaches in the project implementation can be derived from performance and evaluation reports.

5.3.8.2 Land degradation

The May 1999 GEF Council requested implementing agencies to place greater emphasis on the issue of land degradation. Land degradation was defined broadly to include the following issues: soil erosion by wind and/or water; soil denudation; chemical pollution of soils; organic pollution of soils; vegetation degradation of all strata; habitat conversion/loss; loss of soil organic matter; aquifer degradation; riparian degradation; coastal zone degradation related to watershed factors; mountain zone soil stability; fuel wood crisis; uncontrolled bush/forest fires; overgrazing; land use changes; urbanization; drought and desiccation. Project implementation reports have classified several categories of land degradation related activities as "cross-cutting" in the sense of resulting in benefits to several focal areas. Examples are:

- vegetation rehabilitation (increases carbon sequestered, reduces emissions, protects watershed and reduces sediment load in water bodies, and if done with native/endemic species, enhances biodiversity);
- renewable energy / energy saving devices (reduces GHG, reduces pressure on natural resources therefore reduces sediment load in water bodies)

- waste treatment (reduces GHG, reduces pollution on land and in water bodies, reduces pressure on natural resources, and if resulting in fertilizer production then enhances vegetation rehabilitation).
- Soil conservation (assists natural regeneration of native biodiversity, and protects watersheds)
- Fire control (reduces GHG, protects biodiversity)
- GHG monitoring (helps to reduce GHG, provides additional arguments for appropriate land use activities for watershed protection and biodiversity conservation)

In 1999 25% of land degradation projects took place under operational program 3 on forest ecosystems (biodiversity focal area), but linkages to other conventions were seldom recognized by projects even though they had activities that were directly or indirectly relevant (GEF 1999).

The thematic review of land degradation linkages in all GEF focal areas showed that the components addressing land degradation in projects are less strong than anticipated and that their number is not increasing despite considerable opportunities to expand the number and strength of land degradation linkage activities. Recommendations include the development of new strategies for dealing with the land degradation component of the GEF portfolio and the composition of specific guidelines and criteria for land degradation linkage projects (GEF 2001d).

5.3.8.3 GEF Operational Strategy on biological diversity

The main strategic considerations guiding GEF-financed activities to secure global biodiversity benefits are: (a) integration of the conservation and sustainable use of biodiversity within national and, as appropriate, subregional and regional sustainable development plans and policies; (b) helping to protect and sustainably manage ecosystems through targeted and cost-effective interventions; (c) integration of efforts to achieve global benefits in other focal areas, where feasible, and in the cross-sectoral area of land degradation, primarily desertification and deforestation; (d) development of a portfolio that encompasses representative ecosystems of global biodiversity significance; and (e) that GEF activities will be targeted and designed to help recipient countries achieve agreed biodiversity objectives in strategic and cost-effective ways. The operational strategy also states:

> *"Where feasible and cost-effective, activities will be designed to contribute to global environmental benefits in other focal areas and in the cross-sectoral area of land degradation. For example, actions to sequester carbon and minimize land degradation may offer opportunities for biodiversity conservation, and international waters activities may offer opportunities for integrating aquatic biodiversity components." (GEF 2001f)*

This shows that the operational strategy on biological diversity addresses the linkages with the FCCC at the level of general objectives. Thus at the strategic level, the important aspects in relation to synergies and conflicts between the CBD and the FCCC are acknowledged. However at the implementation level, the policy, programme priorities and eligibility criteria as developed under the biodiversity strategy[51] do not refer to cross-sectoral linkages and synergetic effects, but concentrate on the issues specific to the CBD. In this regard the priorities and eligibility criteria could be improved to ensure that an integrated approach that acknowledges the effects of both conventions is implemented.

Under the operational strategy on biodiversity, an operational program on forest ecosystems (operational program number 3) has been established. Unfortunately the program on forest ecosystem only addressed biodiversity issues and does not mention any linkages to carbon storage of forests. Funding for monitoring is provided, but the examples of key indicators include mainly ecosystem structure and functions relevant for biodiversity aspects (e.g. population of key alien, invasive, keystone species) and do not clearly include carbon sequestration effects. The examples of typical GEF activities under this program also concentrate on biodiversity aspects and do not mention any possible linkages to carbon sequestration. Nevertheless, indirectly the operational program could provide useful insights for forest activities that integrate objectives of both conventions, but the way the program is established does not encourage such outcomes.

Participation of affected stakeholders, including indigenous peoples, is of central importance under for the biodiversity-related GEF operational programs, especially in the case of communities that reside inside protected areas and their immediate surroundings. Important factors in designing strategies for effective participation of stakeholders in global biodiversity objectives include access to land and other resources; governance systems relating to conflict management; distribution of benefits and accountability for conserving key resources; and demographic composition, gender roles, and social organization processes that influence human and environmental interactions. The experiences gathered with these project activities could also be useful for land-use change and forestry projects under the KP.

An analysis of the actual GEF project portfolio in the biodiversity focal area[52] shows that very few projects specifically address the linkages between biodiversity and carbon storage in ecosystems. In general, projects focus on biodiversity issues even if they address crosscutting issues such as forest management and they do not address the sequestration functions of ecosystems. In this regard the project portfolio could be improved, especially for forest conservation projects in the project portfolio. Only one project in Brazil, the sustainable management of the Caatinga Ecosystems, includes carbon storage in the project description (GEF 2001a). This project establishes a

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51 Appendix to the operational strategy on biological diversity: policy, strategy and programme priorities

52 For the analysis information on UNDP-GEF portfolio by focal areas (biodiversity) project descriptions from GEF homepage at http://www.undp.org/gef/portf/biolac.htm were used (01.06.2001).

research program of a monitoring system for carbon sequestration control. Several other projects from the biodiversity focal area have the potential to provide useful outcomes for the discussions under the FCCC, especially projects that aim at promoting sustainable use of forests (e.g. Brazil "Promoting Biodiversity Conservation and Sustainable Use in the Frontier Forests of Northwestern Mato Grosso", Cameroon "Sustainable Forest Management by Communities in the Bameda Highlands, Guyana "Program for sustainable forestry") or projects that focus on participatory approaches for ecosystem management (e.g. Cape Verde "Conservation of Biodiversity through integrated participatory community management", Central African Republic "A highly decentralized approach to biodiversity protection and use: the Bangassou Dense Forest") (GEF 2001a). These projects will provide guidance at the national levels with regard to forest management and decision making with stakeholder participation. If forest projects under the Kyoto Protocol would be implemented in these regions, the experiences and the elaborated guidance could be used for the evaluation of such sequestration projects. A further analysis of project case studies would be needed to assess whether the GEF projects could really provide such guidance, as this is not the original intention of the projects.

Supporting protected areas, either new or existing, has been a major focus of the GEF biodiversity portfolio (GEF 2001e). About 60 % of the protected areas covered are part of projects in forest ecosystems. The biodiversity program study concludes that it was not possible to directly answer the question: "what impacts did they have on biodiversity?" (GEF 2001e). This was mainly because projects in the focal area for the most part did not systematically collect information on impacts on biodiversity. Also, for most projects there was no baseline data against which the current status could be compared. In the absence of baseline data, it was only partly possible to assess the impacts that projects were having on biodiversity. The current lack of impact assessment of biodiversity projects is also a considerable barrier for consideration of biodiversity issues under the FCCC.

5.3.8.4 GEF Operational Strategy on climate change

The operational strategy on climate change covers enabling activities to facilitate implementation of effective response measures, mitigation measures to reduce greenhouse gas emissions from anthropogenic sources or protect or enhance removal of such gases by sinks and adaptation activities to minimize the adverse effects of climate change.

Appendix A of the operational strategy on climate change provides guidance on policies, programme, priorities and eligibility criteria. The guidance mentions the need for consistency with the relevant provisions of internationally agreed programmes of action for sustainable development in line with the Rio Declaration and Agenda 21 and UNCED-related agreements, thus consistency with the CBD is in a general way taken into account in the eligibility provisions.

Land degradation is specifically addressed under the operational strategy on climate change as source of greenhouse gas emissions, but no explicit linkages to biodiversity issues are established. The projects in this focal area are mostly related to energy and the reduction of fossil fuel consumption. At the level of operational programs, therefore no linkages to biodiversity issues are addressed, as any linkages are only indirect.

GEF also provides funding to adaptation activities that identify options to facilitate adequate adaptation to climate change. The first stage of this program encompassed the following:

- Assessment of national, regional and/or subregional vulnerability to climate change; and identify a near-term research and development agenda to understand sensitivity to climate change.
- Evaluation of policy options for adequate monitoring systems and response strategies for climate change impacts on terrestrial and marine ecosystems.
- Assessment of policy frameworks for implementing adaptation measures and response strategies in the context of coastal zone management, disaster preparedness, agriculture, fisheries, and forestry, with a view of integrating climate change impact information, as appropriate, into national strategic planning processes.
- building of national, regional and/or subregional capacity, as appropriate, to integrate climate change concerns into medium and long-term planning.

For adaptation strategies, linkages to an integrated national strategic planning process are mentioned, but the program does not mention the objectives of the CBD which are relevant with regard to climate change impacts as well as to impacts of adaptation measures on biodiversity. In this regard the operational program for climate change could be improved and the linkages could be highlighted in a clearer way. Draft versions of the adaptation policy framework for stage II adaptation highlight the requirement of environmental sustainability of adaptation and consistency with other resource policies but do not address biodiversity conservation specifically, but the framework is not yet finally elaborated and future versions might contain an explicit link (NCSP 2001).

An analysis of the actual GEF project portfolio in the climate change focal area[53] shows that very few projects specifically address the linkages between biodiversity and carbon storage in ecosystems. At present only four projects address carbon sequestration (Benin "village based management of wood savannas & the establishment of woodlots for carbon sequestration", India "Optimizing development of small hydro resources in hilly areas", Iran "carbon sequestration in the desertified rangelands") (GEF 2001b). Under the climate change focal area several projects have been established at the global level

[53] For the analysis information on UNDP-GEF portfolio by focal areas (climate change) project descriptions from GEF homepage at http://www.undp.org/gef/portf/climate.htm were used (01.06.2001).

that contribute potentially to the objectives of both conventions. These are the projects on "global alternatives to slash and burn agriculture" which aim to reduce global warming, conserve biodiversity, and alleviate poverty in tropical forests and the "START Global Change Initiative" which will provide tools to assess the potential implications of climate change for the environment and resource management policies" (GEF 2001c)[54]. It seems to be a valuable approach to address key linkages between the Conventions in cross-regional projects to develop future strategies.

For the climate change focal area, GEF project implementation reports remark that forest projects have been finished but the analysis of project results only encompass projects in other sectors and do not mention the forest projects (GEF 1999). No information on evaluation of the global projects such as the "global alternatives to slash and burn agriculture" was found in the available GEF reports; therefore an analysis of their actual contribution to both conventions is not possible.

5.3.8.5 Conclusions and recommendations

GEF brings a number of advantages to the challenge of liking FCCC and CBD. As perhaps the largest provider of assistance for biodiversity and climate projects, GEF has considerable influence. There are several factors that provide GEF with opportunities to link thematic areas, governments, international organizations, and NGOs and with a facility to serve as a catalyst for increased coordination between biodiversity conservation and climate change:

- its relationship with both conventions
- its reliance on implementing agencies that are major development organizations with extensive relationships in recipient countries,
- its network of national focal points,
- and its governance structure.

GEF's operational programs stress the importance of taking a holistic approach and to integrate objectives of both conventions. These are all strengths that GEF should continue to promote and exploit strategically.

Besides these well-articulated strategies and programs, the actual project portfolio contains only very few projects that explicitly address the contributions and benefits of projects to both conventions. Therefore, at the implementation level, there is a considerably need to further promote an integrated approach and to communicate the results to both conventions.

The holistic approach is mainly addressed through one operational program out of twelve and it is essential that not only specific programs on cross-conventional issues are developed, but also that the possible synergies and conflicts are better integrated

54 For the analysis information on UNDP-GEF portfolio by focal areas (Global) project descriptions from GEF homepage at http://www.undp.org/gef/portf/global.htm were used (01.06.2001).

under each GEF operational program where such effects occur.

The operational program on forest ecosystems (operational program number 3 under the biodiversity focal area) should address inter-linkages in addition to the current focus on biodiversity issues and key indicators developed under the program should consider carbon sequestration effects and integrated approaches should be clearly encouraged.

The project portfolio could be improved and more projects should be included that specifically address the linkages between biodiversity and carbon storage in ecosystems, especially for forest conservation projects in the project portfolio.

GEF should continue to strongly support participation of affected stakeholders, including indigenous peoples, under for the biodiversity-related operational programs. The experiences gathered in GEF projects should be collected, summarized and made available for further guidance on land-use change and forestry projects under the KP.

Monitoring, the systematic collection of information of impacts on biodiversity and the establishment of baselines before the start of projects should be strengthened under the biodiversity focal area as the current lack of impact assessment of biodiversity projects is also a considerable barrier for consideration of biodiversity issues under the FCCC.

In the climate change focal area clearer linkages to biodiversity aspects should be included in the elaboration of adaptation strategies and programs.

The approach for global projects under the climate change focal area that address key underlying roots for forest degradation should continue as this seems to be more cost-efficient than many small individual projects.

The performance of project activities to combat land degradation, one of the areas where GEF tried to develop a problem-centred approach, is developing weaker than anticipated and a closer analysis and new strategies seem to be necessary in this cross-cutting area.

At present GEF's monitoring and evaluation of project activities focus also on biodiversity and climate change as separate areas and neither consider the linkages, nor elaborate recommendations with regard to a better integration of both issues into GEF projects. Since integrated approaches in the form of separate operational programs are relatively new, they are not yet reflected in available monitoring and evaluation reports. Further analysis should be conducted whether future project implementation reports are available.

5.4 General considerations and constraints for improved cooperation

Clear priorities under the CBD

For experts from areas other than biodiversity, it is difficult to clearly understand what type of biodiversity is seeked to sustain under the CBD, on what scale, and over what time period. The term "biodiversity" typically refers to ecosystem, species, or genetic diversity. Maintaining desired diversity at one level will have very different requirements than conserving it at another. Conservation priorities and indicators of success are different if one is trying to sustain the population of a specific species or if the aim is to sustain the ecological benefits contributed by that species within larger ecosystem processes (Smith and Martin 2000). This situation complicates the integration of biodiversity goals in the work under other conventions such as the FCCC.

Leadership from governments

Michael Zammit Cutajar, executive secretary of the FCCC, indicated at the 11th Global Biodiversity Forum in Buenos Aires that synergies do not happen naturally between conventions and that leadership is needed to bring the two conventions together (IUCN 1999). At the international level some NGOs and conservation organizations such as IUCN are pushing the work on synergies between the CBD and the FCCC and some international organisations are also performing considerable work on the linkages. But at the level of Parties to the conventions – who are mainly responsible for the decisions and recommendations – leadership to bring the two conventions together is lacking. National work on FCCC and CBD issues is split to different institutions or departments. Few cooperative or informing activities at the national level are reflected by few activities pushing for improved cooperation at the international level. Recent activities that tried to push the work on the linkages between CBD and the FCCC, such as the note from the president of the CBD on climate change and biological diversity (CBD 2000), were promoted from the bodies created under the conventions. Thus, initiative came from the secretariats and the UN administrations, but not from Parties. Leadership from Parties is strongly needed to improve the cooperation and to achieve an integrated approach.

Instruments needed at the international level

Previous chapters of the report have shown that many mitigation or adaptation activities under the FCCC and the KP have the potential to provide benefits or negative impacts on biodiversity and that in many cases the specific management options chosen as well as the area and regions considered will determine positive or negative effects. This also means that the influences with regard to synergies or conflicts between the two conventions are most apparent at the national level. The actual work under the CBD is at a rather general level and no recommendations or decisions have been taken favouring specific management options or management recommendations at the national level. In this regard at the level of implementation of land-use change and forestry activities, very specific guidance would be needed to avoid negative impacts, but guidance at such a level is not provided under the CBD. Due to this situation, the consideration of biodiversity aspects with the implementation of activities will mainly depend on the respective national rules and regulations related to the conservation of biodiversity. In many countries, typically there are weak constituencies for conservation within governments or more broadly in societies, and biodiversity conservation is given low priority in the face of more immediate pressures for increased consumption and generation of income from resource use (Smith and Martin 2000). In this regard, the international work should focus on principles, criteria and instruments that guide countries at the national level to implement coordinated approaches under the common objective of sustainable development.

Under the CBD it is acknowledged that the major factors that affect sustainability are the socio-economic and political root causes of biodiversity loss; and therefore a comprehensive, long-term, and adaptive approach is needed to conserve biodiversity sustainable. Both conventions do not directly address the major political and socio-economic root causes of common problems such as deforestation or unsustainable land use practices but have to deal with the consequences of socio-economic circumstances or unfavourable political situations. In this regard it has to be acknowledged that the conventions cannot provide more or better rules and guidance than those that the Parties to the Conventions are willing to accept and to implement.

More cooperation in the field of adaptation activities needed

For forest activities, potential negative impacts on biodiversity are intensively discussed. For adaptation measures potential negative impacts on biodiversity are rarely highlighted. The examples for possible adaptation activities show that a close cooperation between both conventions should also be established with the further development of adaptation strategies, frameworks and measures under the FCCC and the KP. In the past, few concrete activities have taken place, but this will change considerably with the implementation of the KP as additional funds for adaptation projects will be provided. Since activities under the KP are yet at a planning stage, the implementation of adaptation activities could be used as a new approach for cooperation between the two conventions to start early communication and integrated work instead of remedy mistakes after years of work on a single focus. This will require that cooperation efforts start soon.

6 Linkages between the FCCC and the different multinational forest processes under guidance of the UN forest process

Chapter 4 on the linkages between CBD and the FCCC already showed that forests play a key role in both conventions. In the previous section 5.3.6.5 it was already recommended that discussions on forest management across conventions has to include the work of other international fora, such as the Intergovernmental Panel on Forests of the Commission On Sustainable Development, the Intergovernmental Forum on Forests and existing regional recommendations on sustainable forest management, such as the Paneuropean Criteria and Indicators for Sustainable Forest Management. This chapter mainly focus on the work on criteria and indicators for sustainable forest management that have been developed in multilateral forest processes. Following a similar approach as in the previous chapter, the analysis is mainly performed from the point of view of the work under the multinational forest processes and evaluates whether and how this work could provide inputs to the FCCC, the KP and the CBD in order to enhance synergies and to avoid adverse impacts with regard to sustainable forest management.

6.1 Definition of terms

A criterion is a category of conditions or processes by which a certain goal may be described. It is characterized by a set of related indicators, which are monitored periodically to assess change. (top-down or deductive approach). Indicators are a measure (measurement) of an aspect of a certain criterion. And therefore indicators are *"a quantitative or qualitative variable which can be measured or described and which, when observed periodically, demonstrate trends."* (Montreal Process Working Group, 1998) (bottom-up or inductive approach). Indicators have been defined as quantitative measures, which imply a metric (i.e. distance from a goal, target, threshold, benchmark, etc.) against which some aspects of policy performance can be measured. The use of reference points (as targets or benchmarks) distinguishes indicators from statistics. In this way, indicators build a bridge between the fields of policy-making and science. Policy makers set the targets and measurable objectives, while scientists determine relevant variables of that measure compliance with targets.

6.2 The working process related to criteria and indicators for sustainable forest management in multilateral forest processes

Since the early 1980s citizens, policy makers and politicians all over the world have become increasingly interested in and concerned about forests and issues related to forests as for example deforestation, conservation, use of genetic resources and biological diversity, the contribution of forests to reduce global warming, international trade in forest products, the fate of indigenous forest dwellers, etc. This awareness process initiated several activities on international, national and regional scale. The following sections summarize the main activities and processes in a chronological way showing mutual influences and overlaps.

Most international and regional initiatives on criteria and indicators for sustainable forest management were initiated by the UN Conference on Environment and Development held in Rio de Janeiro in June 1992, although there have been processes prior to the Earth Summit like the ITTO Process.

6.2.1 The International Tropical Timber Organization (ITTO)

The International Tropical Timber Organization (ITTO) was first established by the International Tropical Timber Agreement (ITTA), 1983, which was negotiated with a limited life span under the auspices of United Nations Conference on Trade and Development (UNCTAD) and came into force in 1985. The Organization became operational in 1987. The ITTO is a commodity organization, which brings together countries, which produce and consume tropical timber to discuss and exchange information and develop policies on all aspects of the world tropical timber economy. At present, ITTO has 56 members, including the European Community, which together represent 90 percent of world trade in tropical timber and over 75 percent of the world's tropical forests (ITTO 2001a). In its mission statement the ITTO claims that a continuing supply of tropical timber on the world market depends on quality information about the trade and market place, on efficient timber production and processing methods and on sustainable forest management practices (ITTO 2001b). This led to the development of several guidelines for the practice of sustainable forest management. By 1992 four sets of operational guidelines for achieving sustainable forest management had been developed. The first set on the management of natural tropical forests dates from 1989. It was followed over the next couple of years by a set of guidelines for tropical forest plantations and a set for the conservation of biodiversity in tropical production forests. The fourth set, on prevention and management of fire in tropical forests was completed in early 1997. These guidelines were supplemented in 1992 by another achievement of ITTO, a set of criteria and indicators against which the standard of management and progress towards sustainability can be assessed. In 1998 ITTO prepared and published a document *("Criteria and Indicators for Sustainable Management of Natural Tropical Forests")*, to update the original criteria and indicators taking into account subsequent developments in this field.

6.2.2 The Ministerial Conference on the Protection of Forests in Europe (Helsinki Process)

The "Ministerial Conference on the Protection of Forests in Europe" (MCPFE) is a still ongoing initiative for co-operation between around 40 European countries to address common threats and opportunities related to forests and forestry. This process is structured by a chain of political level conferences (Ministerial Conferences) and mechanisms for the follow-up work like Expert Level Meetings, Round Table Meetings and Ad hoc Working Groups. Since 1990, when the first Ministerial Conference took place in Strasbourg, two further conferences (1993, second Ministerial Conference in Helsinki and 1998 third Ministerial Conference in Lisbon) designed the process till today.

Crucial for the development of criteria and indicators in this process was the Second Ministerial Conference 1993 in Helsinki, which named the whole process afterwards. With the intention to implement the forest related results of the United Nations Conference on Environment and Development (UNCED) thirty-seven states and the European Community signed four resolutions, and for the first time a common definition of Sustainable Forest Management (SFM):

"Sustainable management means the stewardship and use of forests and forest lands in such a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems." (Liaison Unit Vienna 2000)

Resolutions on "General Guidelines for the Sustainable Management of Forests in Europe", "General Guidelines for the Conservation of the Biodiversity of European Forests" and "Strategies for a Process of Long-term Adaptation of Forests in Europe to Climate Change" were adopted. 1998 followed a resolution on "Pan-European Criteria, Indicators and Operational Level Guidelines" and pan-European operational level guidelines were endorsed. The operational level guidelines are designed for sub-national application at a practical level and represent a common framework of recommendations for sustainable forest management that can be used on a voluntary basis.

6.2.3 The UN Forest Process initiated by the United Nations Conference on Environment and Development (UNCED)

These debates on forests initiated prior to the United Nations Conference on Environment and Development (UNCED) in June 1992 must be seen as one of the reasons for forests occupying a prominent position in the international deliberations at the Earth Summit. The possibility to design a common framework for international forest policy and to develop mechanisms to implement such policy was discussed prior to and during the Summit. Although delegates could not agree on such a framework, two results of this conference were dedicated entirely to forests namely Chapter 11 "Combating Deforestation" of Agenda 21 and the "Non-legally binding authoritative statement of principles for a global consensus on the management, conservation and sustainable development of all types of forests". The Chapter 11 of Agenda 21 calls for the formulation of scientifically sound criteria and guidelines for the management, conservation and sustainable development of all types of forests.

This was the starting point for the establishment of special interagency arrangements for cooperation on forests and forestry related issues by UN agencies as well as for the engagement of different governments in a series of national, bi-lateral and multilateral initiatives. Subsequent to the UNCED the Commission on Sustainable Development (CSD) was created in December 1992 to ensure an effective follow-up process of the Earth Summit and to monitor and report on implementation of the agreements at the local, national, regional and international levels.

In its third session the CSD decided to establish an open-ended ad hoc Intergovernmental Panel on Forests (IPF) to pursue consensus and formulation of coordinated proposals for action. The issue of criteria and indicators for sustainable forest management was one of the main priorities in the work of the IPF. The Panel's Programme of Work was expected to be completed within its two-year mandate in a limited time frame, as it had to submit a progress report to the CSD in 1996 and a final report to the Fifth Session of the CSD in 1997. The Panel presented about 150 negotiated proposals and delegates could not agree on a few major issues, including financial assistance and trade-related matters, or whether to begin negotiations on a global forest convention (IISD 2001). Therefore the UN General Assembly at its Special Session to Review and Appraise the Implementation of Agenda 21 (Earth Summit+5), decided to continue the intergovernmental policy dialogue on forests through the establishment of an ad hoc open-ended Intergovernmental Forum on Forests (IFF), again under the aegis of the CSD. In addition, the General Assembly decided, *"the Forum should also identify the possible elements of and work towards consensus on international arrangements and mechanisms, for example, a legally-binding instrument."* The Economic and Social Council (ECOSOC), by its resolution 1997/65, established the IFF. From October 1997 to February 2000 the IFF met four times producing about 120 conclusions and proposals for action, which have been submitted to the eighth session of the CSD held in April 2000.

All UN initiatives related to forests have the common aim to provide guidance to the international community of states concerning their research of criteria and indicators for sustainable forest management. Thus the UN-related process must be seen as a kind of a "backbone" for the other multinational processes although not having developed any specific criteria and indicators.

6.2.4 The Montreal Process

Following UNCED, Canada convened an International Seminar of Experts on Sustainable Development of Boreal and Temperate Forests. This seminar, held in Montreal in 1993 focused specifically on criteria and indicators and how they can help define and measure progress towards sustainable development of forests. The European countries elected to work as a region in the Pan-European Forest Process in the follow-up to the Ministerial Conferences on the Protection of Forests in Europe (MCPFE, later named Helsinki Process, see above). Subsequently, an initiative was launched among non-European temperate and boreal countries to develop and implement internationally agreed criteria and indicators for sustainable forest management. The Montreal Process began in June 1994, in Geneva, with the first meeting of the Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. The member countries[55] come from five of the seven continents and together represent about 90 per cent of the world's temperate and boreal forests, as well

[55] Argentina, Republic of Korea, Australia, Mexico, Canada, New Zealand, Chile, Russian Federation, China, United States of America, Japan and Uruguay

as areas of tropical forests, and 60 per cent of the world's forests. In 1995 the Montreal Process countries issued a declaration containing a set of seven national-level criteria and 67 indicators to guide policymakers, forest managers and the general public in the conservation and sustainable management of temperate and boreal forests. The Santiago Declaration is an important step towards implementing the sustainable forest management principles agreed to in Rio.

6.2.5 Other processes related to the development of criteria and indicators for sustainable forest management

6.2.5.1 The Tarapoto Proposal: Criteria and Indicators for the Sustainability of the Amazonian Forest

The "Regional Workshop on the Definition of Criteria and Indicators for Sustainability of Amazonian Forests" was held in Tarapoto, Peru, February 23-25, 1995. Representatives of the Amazonian Cooperation Treaty Member Countries (Bolivia, Brazil, Colombia, Peru, Suriname and Venezuela), FAO and UNDP attended the meeting. It resulted in the Proposal of Sustainability Criteria and Indicators for the Amazon Forests (also known as the "Tarapoto Proposal"). The twelve criteria and 77 associated indicators adopted were grouped in three categories: national level, management unit level and global services level.

6.2.5.2 The Central American Process

The "Expert Meeting on Criteria and Indicators for Sustainable Forest Management in Central America" was held in Tegucigalpa, Honduras, January 20-24, 1997. The meeting was attended by representatives of Central American countries (Belize, Costa Rica, Cuba, El Salvador, Guatemala, Honduras, Nicaragua, Panama), as well as the organizers (FAO, Central American Commission on Environment and Development (CCAD), Consejo Centroamericano de Bosques y Areas Protegidas (CCAB - AP)) and other interested organizations. The meeting resulted in 4 criteria and 40 indicators at the regional level, and 8 criteria and 52 indicators at the national level. Following the Expert Meeting, two sub-regional meetings later defined 5 criteria and 50 indicators at the forest management unit level.

6.2.5.3 Criteria and Indicators for Sustainable Forest Management in Dry-zone Africa

An Expert Meeting on Criteria and Indicators for Sustainable Forest Management in Dry Zone Africa was jointly organized by UNEP and FAO in Nairobi, Kenya, November 21-24, 1995. Fourteen experts from dry-zone African countries presently not involved in any international initiative and eight observers from ongoing processes and from NGOs (IUCN, Ecoterra) participated. The outcome of the meeting was reported to the 10th session of the African Forestry and Wildlife Commission (one of six regional forestry commissions of the FAO) held in South Africa November 27-1 December,

1995. The Commission commended the work carried out, endorsed the report of the Nairobi Expert Meeting, and recognized the need to further develop, improve and adapt the criteria and indicators.

6.2.5.4 Criteria and Indicators for Sustainable Forest Management in the near East

An Expert Meeting on Criteria and Indicators for Sustainable Forest Management in the Near East was jointly organized by FAO and UNEP in Cairo, Egypt, October 15-17, 1996. Seventeen participants (14 experts and 3 observers) were invited according to their specialized knowledge. Observers included representatives from the Arab Centre for Studies of Arid Zones and Drylands (ACSAD) and the Arab Organization for Agricultural Development (AOAD). The outcome of the meeting was reported to the 12th Session of the Near East Forestry Commission, which endorsed the recommendations of the Expert Meeting in principle, and made several follow-up recommendations. In response to some of these recommendations, FAO organized a workshop of the national Focal Points on criteria and indicators for sustainable forest management in Cairo, Egypt, in July 1997, in which the issue was further discussed and some progress was made towards implementation at the country level.

6.2.5.5 Initiatives of the African Timber Organization (ATO) on Criteria and Indicators for Sustainable Forest Management

Similar to other regional initiatives, the African Timber Organization (ATO) identified its own criteria and indicators for sustainable forest management in its 13 timber producing member countries and for building a unique scheme of certification for African wood products at the regional level. After several consultation missions, studies and round table expert meetings on the subject, ATO, in conjunction with CIFOR, has undertaken a field test of criteria and indicators in Côte d'Ivoire in 1995. Based on the results of all the studies and the test, a preliminary draft set of five principles, two sub-principles, 28 criteria and 60 indicators were recently issued by ATO after endorsement by its last Ministerial Conference in Angola in May 1996. Therefore ATO criteria and indicators may be used as a scientific tool for classifying, qualifying and certifying the degree of management in any given forest area. Next steps of the so called "green label" initiative include the refining of these principles, criteria and indicators through complementary tests in some other ATO countries and discussions with all the stakeholders, as well as the design of a broadly accepted certification scheme.

6.2.6 Summary of forest related processes

Table 22 gives an overview about the amount of forested area in the different ecological regions and number of countries included by the Helsinki- and the Montreal Process concerning temperate and boreal forests, the ITTO and the Tarapoto initiatives for tropical regions and the UNEP/FAO Dry-Zone Africa initiative[56].

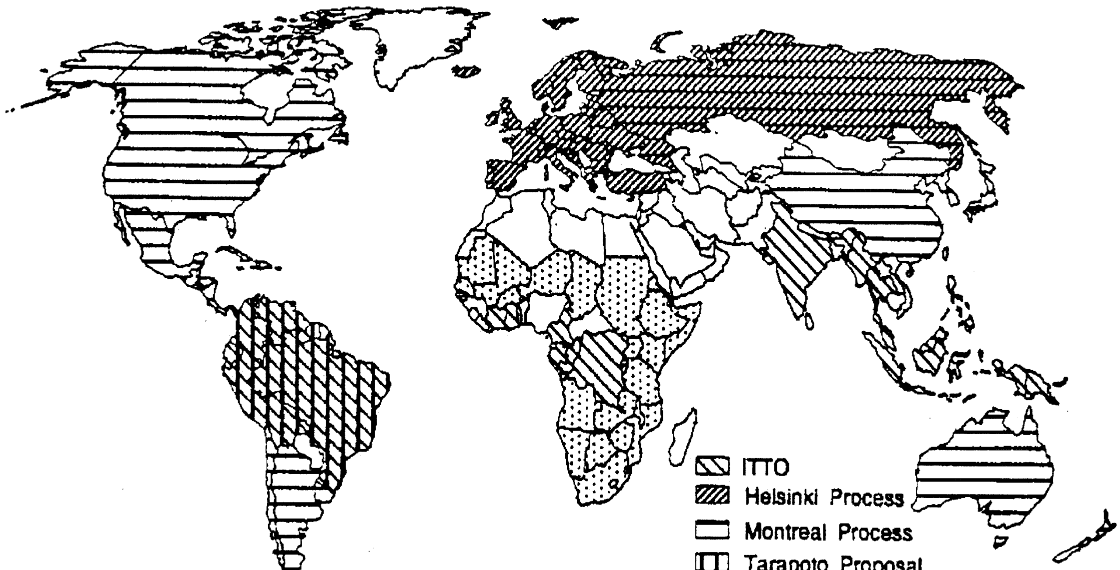
Table 22 Number of countries and amount of forested area in different ecological regions covered by different work processes on criteria and indicators

Ecological Region	Initiative	Number of countries involved	Forested Area - 1000 ha -
Temperate and Boreal Forests	Helsinki-Process	38	904,577
	Montreal-Process	12	1,500,000
Tropical Forests	ITTO Initiative (only wood producing countries)	25	1,305,046
	Tarapoto-Process	8	540,000
Forests in the Dry-Zone	Dry-Zone Africa Initiative	27	278,021

Source: Schneider (1997)

Figure 15 visualizes the figures presented in Table 22 above on a global map.

Figure 15 Share of surface area of regional and national initiatives developing criteria and indicators for sustainable forest management



Source: Ministry of Agriculture and Forestry / Finland (1996)

56 Data and figures for the Central American Process and the Expert Meeting on Criteria and Indicators for Sustainable Forest Management in the Near East jointly organized by FAO and UNEP have not been available.

The crucial aspect concerning the use of criteria and indicators developed in multilateral forest processes for purposes under the FCCC is the geographical scope (global, regional, national) and the implementation level (from generic principles to individual level of a forest management unit) they address. As already mentioned in previous chapters, conflicts between biodiversity and activities under the FCCC and the KP mainly arise at the implementation level with regard to the specific area and specific management options. Thus, the main challenge is to bring down the internationally developed and agreed criteria and indicators to a level on which implementation becomes feasible. Therefore many countries have developed or are in the development process of National Forest Programmes that focus on implementation of criteria and indicators for sustainable forest management on a national level. However, crucial for the assessment of sustainability aspects of certain management methods or forest-related projects remains the existence of a criteria and indicators catalogue on the scale of the forest management unit (FMU). Tangible investigations whether management methods are in compliance with sustainability goals are feasible only on this scale. Table 23 provides an overview which multilateral processes address this level of implementation in their work on forest criteria and indicators. Unfortunately many processes do not address the level of forest management, but remain at a rather general level.

Table 23 Summary of ongoing international processes on criteria and indicators for sustainable forest management and the implementation level they are addressing

Process	Number of Criteria	Number of Indicators	Level of Implementation	Forest Type
Helsinki	6	27	Regional and National Level Operational Guidelines on Forest management unit	Boreal and Temperate
Montreal	7	67	National Level	Boreal and Temperate
Tarapoto	1 7 4	7 47 22	Global Level National Level Forest management unit Level	Amazon Forests
Dry-Zone Africa	7	47	National Level	Sub-Sahara Forests and Highland Forests
Near-East	7	65	National Level	Dry-Forests
Central America	4 8	40 42	Regional Level National Level	All Types of Forests
ATO	26	60	Regional /National Level	Congo Basin Forests

Source: FAO / UNEP 1999

6.3 Analysis of the different criteria and indicators catalogues

The following sections compile and describe some of the existing criteria and indicators catalogues. They focus on the analysis of the Montreal and Helsinki criteria and indicators as these two processes have been the first multinational efforts. The later developed catalogues show a multitude of similarities.

Every catalogue lists quantitative, qualitative or descriptive indicators that – when periodically measured and monitored – show the direction of change. In most cases, quantitative and qualitative indicators provide information mainly on the conditions and functions of forests, and on the values or benefits associated with the goods and services that forests provide. Descriptive indicators generally provide necessary information on existence of forest policy instruments, and the extent to which they support and enhance the achievement of sustainable forest management (ISCI 1996).

The criteria developed under different initiatives are rather similar but the structure of the (criterion) sets varies. Every set addresses the topics policy framework, maintenance of productive capacity of forest ecosystems, ecosystem health and vitality, biological diversity, protective functions (mainly soil and water) and socio-economic functions and conditions. Due to the period of origin in which the discussions on carbon storage and the role of forest ecosystems for the global carbon cycle have not yet been intensively discussed, the ITTO initiative does not separately mention this topic in contrast to the other catalogues.

Significant differences exist concerning the lists of indicators not only because of the different geographical scope but also because of the two different approaches of the Pan-European and the Montreal Process.

The choice of indicators under the Pan-European Process was made with the following aims:

- scientifically verified
- technical practicable
- financial feasible

Data for all indicators should be available from existing statistics and/or monitoring systems (forest inventories and other existing forest-related data systems) and ad hoc to ascertain.

The Montreal Process supports in contrast a holistic approach ("Management of the Ecosystem of Forests"). The choice of indicators was made under the aspect of which kind of data is scientific desirable. 27 out of 47 quantifiable aspects of indicators (57 %) are characterised as *"those which may require the gathering of new or additional data and/or a new program of systematic sampling or basic research"* (Montreal Process Working Group 1998). For another 17 % of the aspects it is considered to be useful to collect additional data to the existing statistics. US scientists estimate the period for the first scientifically sound data set available to be 10 – 15 years (Schneider 1995). For a near-term use this approach seems not to be appropriate.

It is not surprising that even with the measurement of the Pan-European indicators (although not following such an "ambitious" approach as the Montreal Process) the member states had "considerable problems" because only 42 % of the Montreal indicators could have been measured without any serious problems whereas 40 % caused considerable problems as pre-tests have found (Schneider et al. 1996). These comments could give a first hint concerning the technical challenges whether existing criteria and indicators should be applied to assess the sustainability of certain management methods or forest-related projects on the scale of the forest management unit.

6.4 Linkages of criteria and indicators to carbon storage function

The Montreal catalogue of criteria and indicators only provides one single criterion that is related to carbon storage (Criterion 5: Maintenance of forest contribution to global carbon cycles). The same occurs in the Pan-European Process (Criterion 1: Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles) as well as in the both UNEP / FAO initiatives in Dry-Zone Africa and the Near East (Criterion 1: Maintenance of forest resources, including their contribution to global carbon cycles). In the ITTO initiative no such criterion can be found.

With regard to indicators related to carbon storage, the UNEP/ FAO initiative (for sustainable forest management in Dry-Zone Africa) presents two indicators concerning "total areas of forests, plantations and other wooded lands and their changes over time" and simply "biomass (and its changes over time)" (UNEP/FAO 2000). While measurement of the first criterion is rather clear, no further guidance is provided with regard to the estimation of the practicalities of biomass changes addressed (which could be of use for discussions on accounting and estimation under the KP).

The Pan-European Process divides the criterion related to carbon cycles into four concept areas. A characteristic feature of the Pan-European Process is the existence of descriptive indicators under every criterion and therefore as well under every concept area, as a subdivision of a criterion. These descriptive indicators establish the political framework for the implementation of the aims formulated by a criterion. Three such indicators can be found dealing with the following topics:

- Concept area land use and forest area: Area of forest and other wooded land and changes in area (classified, if appropriate, according to forest and vegetation type, ownership structure, age structure, origin of forest)
- Concept area growing stock: Changes in: a. total volume of the growing stock, b. mean volume of the growing stock on forest land (classified, if appropriate, according to different vegetation zones or site classes), c. age structure or appropriate diameter distribution classes
- Concept area carbon balance: Total carbon storage and, changes in the storage in forest stands

Under the Montreal process the following indicators were developed for criterion 5 (Maintenance of forest contribution to global carbon cycles):

- Total forest ecosystem biomass and carbon pool, and if appropriate, by forest type, age class, and successional stages
- Contribution of forest ecosystems to the total global carbon budget, including absorption and release of carbon (standing biomass, coarse woody debris, peat and soil carbon)
- Contribution of forest products to the global carbon budget

The comparison shows that the Montreal indicators are much closer to full carbon accounting approaches as discussed under the KP, which means a more complete accounting of all ecosystem compartments. Positive is also the description of the carbon pools that should be assessed. However, the Montreal Process Working Group itself defines the first as well as the third indicator as in the category of indicators that may require the gathering of new or additional data and / or a program of systematic sampling or basic research. Only the second indicator is in the category of indicators "for which most data are available" (Montreal Process Working Group 1998).

A fundamental problem with the use of indicators from multilateral forest processes to resolve problems or conflicts under the KP is the different focus of the criteria and indicators catalogues. The essential idea of the development of criteria and indicators catalogues was not the aim to provide tools for a problem resolution in a special case and under specific circumstances of the KP. Therefore it is not a surprising fact that often criteria and indicators catalogues do not address the detailed implementation level at which conflicts occur and which would be necessary to resolve the discussed problems.

6.5 Biodiversity aspects

Aspects of biodiversity are the subject of a separate criterion in each criteria and indicator catalogue. Following the definition of Norse et al. (1996) who state that the assessment of biodiversity "includes diversity within species, between species and of ecosystems" (Norse et al.1996) the different criteria and indicators catalogues divide the presented indicators into three levels of ecosystem, species and genetic diversity-related indicators; with that they follow as well a suggestion of the SBSTTA of the CBD.[57] The same document accuses the scope of the ongoing criteria and indicators processes *"to be too wide for the purposes of the CBD because their focus is much wider than biodiversity"* and continues *"We also find their consideration of forest biodiversity to be too general, and their application of forest biological diversity criteria and indicators to be at an inappropriate scale."*[58].

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[57] UNEP/CBD/SBSTTA/3/Inf.5, p.22

[58] UNEP/CBD/SBSTTA/3/Inf.5, p.20

The problem of the inappropriate scale refers to the fact that the presented processes formulate almost exclusively criteria and indicators at the national level while *"regional forest types and socio-political systems vary so much that lack of agreement and applicability is not surprising"*[59]. Further consideration of the types of indicators suggested by the SBSTTA[60] reveals that their scope under the CBD demands much more detailed biodiversity information than the particular indicators under the biodiversity-related criteria of the different forest processes are able to provide.

6.6 Conclusions and recommendations

As shown in section 6.3, the different catalogues address different levels of implementation. Most of the catalogues address regional (equivalent to multinational) or national levels. Only a few processes have already developed criteria and indicators or guidelines at the level of forest management. Examples are the Pan-European Operational Level Guidelines for Sustainable Forest Management or the criteria and indicators of the Tarapoto Proposal (ATC 2001). However, any negative impacts and trade –offs of forest-related management practises discussed under Articles 3.3/3.4 of the KP may only be measured by the consideration of "specific characteristics of the case concerned" (e.g. a specific forestry project or a specific management option) and the existing criteria and indicators do not provide for a clear framework that prevents adverse impacts in all cases.

Another problem is the fact that the development of criteria and indicators needs to be accompanied by certain standards, quantitative limits and thresholds that provide guidance for decision-makers. Only the existence of such standards allows identifying whether a certain trend, monitored by the periodical assessment of certain indicators under a criterion, should be valued as a positive or negative fact. Standards must be regionally adapted because of different characteristics of ecosystems. Such standards do not exist for the different multilateral processes. Therefore it remains doubtful how the guidance and trends that are measured with the indicators will be used for decision-making.

Despite the considerable work that was already performed in relation to sustainable forest management in these processes, the major problem for the use of this work under the FCCC is the lack of international agreement on a specific set of rules, criteria and indicators for sustainable forest management, which is shown by the multitude of forest-related processes.

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59 UNEP/CBD/SBSTTA/3/Inf.5, p.21

60 Types of indicators, UNEP/CBD/SBSTTA/3/Inf.5, p. 22

7 Linkages between the Ramsar Convention and the United Nations Framework Convention on Climate Change

7.1 Background

The Ramsar Convention (RC) was adopted in the Iranian city of Ramsar in 1971, and came into force in 1975. Until of 14 September 2000, 122 Parties ratified the Convention and many others were willing to join. The Convention's mission is *"the conservation and wise use of wetlands by national action and international co-operation as a means to achieving sustainable development throughout the world"*[61]. Ramsar is the only global environmental treaty dealing with a particular ecosystem.

Under the Ramsar Convention *"wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"*[62]. According to the Ramsar Convention wetlands have fundamental ecological functions. They regulate water regimes and house a rich biodiversity. Therefore they constitute a resource of great economic, cultural, scientific and recreational value that is worth to be maintained. For the conservation of wetland areas the Convention lays down a "wise use". Wise use is defined as *"sustainable utilisation for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem"* – sustainable utilisation is understood as *"human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations"*. 'Wise use' may also require strict protection[63].

7.2 Functional synergies and conflicts

As shown in the former chapters, land use change activities in natural boreal or tropical wetlands present considerable additional sources of greenhouse gas emissions compared with natural wetlands.

The level of the impact on climate change depends on the conversion form: agricultural use causes a higher additional greenhouse effect than the drainage of wetlands. In total, carbon emissions from wetland conversion to agricultural land is estimated to range between 0.05 and 0.11 Gt C per year (Bergkamp and Orlando 1999). Because of the high relevance of wetlands as carbon stocks and because of CH_4 emissions, the protection and the wise use of these biota can make a considerable contribution to the activities to prevent climate change and for the protection of ecosystem diversity. Therefore the key activity that is most beneficial under both conventions is the conservation and protection of existing wetlands.

61 www.ramsar.org/; 6.8.2000

62 www.ramsar.org/; 6.8.2000

63 www.ramsar.org/; 6.8.2000

With regard to direct human interventions or management options, restoration of wetlands that have formerly been drained for agricultural or other purposes is another area where mutual synergies exist. However, inundation of such lands could also bear the potential of increased methane and N_2O emissions. In coastal wetlands, carbon storage will dominate over methane emissions (Bergkamp and Orlando 1999). Restoration of wetlands can lead to increases in biodiversity and are often carried out with the specific aim of biodiversity conservation. However, there are large uncertainties associated with the possible impacts of restoration on climate-relevant processes and the biodiversity impacts also remain unclear (IPCC 2000).

In recent years significant areas of peatlands were damaged by fires[64], which contributed considerably to atmospheric greenhouse gas emissions. The promotion of management and prevention of peatland fires would be beneficial under both conventions.

The predicted changes in global climate due to greenhouse gases will also affect the different types of wetlands' ecosystems. It is understood that the benefits and services wetlands provide degrade by climate change effects such as increases in temperature, sea level rise, and changes in precipitation. The real effects depend on various aspects, such as how much will sea-level rise, how the temperature will increases and as well which possibilities exist for wetland ecosystems (mainly for the species) to migrate to alternative areas. The real losses in wetland functions could not be predicted at the moment (Bergkamp and Orlando 1999). Wetlands lag behind other ecosystems in being adequately modelled and are often excluded from global models of the effects from climate change (Parish and Looi 2000).

In the area of adaptation to climate change, there are potentials for synergies as well as for conflicts between both conventions: For flood protection, the rehabilitation and restoration of natural wetlands is recommended which would provide mutual benefits under both Conventions. Potential conflicts between objectives of the RC and objectives under the UNFCC could arise from adaptation activities to sea level rise in coastal zones, especially from so-called "hard" adaptation technologies such as

- the construction of dikes, levees and floodwalls, floodgates and tidal barriers,
- the prevention of saltwater intrusion in coastal estuaries and groundwater aquifers using barriers,
- the alteration of discharge of rivers to keep the salt wedge at the river mouth in dynamic equilibrium,
- the artificial movement of freshwater inlets further upstream.

Such "hard" adaptation technologies have the potential to significantly alter the natural conditions of coastal zones estuaries or rivers, which will impact and change the wetlands in such areas.

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64 In 1997/1998 1.5 million ha were burnt mainly in Indonesia but also in parts of Malaysia, Thailand and Brunei which released more than 700 million tonnes of CO_2 (Parish and Looi 2000)

7.3 Interfaces at the Convention level

7.3.1 Process under the RC

The concept of "wise use" of wetlands - addressed in Article 3.1 of the RC – has a central importance not only for the RC itself but also for the linkage to the FCCC. As shown in section 7.1, wise use is defined as *"sustainable utilisation for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem"*. Sustainable utilisation means *"human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations"*. To fulfil the objectives of the "wise use concept", many actions concerning wetlands are necessary. The RC has yet adopted or will adopt activities to implement this concept. But it has also taken into account that some of the activities that are discussed under the FCCC will have consequences for the RC objectives.

Within the discussions of the RC, synergies between the two conventions are clearly acknowledged: The necessity to improve the connections to the FCCC is emphasised in the Ramsar Strategic Plan (1999 – 2002)[65]. At the Ramsar Conventions' COP 7 in Costa Rica in 1999 three decisions were taken concerning the interactions to the FCCC that are

- To welcome *"the actions proposed by the Ramsar Bureau [...] to open dialogue with the secretariat of the United Nations Framework Convention on Climate Change to progress future co-operation"* (Resolution VII.4, 7).
- To request *" the Ramsar Bureau to give priority in its programme of work for the next triennium, as resources allow, [...] the development of a Memorandum of Co-operation with the FCCC"* (Resolution VII.4, 13.).
- To highlight the awareness *"of the need to include all wetland carbon sinks and sequestration initiatives as key issues in the global discussion concerning the Kyoto Protocol under the FCCC"* (Recommendation 7.1, 5.).

In the Work Plan 1999 – 2002 of the Scientific Technical Review Panel (STRP) of the RC, it is stated, that the STRP will prepare for consideration at COP 8[66] a comprehensive review of the potential impacts of climate change on wetlands and the roles that wetlands can potentially play in mitigating the effects of climate change and sea level rise[67]. Therefore at the 8th meeting of the STRP 1999 in Gland (Switzerland) a

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65 The Ramsar Strategic Plan 1997 – 2002 was accepted at the 6th Conference of Parties (COP 6) 1996 in Brisbane.

66 COP 8 is scheduled for 18 – 26/11/2002, Valencia, Spain

67 Scientific Technical Review Panel Work plan 1999 – 2002; refer to Convention Work Plan 2000-2002, Action 5.1.6 annexed to Resolution VII.27

paper tabled by the IUCN[68] was recognized by the panel as the centrepiece of Ramsar's way forward. The Bureau considered this issue to be of very high priority. The IUCN paper summarises the state of knowledge on relationships between wetlands and climate change, analyses the documentation of both conventions, and suggests ways to establish links between the two conventions at the secretariat, subsidiary bodies, and national levels. Three broad themes of common interest are identified:

- The predicting and monitoring of the impacts of climate change on wetland areas;
- the role of wetlands in adapting to, and mitigating the impacts of, climate change; and;
- the role of wetlands, notably peatlands and forested wetlands, in reducing greenhouse gas emissions" (Blasco 2000).

The paper on "Climate Change and the Ramsar Convention" was distributed to the 5th Conference of Parties of the UNFCCC in November 1999. The STRP will consider the task of reviewing climate change impacts on wetlands at COP 8, as well as ways in which wetlands can mitigate climate change and sea level rise. At the 9th meeting of the STRP, it was reaffirmed that linkages between the RC and the FCCC are important, but that they are proceeding slowly. The objective was expressed to formally establish cooperation with FCCC at its COP 7 in 2001. The 9th STPR took the following decisions concerning the further work on wetlands and climate change (decision STRP 9.11):

- A Working Group on Climate Change and the Ramsar Convention will be established;
- The Bureau was requested to work with IUCN and the other members of the new Working Group to develop a project that would provide guidance on climate change and wetlands for COP 8;
- The Working Group on Ecological Character was invited to provide a report on the use of risk assessment in relation to climate change for inclusion in the COP guidance on climate change;
- The 11th SBSTA under the FCCC requested to the Climate Change secretariat *"to liase with the secretariat of the Convention on Wetlands on the specific issues identified in the oral report delivered by the representative of that secretariat in order to determine how co-operation between the conventions could be strengthened"*. A joint FCCC/Ramsar workshop was requested to address how Ramsar can assist the FCCC Parties and to move toward greater collaboration between the secretariats.

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68 Bergkamp, G.; Orlando, B.: Wetlands and Climate Change. Exploring collaboration between the Convention on Wetlands (Ramsar, Iran 1971) and the UN Framework Convention on Climate Change; October 1999

7.3.2 Process under the FCCC

The main connecting points to the RC addressed by the FCCC and the Kyoto Protocol are

- the decisions on the accounting of land use, land use change and forestry activities under the KP (Articles 3.3 and 3.4) and the commitments to protect and enhance greenhouse gas sinks (Articles 4.1(b),(d) (commitments of Annex I Parties) and Article 4.2(a) (commitments of all Parties) of the FCCC,
- the decisions on the project based activities joint implementation and the Clean Development Mechanisms, (Articles 6 and 12 of the Kyoto Protocol) as they will imply concrete mitigation and sequestration projects,
- the cooperation in preparing for adaptation to the impacts of climate change (Article 4.1.e FCCC) and the actions including technology transfer and funding to minimise the adverse effects of climate change in developing country Parties (Articles 4.8 and 4.9 of the FCCC) as well as Article 12.8 (adaptation fund) of the KP.

At the FCCC's 12th session of subsidiary bodies the Deputy Secretary General and at the FCCC's COP 6 the Secretary General of the Ramsar Convention emphasized, that *"Ramsar as a Convention believes that establishing increasingly direct working relationships between UNFCCC's SBSTA and the IPCC with Ramsar's STRP, and linking this with related joint work with the Convention on Biological Diversity, would greatly assist such work on topics of common interest"* (Blasco 2000; Davidson 2000).

Under the FCCC exists only one recommendation concerning the closer co-operation between the two conventions[69]. Decisions, comparable to those under the Ramsar Convention, are still lacking in the FCCC process. No official documents under the FCCC exist so far that address cooperating activities with the RC related to the areas addressed in section 7.2. Thus, under the FCCC the work on the synergies between the two conventions should be strengthened because wetlands and of course the protection and/or wise use of these ecosystems will provide a great benefit to prevent adverse effects of climate change. So there has to be an interest in the FCCC to define concepts for the use and protection of wetlands and to implement them in both conventions to ensure that the activities will be translated into action.

The restoration or conservation of wetlands could be considered for accreditation under the KP (e.g. under Article 3.4 (additional activities in land-use, land-use change and forestry) or as JI or CDM projects. The discussion under the KP on the accounting of land-use, land-use change and forestry activities mainly focus on forest ecosystems and wetlands are not well discussed. However, the Bonn agreement from the resumed session of COP 6 (FCCC) and the decision text on land-use, land-use change and forestry activities excluded the mere presence of carbon stocks from accounting and

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[69] FCCC/SBSTA/1999/14: Report of the Subsidiary Body for Scientific and Technological Advice on its eleventh session, Bonn 25 October – 5 November 1999

only included forest management, cropland management, grazing land management and revegetation under the eligible activities under Article 3.4.[70] Restoration of wetlands could be included under the definition of revegetation[71] but the accounting of wetland conservation seems to be excluded. More important, the destruction of wetlands with considerable contributions to greenhouse gas emissions and biodiversity loss, is clearly not covered by the categories in the LULUCF decision text as no opposite categories to revegetation, such as devegetation, is included at present but the decision includes a request to IPCC to start methodological work on devegetation activities[72]. Thus, one of the major threats acknowledged under the RC is presently not taken into account with its implications on greenhouse gas emissions.

Prevention or management of peatland fires also seem to be excluded from accounting under the KP as these activities are not covered by the COP 6.5 decision text[73] on land-use change and forestry and activities for fire prevention or management will not fit to any of the categories of eligible activities.

The Bonn agreement limits the eligibility of land-use, land-use change and forestry projects under the CDM to afforestation and deforestation activities and therefore also excludes project activities such as restoration of wetlands or fire management for peatlands[74].

Adaptation strategies and measures will play a more dominant role in the future together with the adaptation fund that will be established according to decisions from the resumed session of COP 6 under the FCCC. At present no cooperative activities e.g. for coastal zones or estuaries have been developed with the RC. In the area of adaptation to climate change, close linkages to the RC should be established as soon as the work under the FCCC and the KP will start to address the implementation of adaptation activities. IPCC also recommends incorporating options for coastal management with policies in other areas such as land-use plans.

Section 7.2 concluded that the implications of climate change on wetlands at present are not well understood and that related research on wetlands lags behind other ecosystems. Therefore there is a need for enhanced cooperation in the area of research and systematic observation to close this gap. The impacts of climate change on wetlands and coastal ecosystems is addressed in IPCC's third assessment report (IPCC 2001b), thus existing research activities on this topic have been included in the scientific work under the FCCC. Since the IPCC is only able to summarize existing research results, any

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70 FCCC/CP/2001/L.11/Rev.1

71 Decision provides the following definition : Revegetation is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definition of afforestation and reforestation.

72 FCCC/CP/2001/L.11/Rev.1

73 FCCC/CP/2001/L.7

74 FCCC/CP/2001/2/Add.2, p. 14, paragraph 8

further developments in this area will depend on the national research priorities of countries.

Besides the mutual wishes and support for cooperation, concrete and specific cooperative activities are still lacking under both conventions at present. Future discussions should focus more on the implementation level and concrete cooperating activities and thematic areas. Especially in the area of coastal adaptation, there seems to be an urgent need for mutual cooperation between the two conventions in the development of activities under the FCCC and the Kyoto Protocol.

7.4 Recommendations

The initial process of closer co-operation between the two conventions should be intensified, because well co-ordinated provisions under both conventions can have a positive impact on both conventions' objectives.

The Ramsar Convention Process should integrate the objective of carbon storage in the objectives for protection and wise use of natural wetlands because of the immense capacity of carbon storage in the wetlands' soils and biomass. Existing attempts for closer cooperation with FCCC should continue and should be strengthened especially with regard to the areas addressed in the previous section.

Under the FCCC it is recommended to integrate the following issues in the FCCC process:

- The Ramsar principle of protection and wise use of natural wetlands should be acknowledged under FCCC process for any mitigation or adaptation activities;
- The process under the FCCC should seek to integrate the Ramsar's list of wetlands with global importance and the vision of the Ramsar list[75] in the recommendations relating to mitigation and adaptation activities. The list could for example be used in the certification process of CDM activities to avoid that land project activities take place in protected areas under the RC.
- The FCCC should closely cooperate with the RC in the future development of work on adaptation strategies and activities.
- Despite their large potentials, mitigation activities related to wetlands such as wetland restoration or prevention of peatland fires should receive more attention in the work on the implementation of mitigation activities under the FCCC.
- Funding institutions responsible for the future adaptation[76] fund should closely cooperate with institutions of the RC in the design of adaptation frameworks and activities.

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75 Vision of the Ramsar list: "To develop and maintain an international network of wetlands which are important for the conservation of global biological diversity and for sustaining human life through the ecological and hydrological functions they perform."

76 Currently it is proposed that GEF will be the financial institution managing the adaptation fund.

- Future research and assessment activities should continue to provide information on climate change impacts on wetlands.

In relation to both conventions,

- the linkages between the conventions should be further analysed and documented at different levels (e.g. global and national) including the assessment of any perverse incentives and conflicts created under the provisions of the FCCC which may lead to further degradation and losses of wetlands,
- the dialogue between the respective convention secretariats should be enhanced to identify and implement mechanisms for enhanced cooperation and information exchange.

8 Legal aspects

The analysis of linkages and interfaces between conventions also raises the question with regard to the legal form and legal procedures that are necessary for provisions that should be applicable to several conventions. The general problem is that the lists of ratifying Parties are not identical. For example up to now, the 122 Parties (14 September 2000) have ratified the Ramsar Convention whereas 184 Parties have ratified the FCCC (as of 25 May 2000). A Convention or a Protocol is only binding to those Parties that have ratified; this also applies to any instruments implemented under a convention.

In general, there are two ways to implement provisions from one convention in another: On the one hand, references and quotations of relevant parts of documents can be used, on the other hand, similar decisions could be envisaged under two conventions. With regard to their legal character both possibilities are equal. With the adoption of a decision e.g. under the Kyoto Protocol which includes provisions adopted under the CBD, also those Parties accept this part of CBD provisions even if they have not ratified the CBD.

Decision texts often include wording starting with "is consistent with", followed by references to other conventions. This type of wording does not mean that a Party that adopts this decision has to be a Party to the other convention, but that it should not violate the rules or objectives of the other convention. This type of wording is not a legally binding provision for the adopting Party, but the Party can decide – if it is not bound by the other convention – whether it modifies the provisions according to its own interpretation.

9 Summary of recommendations

9.1 Recommendations with regard to the future work under the conventions

9.1.1 Recommendations for improved linkages between the FCCC and the CBD

At present the FCCC and the CBD are mainly implemented in parallel processes rather than jointly, yet clear interfaces and linkages exist between both conventions. Potential collaborative activities fall into two main groups:

1. Analysis of the impacts of climate change on biological diversity, and
2. The integration of biodiversity considerations in the implementation of the FCCC and the Kyoto Protocol, such as in the implementation of land-use change and forestry activities or adaptation measures.

This report only analysed the second category of cooperation activities and excludes the area of climate change impacts on biodiversity. The main focus of the analysis was a closer consideration of the work under the CBD and its relevance and contributions to resolve the conflicts with biodiversity issues encountered with the implementation of the KP.

9.1.1.1 Work on key thematic areas under the CBD

Ecosystem approach

Conservation organizations promote to adopt and to integrate the ecosystem approach as developed under the CBD in the context of the FCCC and the KP. The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. A more detailed look at the principles and the operational guidance for the ecosystem approach developed under the CBD leaves some doubts whether the approach is really able to contribute significantly to resolve the problems under the KP. At least some of the operational principles could be read in a way that no further action under the KP is needed and that stakeholders at the national or regional level should deal with potential conflicts and adverse impacts. However, the ecosystem approach could provide useful guidance in other areas than those described above, but it clearly does not yet provide the adequate means to balance climate change, biodiversity and social objectives at the implementation level for project activities or concrete adaptation measures.

Sustainable use

The services of the biosphere as discussed under the CBD related to climate protection should be extended to other services than carbon storages (service with regard to water cycle, energy budget and albedo, radiation). Recommendations with regard to sustainable use of forests and grasslands should be developed under the CBD.

Conservation and protected areas

It would be helpful to have a clear list from the CBD that identifies sites of high interest for biodiversity. For such sites, coordinated and mutually supportive approaches could be developed between activities under both Conventions and LULUCF activities. Project developers at the regional level could more easily be aware of sites where thorough considerations of biological diversity is needed. Articles 8.c, 8.d, 8.k and 8.l. of the CBD are key Articles for the linkages between the two conventions because they present the basis for an effective legal framework for biodiversity protection of all areas within a Party's jurisdiction at the national level. If such legal frameworks exist, they will provide adequate guidance at the national level to minimize or eliminate potential negative impacts of activities under the FCCC and the KP. Therefore implementation of these provisions should be promoted and objective assessments of the actual implementation progress by Parties are needed. The results of such assessments can determine the need for further actions at the global level either under the FCCC or the CBD.

9.1.1.2 Monitoring, reporting and information exchange

Identification and Monitoring

Article 7 CBD on identification and monitoring is a key article for the integration of both conventions as only the information and data on important components of biodiversity identification allows adequate measures for conservation when mitigation or adaptation activities are implemented. Further work on identification and monitoring is needed under the CBD, such as a programme to further study the direct links between the pressures on and the state of biological diversity. At the implementation level, which is important for activities under the FCCC and the KP, there is still a lack of standardized monitoring programme for biodiversity issues. This fact complicates considerably the integration of biodiversity issues in the implementation of activities or projects. The work under the CDB on monitoring issues should be strengthened and promoted to establish an adequate knowledge base for cross-conventional problems. Easy accessible biodiversity data would also be an important pre-requisite for an adequate integration of biodiversity aspects with mitigation or adaptation activities under the FCCC and the KP. The global accessibility of monitoring data is also an area where further progress is needed.

The information from Parties presented in second national reports is very valuable to assess whether and to which degree present monitoring activities in different countries match with the need to monitor adverse impacts of forest related mitigation measures and projects. Currently only few second national reports are available. Therefore a more complete assessment of second national reports should be conducted at a later stage. If information from second national reports shows that biodiversity monitoring is very limited or inexistent in a country, a more careful approach with regard to project validation and monitoring could be required under the FCCC. An assessment of the existing progress on monitoring of biodiversity could also provide useful information for the scientific discussions on monitoring, accounting and eligibility under the FCCC.

The CBD is providing work on biodiversity indicators at the global level, which has to be rather general, abstract and aggregated to be globally applicable. For the resolution of conflicts between mitigation or adaptation activities under the FCCC and biological diversity in many cases concrete, specific, regional or site-specific biodiversity indicators would be most useful and would guarantee to be appropriate and applicable to the specific problems. This means that there is a clear gap between the progress that can be achieved under the CBD on biodiversity indicators and the factual need under the FCCC and the KP. The secretariat under the CBD is currently assessing experiences gained in the implementation of national and regional processes with indicators for forest biodiversity. This issue will be substantially reviewed at the seventh meeting of the subsidiary body. Any future initiatives should be further analysed with regard to possible contributions to the FCCC and the KP. Nevertheless, the gap between the needs at project and at global level will remain.

Reporting under the FCCC

Useful information on biodiversity issues is already provided in national communications of Parties under the FCCC with any formal requirements in the respective guidelines. The reporting on biodiversity issues in national communication to the FCCC is somewhat arbitrary and incidental, incomplete, very different in scope, extension and degree of detail because of the lack of guidance. This does not allow a systematic use of the reported information under the CBD, even if individual contributions are very valuable and informative. In two areas it seems especially relevant to improve the reporting guidelines under the FCCC to encourage reporting on linkages between climate change and biodiversity. The first area is the reporting on mitigation policies and measures in the forest and agricultural sectors, the second area is the impacts of climate change on ecosystems and biodiversity, related research activities as well as the consideration of biodiversity aspects with the planning and implementation of adaptation measures. Country-specific experiences on these issues could enhance global understanding and formulation of adequate international policies. These requirements should not be mandatory but encourage Parties to report in order to improve understanding and exchange of information.

It should also be considered how this information could and should be made available for the CBD process. More specific proposals are included in the respective section of the report.

The Consultative Group of Experts (CGE) on non-Annex I national communications[77] under the FCCC is currently developing proposals to improve guidelines for non-Annex I national communications. It is likely that the section on vulnerability assessment, climate change impacts and adaptation in reporting guidelines for non-Annex I national communication will be revised in order to provide more specific and structured

[77] The Consultative Group of Experts (CGE) was established according to decision 8/CP.5

guidance to Parties how to report on these issues and which elements to include. Any revision should address the linkages between adaptation activities and biodiversity as well as climate change impacts on biodiversity. Parties addressed these issues without any formal requirements in their national communications in the past, but there seems to be a lack of awareness that this information could be provided in a more systematic was and should be exchanged with the CBD. In this regard it is recommended to develop specific proposals how biodiversity issues could be integrated in the reporting guidelines for national communications under the FCCC.

Reporting under the CBD

Many proposals under the FCCC that addressed possible ways to consider adverse effects of climate change related measures and projects on biodiversity, have been limited to very general recommendations and in most cases they have not been based on the analysis of country-specific information in relation to the tools or solutions that countries have in place to address such conflicts (e.g. criteria and indicators, EIA, SIA, management rules and guidelines etc.). The information already provided under the CBD in national reports and thematic reports should be assessed in a more comprehensive analysis as it could contribute significantly to fill this gap. Such an analysis could be one important step in the direction of a discussion on recommendations that base on country experiences and established activities.

Reporting guidelines and formats under the CBD could be improved to enhance the mutual usefulness of the reported information. Cross-linkages are often not considered in the elaboration and revision of reporting guidelines and formats. Under the CBD it should be considered how Parties could be encouraged to provide more specific and detailed information if so available. If Parties only fill in the multiple choice formats without providing additional information in the respective boxes, the answers are not very helpful for any further analysis and assessment, as the most relevant information usually is contained in the comment boxes.

In the revision of guidelines and formats it should also be considered whether and how an improved mutual cooperation between the conventions could streamline reporting obligations and reduce reporting burdens of Parties. Recommendations should not only increase reporting requirements but also use existing linkages to avoid repeated reporting of similar issues in different reports.

Information exchange and monitoring

Under both Conventions, ways to enhance the mutual information exchange should be explored. One option would be to produce specific compilation and synthesis reports or technical papers that summarize the reported information relevant under the other convention. Other ways and means for such information exchange exist, such as the development of a meta-database covering both conventions, the development of an inter-convention web site and search engine, the development of a lessons-learned network or joint working groups under both conventions. These possibilities should be further explored and promoted.

9.1.1.3 Instruments and tools to address and resolve conflicts under both conventions

The analysis in the report has shown that potential conflicts between the CBD and the implementation of the KP mainly arise at the implementation level of specific activities and projects. Whether an activity is a benefit or threat for biodiversity also often depends on the management option chosen. Therefore it is difficult to agree to common global criteria, indicators and standards as such an agreement would be needed at a very detailed level. In such a situation, it seems important that frameworks for common instruments and tools are agreed at the international level that provide guidance for potential conflicts at the national level. Different instruments are developed under different conventions, e.g. CBD focuses on EIA and SEA, the Aarhus Convention on participation of stakeholders, the forest process on management rules and principles. All elements could contribute to an appropriate implementation of articles related to forestry and agriculture under the KP. However, the success of such an approach will depend on the implementation and appropriate application across all Parties involved in those conventions. Improved exchange and discussion of actual progress of implementation and application of such instruments across conventions is recommended. Further research based on actual progress of implementation of these instruments is necessary to evaluate the usefulness and the possibilities of application of these instruments under the FCCC.

Impact assessments

Since EIAs require national legislation, the specific implementation of the general rules provided in Article 14 CBD can vary significantly. This may substantially reduce the value of the instrument if no comparable implementation can be achieved across Parties. A closer analysis of EIA legislation and procedures in different countries is needed in order to provide a clearer view on the usefulness and the problems of the practical implementation of EIAs as a general tool to harmonize objectives of CBD with objectives of FCCC in relation to LULUCF activities.

The considerable discretion left to Parties in relation to "appropriate" procedures and arrangements under Article 14 CBD should be reduced. This lack of preciseness considerably weakens the comparable implementation of the Article. In this regard the development of guidelines on the incorporation of biodiversity-related issues into legislation and/or processes on environmental impact assessment should be supported and it should be ensured that the development process considers the use of these guidelines for projects in forestry and agriculture. The guidelines should elaborate some minimal standards for implementation of procedures and arrangements to ensure some basic standards across Parties.

With regard to Articles 3.3 (accounting of afforestation, reforestation and deforestation) and 3.4 (accounting of additional LULUCF activities) it should be evaluated whether EIAs and SEAs are the most appropriate instruments to integrate biodiversity aspects into forest policies. In general SEAs and EIAs are less focused on forestry activities as many countries have chosen a different approach that establishes binding principles and criteria for forest management in the framework of the national forest policy. Further analysis on the mutual usefulness, or contradiction between EIAs/SEAs and criteria and principles for sustainable forest management should be conducted.

In developing countries adequate planning processes are often lacking as well as capacities for ecological assessments. Financial and human resources and political support are also limited. Even if the concrete implementation of EIA under the CBD varies considerably between countries, it can strengthen the importance of adequate planning processes considering ecological impacts. In this regard Article 14 CBD has a strong potential to promote effective planning systems and an enhanced importance for strategic planning in developing countries. This process will also be useful in the case of any project activities under the CDM in developing countries. It is important that the appropriate application of instruments and tools such as EIA are promoted by the financial mechanisms and capacity building activities under the conventions as the capacities to apply such tools ensures the implementation of the objectives under both conventions.

Participation

With Article 14, the CBD acknowledged the key role of public participation for the implementation of the Convention. In addition, CBD also recognizes the important role of local participation and participation of indigenous and local communities to the conservation and sustainable use of biological diversity. The key role of participation of stakeholders is not taken into account in the discussions and documents on forest activities under the FCCC and the KP. Rules under the Kyoto Protocol for the Clean Development Mechanism (CDM) and Joint Implementation (JI) should incorporate the principles of public participation as already implemented under the CBD or as affirmed in recent international environmental agreements, including the Rio Declaration and the UNECE Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters, known as the Aarhus Convention. Involvement of civil society can ensure that the CDM and JI contribute to an overall program of sustainable development and assist in verifying that standards and criteria for projects at the national or international level are met. In this regard involvement of indigenous and local communities is a general requirement that CDM and/or JI projects should fulfil and should include biodiversity issues but should not be limited to such aspects.

National legal frameworks and necessary administrative measures to respect, preserve, maintain the knowledge, innovations and practices of indigenous and local communities relevant to the conservation and sustainable use of biological diversity should be further supported under the CBD. Such a legal status would facilitate the consideration of these issues in the project validation phase under the KP.

Negative and positive lists

It would be useful for the discussions under the FCCC, if the CBD would help to identify elements for negative or positive lists in relation to adverse impacts on biodiversity. For the identification of such lists, expertise under the FCCC does not seem to be appropriate. Any such tool can only be implemented for forest or land-use related activities under the FCCC if more scientific guidance is provided.

9.1.1.4 Financial resources and financial mechanism

GEF brings a number of advantages to the challenge of linking FCCC and CBD. As perhaps the largest provider of assistance for biodiversity and climate projects, GEF has considerable influence. There are several factors that provide GEF with opportunities to link thematic areas, governments, international organizations, and NGOs and with a facility to serve as a catalyst for increased coordination between biodiversity conservation and climate change:

- its relationship with both conventions
- its reliance on implementing agencies that are major development organizations with extensive relationships in recipient countries,
- its network of national focal points,
- and its governance structure.

GEF's Operational Programs stress the importance of taking a holistic approach and to integrate objectives of both conventions. These are all strengths that GEF should continue to promote and exploit strategically.

Besides these well-articulated strategies and programs, the actual project portfolio contains only very few projects that explicitly address the contributions and benefits of projects to both conventions. Therefore, at the implementation level, there is a considerably need to further promote an integrated approach and to communicate the results to both conventions. The holistic approach is mainly addressed through one operational program out of twelve and it is essential that not only specific programs on cross-conventional issues are developed, but also that the possible synergies and conflicts are better integrated under each GEF operational program where such effects occur.

The operational program on forest ecosystems (operational program number 3 under the biodiversity focal area) should address inter-linkages in addition to the current focus on biodiversity issues and key indicators developed under the program should consider carbon sequestration effects and integrated approaches should be clearly encouraged.

In the climate change focal area clearer linkages to biodiversity aspects should be included in the elaboration of adaptation strategies and programs. The approach for global projects under the climate change focal area that address key underlying roots for forest degradation should continue as this seems to be more cost-efficient than many small individual projects.

GEF should continue to strongly support participation of affected stakeholders, including indigenous peoples, under for the biodiversity-related operational programs. The experiences gathered in GEF projects should be collected, summarized and made available for further guidance on land-use change and forestry projects under the KP.

Monitoring, the systematic collection of information of impacts on biodiversity and the establishment of baselines before the start of projects should be strengthened under the biodiversity focal area as the current lack of impact assessment of biodiversity projects is also a considerable barrier for consideration of biodiversity issues under the FCCC.

At present GEF's monitoring and evaluation of project activities focus also on biodiversity and climate change as separate areas and neither consider the linkages, nor elaborate recommendations with regard to a better integration of both issues into GEF projects. Since integrated approaches in the form of separate operational programs are relatively new, they are not yet reflected in available monitoring and evaluation reports. Further analysis should be conducted when future project implementation reports are available.

9.1.1.5 General recommendations

Clearer guidance on priorities under the CBD to other processes

For experts from areas other than biodiversity, it is difficult to clearly understand what type of biodiversity the CBD tries to conserve as the term "biodiversity" typically refers to ecosystem, species, or genetic diversity. Maintaining desired diversity at one level will have very different requirements than conserving it at another. This situation complicates the integration of biodiversity goals in the work under other conventions such as the FCCC.

Improved cooperation on impacts of adaptation measures

For forest activities, potential negative impacts on biodiversity are intensively discussed. For adaptation measures potential negative impacts on biodiversity are rarely highlighted. The examples for possible adaptation activities given in the report show that a close cooperation between both conventions should also be established with the further development of adaptation strategies, frameworks and measures under the FCCC and the KP. In the past, few concrete activities have taken place, but this will change considerably with the implementation of the KP, as additional funds for adaptation projects will be provided. Since activities under the KP are yet at a planning stage, the implementation of adaptation activities could be used as a new approach for cooperation between the two conventions to start early communication and integrated work.

Leadership of Parties needed

At the international level leadership from Parties to improve the linkages and cooperation between the two conventions is lacking. Activities are mainly pushed by some NGOs and conservation organizations, international organisations and by the Convention secretariats. Few cooperative or informing activities at the national level seem to be reflected by few activities pushing for improved cooperation at the international level. Leadership from Parties is strongly needed to improve the cooperation and to achieve an integrated approach.

9.1.2 Recommendations for improved linkages between the FCCC and the multilateral forest processes

Considerable work on criteria and indicators for sustainable forest management has been developed in a series of multilateral forest processes, including the UN forest process, ITTO, the Helsinki and Montreal process and others. The analysis in the report evaluated whether and how this work could provide inputs to the FCCC and the KP in order to enhance synergies and to avoid adverse impacts with regard to sustainable forest management.

The crucial aspect concerning the use of criteria and indicators developed in multilateral forest processes for purposes under the FCCC is the geographical scope (global, regional, multinational, national) and the implementation level (from generic principles to individual level of a forest management unit) they address. Conflicts between biodiversity and activities under the FCCC and the KP mainly arise at the implementation level with regard to the specific area and specific management options. Thus, the main challenge is to bring down the internationally developed and agreed criteria and indicators to a level on which implementation becomes feasible. Unfortunately many processes do not address the level of forest management, but remain at a rather general level and only few processes have already developed criteria and indicators or guidelines at the level of forest management. Examples are the Pan-European Operational Level Guidelines for Sustainable Forest Management or the criteria and indicators of the Tarapoto Proposal.

Another problem is the fact that the development of criteria and indicators needs to be accompanied by certain standards, quantitative limits and thresholds that provide guidance for decision-makers. Only the existence of such standards allows identifying whether a certain trend, monitored by the periodical assessment of certain indicators under a criterion, should be categorized as a positive or negative fact. Standards must be regionally adapted because of different characteristics of ecosystems. Such standards do not exist for the different multilateral processes. Therefore it remains doubtful how the guidance and trends that are measured with the indicators developed can already be used for decision-making at the present stage of development.

Despite the considerable work that was already performed in relation to sustainable forest management in these processes, the major problem for the use of this work under the FCCC is the lack of international agreement on a specific set of rules, criteria and indicators for sustainable forest management, which is shown by the multitude of forest-related processes. Thus, a global agreement on criteria and indicators that encompasses the regional approaches seems to be the most important need in order to integrate the work under the forest processes in provisions and activities under the FCCC and the KP.

9.1.3 Recommendations for improved linkages between the FCCC and the Ramsar Convention on wetlands

The initial process of closer co-operation between the two conventions should be intensified, because well co-ordinated provisions under both conventions can have a positive impact on both conventions' objectives.

The Ramsar Convention Process should integrate the objective of carbon storage in the objectives for protection and wise use of natural wetlands because of the immense capacity of carbon storage in the wetlands soils and biomass. Existing attempts for closer cooperation with FCCC should continue and should be strengthened especially with regard to the following areas:

- the predicting and monitoring of the impacts of climate change on wetland areas;
- the role of wetlands in adapting to, and mitigating the impacts of, climate change; and;
- the role of wetlands, notably peatlands and forested wetlands, in reducing greenhouse gas emissions.

Under the FCCC it is recommended to integrate the following issues in the FCCC process:

- The Ramsar principle of protection and wise use of natural wetlands should be acknowledged under FCCC process for any mitigation or adaptation activities;
- The process under the FCCC should seek to integrate the Ramsar's list of wetlands with global importance in the recommendations relating to mitigation and adaptation activities. The list could for example be used in the certification process of CDM activities to avoid that land project activities take place in protected areas under the RC.
- Despite their large potentials, mitigation activities related to wetlands such as wetland restoration or prevention of peatland fires should receive more attention in the work on the implementation of mitigation activities under the FCCC.
- The FCCC should closely cooperate with the RC in the future development of work on adaptation strategies and activities.
- Funding institutions responsible for the future adaptation fund under the KP should closely cooperate with institutions of the RC in the design of adaptation frameworks and activities.
- Future research and assessment activities should continue to provide information on climate change impacts on wetlands.

In relation to both conventions,

- the linkages between the conventions should be further analysed and documented at different levels (e.g. global and national) including the assessment of any perverse incentives and conflicts created under the provisions of the FCCC which may lead to further degradation and losses of wetlands.

- the dialogue between the respective convention secretariats should be enhanced to identify and implement mechanisms for enhanced cooperation and information exchange.

9.2 Recommendations with regard to future research needs

9.2.1 Climate related functions of the biosphere

The role of the biosphere for the carbon cycle has been the subject of many studies and research projects in the past. Biological units are involved in the processes of generation, storage, transport, and release of biogenic methane. Less research activities are dedicated to these processes and scientists have only recently begun to understand the mechanisms and the potential for a natural methane feedback to climate change. Significant uncertainty surrounds many of the results. Thus, additional research in the field of natural methane emissions is needed to reduce this uncertainty, especially with regard to wetlands. This research should focus on systems not previously measured, in addition to developing better information on areas of different ecosystem types. Great uncertainty exists in the future wetland emission scenarios.

Similar large uncertainties as for CH_4 emissions occur for the correct estimation of global emissions of N_2O from different natural sources. A better understanding at the process level and better availability of global data for different sources is needed to arrive at a more accurate estimate and better assessments of future climate effects.

However, even building on a much larger amount of research activities, there are still gaps in the knowledge related to carbon storage in ecosystems. Especially for certain forest types, forest management options, grasslands and estimates of the soil carbon pools are lacking. There are also methodological problems associated with the estimation of carbon processes in ecosystems.

This report highlighted that the biosphere performs other important functions in the climate system beside carbon storage, e.g. in water cycling processes or for the energy balance of the land surface

The roles of the biosphere in water cycling processes that influence the climate system are not well understood. Research over long timescales is lacking. Often assumed perturbations of ecosystems used in model scenarios to determine the influence of vegetation are too large-scale to be realistic (e.g. deforestation of the whole Amazon forests as a modelling scenario). Long-term measurements over large spatial scales are needed. Another important aspect for future research is that the role of biological units and geographical regions for the water cycling processes has not been studied in a detailed and systematic way. The question how local and regional effects add up to global effects is still unanswered. With respect to management options, the evaporative characteristics of different tree species are still unclear, and consequently information on the influence of large-scale reforestation / afforestation on the water cycle are missing.

Research gaps also exist for the influence of the biosphere on the albedo and energy balance of the land surface. Experimental and modelling studies have concentrated on either a global evaluation or an evaluation of processes in some key regions (Sahel, boreal forests). Most modelling studies on land-use change operate with very drastic effects (replacement of the whole Amazonian forest by grassland), so that the effect of smaller-scale changes is not yet quantified. Many studies in desert and savanna ecosystems are often performed under the aspect of desertification, so that they lack conclusions with regard to links with global climate change. It is thus recommended to extend studies on albedo, surface effects and radiation budgets to other regions and to include the aspect of global climate effects in desertification studies.

9.2.2 Influence of biodiversity on the climate system

Correlations with biodiversity have been found for some of the functions of the biosphere within the climate system (carbon cycle, water cycle and energy balance). Some functions are not directly correlated to biodiversity of species, but to structural and functional traits of biotic units. This means that the replacement of single species or whole vegetation types can lead to significant changes in climate-relevant cycles. However, most studies are either case studies that examine a single species or a single processes and it is difficult to derive general conclusions for whole ecosystem types. Quantification of the contribution of single processes (e.g., species invasions) on climate-relevant cycles is also not yet possible. The report has shown that interesting findings on the role of individual species for climate related functions can be derived from the research on invasive species. A systematic review of the effects of species invasions on climate-relevant processes is outstanding and would be helpful.

9.2.3 Need for more integrated research activities

In the past, research has mainly concentrated on either biodiversity or climate change. Thus the number of studies that reveal information about the linkages and interactions remain very limited. There are still large knowledge gaps around the questions:

- Which ecosystems are important for climate processes and biodiversity conservation?
- Which management / mitigation options favour both climate protection and biodiversity conservation in different ecosystem types?

Many studies are now undertaken that examine the carbon sequestration potential of different ecosystem types or management options with respect to the Kyoto Protocol. Such studies should generally look at the role of biodiversity within these systems, and analyse how different management options affects biodiversity on and off site.

Useful approaches have started to identify regions with significance for both biodiversity and the climate system and to create maps for both thematic areas and combine these maps in a second step. Further research in this area is needed to arrive at a valuation of the different functions of the biosphere, biodiversity and its components.

10 References

Aber, J.D., Nadelhoffer, K.J., Steudler, P. and Mellilo, J.M. 1989: Nitrogen saturation in forest ecosystems. BioScience 39: 378-386

Allen, D.G., Harrison, J.A., Navarro, R.A., van Wilgen, B.W., Thompson, M.W. 1997: The impact of commercial afforestation on bird populations in Mpumalanga Province, South Africa – insights from bird atlas data. Biological Conservation 79: 173 – 185.

Altieri, M.A. 1999: The ecological role of biodiversity in agroecosystems. Agriculture, Ecosystems and Environment 74: 19 - 31

Arrigo, K.R., Robinson, D.H., Worthen, D.L., Dunbar, R.B., DiTullio, G.R., VanWoert, M. and Lizotte, M.P. 1999: Phytoplancton Community Structure anmd the drawdown of nutrients and CO2 in the Southern Ocean. Science 283: 365 – 367

ACT (Amazon Cooperation Treaty) 2001: Criterios e indicadores de sostenibilidad del bosque amazonico. Propuesta de Tarapoto. URL: http://www.tratadoamazonico.org/index2.html, 2001-06-22

Avissar, R. and Liu, Y. 1996: A three-dimensional numerical study of shallow convective clouds and precipitation induced by land-surface forcing. Journal of Geophysical research 101: 7499 – 7518

Barthlott, W., Lauer, W, Placke, A. 1996: Global distribution of species diversity in vascular plants: Towards a world map of phytodiversity. Erdkunde 50:317 – 327.

Bergkamp, G.; Orlando, B. 1999: Wetlands and Climate Change. Exploring collaboration between the Convention on Wetlands (Ramsar, Iran 1971) and the UN Framework Convention on Climate change; October 1999

Betts, A.K., Ball, J.H., Beljaars, A.C.M., Miller, M.J., and Viterbo, P.A. (1996): The land surface-atmosphere interaction: a review based on observational and global modelling perspectives. Journal of geophysical research, Vol. 101, No D3: 7209 – 7225

Betts, R.A., Cox, P.M., Lee, S.E. and Woodward, F.I. (1997): Contrasting physiological and structural vegetation feedbacks in climate change simulations. Nature 387: 796 – 799

Blasco, D. 2000: Statement to the 6th Conference of Parties to the United Nations Framework Convention on Climate Change, Den Haag, Netherlands, November 2000.

Bonan, G., Pollard, D. and Thompson, S.L. (1992) : Effects of Boreal Forest Vegetation on Global Climate. Nature 359, 716 – 718.

Brown, P. 1998: Climate, Biodiversity and forests – Issues and opportunities emerging from the Kyoto protocol. Washington, D.C.: World Resources Institute.

Brune, A. 1998: Termite guts: the world's smallest bioreactors; Tibtech (16): 16 ff.; January 1998

Bull, E.L. and Meslow, E.C. 1977: Habitat requirement of the pileated woodpecker in northeastern Oregon. Journal of Forestry 75: 335-340.

Burrows, W.H., Compton, J.F., and Hoffmann, M.B. 1998: Vegetation thickening and carbon sinks in the grazed woodlands of north-east Australia. In: Proceedings Australian Forest Growers Conference, Lismore, NSW: 305-316.

Carpentier, C.L., Vosti, S.A. and Witcover, J. 2000: Intensified production systems on western Brazilian Amazon settlement farms: could they save the forest? Agriculture Ecosystems & Environment. 82 (1-3 Special Issue SI): 73-88

Cavalier, J. et al. 1998: The effects of abandoned plantations of *Pinus patula* and *Cupressus lusitanica* in the Central Andes of Columbia. Biodiversity and Conservation, Vol. 7(3), London.

CBD (Convention on Biological Diversity) 2000: Climate change and biological diversity: cooperation between the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change. Note by the Executive Secretary of the Convention on Biological Diversity submitted to the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) at its sixth session and the UNFCCC Subsidiary Body on Scientific and Technological Advice at the second part of its thirteenth session, The Hague, 13-24 November 2000.

Chang , C., Cho, C.M., Janzen, H.H.(1998) : Nitrous Oxide Emission from long-term Manured Soils. Soil Science Society of America Journal 62 (3): 677 – 682.

Chanton, J.P., Whiting, G.J., Happel, J.D., Gerard, G. 1993: Contrasting rates and diurnal patterns of methane emissions from emergent aquatic macrophytes. Aquatic Botany 46: 111-128.

Chapin, F.S. III, Zavaleta, E.S., Eviners, V.T., Naylor, R.L., Vitusek, P., Reynolds, H.L., Hooper, D.U., Lavorel, S., Sala, O.E., Hobbie, S.E., Mack, M.C., Diaz, S. (2000): Cosequences of changing biodiversity. Nature 405: 234 – 242

Chomitz, K.M. and Kumari, K. 1998: The Domestic Benefits of Tropical Forests: A Critical Review. In: The World Bank Research Observer Vol. 13, No. 1: 13–35

Christian. J.M. and Wilson, S.D. 1999: Long-term impacts of an introduced grass in the northern Great Plains. Ecology 80: 2397 – 2407

Clarke, G.K.C., H. Le Treut, R.S. Lindzen, V.P. Meleshko, R.K. Mugura, T.N. Palmer, R.T. Pierrehumbert, P.J. Sellers, K.E. Trenberth, J. Willebrand 2001: Physical Climate Processes and Feedbacks. In: IPCC 2001: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)] Cambridge University Press, Cambridge UK and New York.

Costanza, R., d'Arge , R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Naeem, S., Limburg, K., Paruelo, J., O'Neill, R.V., Raskin, R., Sutton, P. and van den Belt, M. (1997): The Value of the World's Ecosystem Services and Natural Capital. Nature 387: 253-260.

Couzin J.(1999): Climate change - Landscape changes make regional climate run hot and cold. Science. 283 (5400): 317

Cox, P.M., Betts, R.A., Jones, C.D., Spall, S.A., Totterdell, I.J. (2000): Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model. Nature 408: 184 - 187

Cramer, W., Kicklighter, D.W., Bondeau, A., Moore III B, Churkina, G., Nemry, B., Ruimy, A., Schloss, A.L. and the participants of the Potsdam NPP model intercomparison 1999: Comparing global models of terrestrial net primary productivity (NPP): overview and key results. In: Global Change Biology 5 (Suppl. 1): 1 – 15

Crosthwaite, J., Madden, B., O'Connor, K.F. 1996: Native pasture and the farmer's choice – evaluation of management and sowing options. New Zealand Journal of Agricultural Research. 39(4): 541-557

Davidson, N. 2000: Statement to the 12th meeting of the Subsidiary Body for Scientific and Technical Advice of the United Nations Framework Convention on Climate Change, Bonn, Germany, June 2000

Davies, S.J. and Unam, L. 1999: Smoke-haze from the 1997 Indonesian forest fires: effects on pollution levels, local climate, atmospheric CO2 concentrations and tree photosynthesis. Forest Ecology and Management 124 (2 - 3): 137 – 144

Dentener, F., R. Derwent, E. Dlugokenck, E. Holland, I. Isaksen, J. Katima, V. Kirchhoff, P. Mattson, P. Midgley, M. Wang 2001: Atmospheric Chemistry and Greenhouse Gases. In: IPCC 2001: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)] Cambridge University Press, Cambridge UK and New York.

De Ridder, K and Gallee, H. 1998: Land-surface induced regional climate change in southern Israel. In: Journal of Applied Meteorology 37 (11): 1470 - 1485

DeLucia, E.H., Hamilton, J.G., Naidu, S.L., Thomas, R.B., Andrews, J.A., Finzi, A., Lavine, M., Matamala, R., Mohan, J.E., Hendrey, G.R., and Schlesinger, W.H. 1999: Net primary production of a forest ecosystem with experimental CO2 enrichment. Science 284: 1177-1179.

Dinerstein, E., Olsen, D,M., Graham, D.J., Webster, A.L., Primm, S.A., Bookbinder, M.P. and Ledec, G. 1995: A conservation assessment of the terrestrial ecoregions of Latin America and the Caribbean. The World Bank, Washington, D.C.

Domisch, T., Finér, L., Karsisto, M., Laiho, R., Laine, J. 1998: Relocation of carbon from decaying litter in drained peat soils. Soil Biology and Biochemistry, Vol. 30, No. 12: 1529-1536.

Done, T.J., Ogden, J.C., Weibe, W.J. and Rosen, B.R. 1996: Biodiversity and ecosystem function of coral reefs. In: Mooney, H.A., Cushman, J.H,. Medina, E., Sala, O.E .and Schulze E.-D. (eds.): Functional Roles of Biodiversity: A Global Perspective, pp 393 – 429. SCOPE 55, Heidelberg, Berlin, New York: Springer

E. -D. Schulze, F. A. Bazzaz, K.J. Nadelhoffer, T. Koike and S. Takatsuki 1996: Biodiversity and ecosystem function of temperate broadleaf forests. In: Mooney, H.A, et al (1996): Functional roles of biodiversity. SCOPE report 55: 71 - 98

Eltahir, E.A.B. and Bras, R.L. 1996: Precipitation recycling. In: Reviews of Geophysics 34: 367 – 378

Enquete-Kommission 1988: Schutz der Erdatmospäre. Eine internationale Herausforderung. Zwischenbericht der Enquete-Kommission des 11. Deutschen Bundestags „Vorsorge zum Schutz der Erdatmosphäre", Economica Verlag, Bonn 1988

Enquete-Kommission Schutz der Erdatmosphäre 1994: Studienprogramm Landwirtschaft Teilband II, Bonn.

ENN (Environmental News Network) 2001: Biodiversity: buffer against climate change, 10.5.2001, URL: http://www.enn.com/news/enn-stories/2001/05/05102001/biodiversity_43462.asp

EPA (Environmental Protection Agency) 2000: Current and Future Methane Emissions From Natural Sources, URL: http://www.epa.gov/ghginfo/

Evans, J. 1992. Plantation Forestry in the Tropics. 2nd Ed. Claredon Press, Oxford.

Falkowski P.G., Barber R.T., Smetacek V. 1998: Biogeochemical controls and feedbacks on ocean primary production. Science. 281(5374): 200-206

Farquhar, G.D., M.J.R. Fasham, M.L. Goulden, M. Heimann, V.J. Jaramillo, H.S. Kheshgi, C. Le Quéré, R.J. Scholes, D.W.R. Wallace: The Carbon Cycle and Atmospheric Carbon Dioxide. In: IPCC 2001a: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)] Cambridge University Press, Cambridge UK and New York.

FCCC/CP/2001/L.7: Review of the implementation of commitments and of other provisions of the convention. Preparations for the first Conference of the Parties serving as the meeting of the Parties (decision 8/CP.4) – Decision 5/CP.6 Implementation of the Buenos Aires Plan of Action, Bonn 24.07.2001.

FCCC/CP/2001/L.11/Rev.1: Preparations for the first Conference of the Parties serving as the meeting of the Parties (decision 8/CP.4) – Matters relating to land-use, land-use change and forestry, Bonn, 27.07.2001.

FCCC/CP/2001/2: Review of the implementation of commitments and of other provisions of the Convention – consolidated negotiation text proposed by the president, 11 June 2001.

FCCC/CP/2001/2/Add.1: Decisions concerning finance, technology transfer, adaptation, capacity building, Articles 4.8 and 4.9 of the Convention and Article 3.14 of the Kyoto Protocol, 11 June 2001.

FCCC/CP/2001/2/Add.2: Decisions concerning mechanisms pursuant to Articles 6, 12 and 17 of the Kyoto Protocol, 11 June 2001.

FCCC/CP/2001/2/Add.3: Decisions concerning land-use, land-use change and forestry, 11 June 2001.

FCCC/CP/1999/7: Review of the implementation of commitments and of other provisions of the Convention – UNFCCC guidelines on reporting and review, 16.02.2000.

FCCC/CP/1996/15/Add.1: Report of the Conference of the Parties at its second session, Part two: Action taken by COP 2, 29.10.1996.

FCCC/SBSTA/1999/14: Report of the Subsidiary Body for Scientific and Technological Advice on its eleventh session, Bonn 25 October – 5 November 1999

FCCC/SBSTA/2001/L.3: Cooperation with international organizations - Draft conclusions by the Chairman: Cooperation with other conventions, Bonn 14th session, 26 July 2001.

FCCC/SBSTA/2001/MISC.3: Cooperation with international organizations – submissions from Parties, 14.05.2001.

FCCC/TP/1997/3: Klein, R.J.T, Tol, R.S.J. 1997: Adaptation to climate change : options and technologies. Technical paper.

Fearnside, P.M. and Ferraz, J. 1995: a conservation gap analysis of Brazils Amazonian vegetation. Conservation Biology 9: 1134 – 1147.

Flaig, H., and Mohr, H. 1996: Der überlastete Stickstoffkreislauf. Strategien einer Korrektur. Nova Acta Leopoldina 70 (289): 5 – 168.

Fraedrich, K., Kleidon, A. and Lunkeit, F. 1999: A green planet versus a desert world: Estimating the maximum effect of vegetation on the atmosphere. Journal of Climate 12 (10): 3156-3163

Gattuso, J.P., Frankignoulle, M. and Smith, S.V. 1999: Measurement of community metabolism and significance in the coral reef CO2 source-sink debate. Proceedings of the National Academy of Sciences of the United States of America 96 (23): 13017 – 13022

GEF (Global Environment Facility) 1999: Project Implementation review 1999. UNDP/GEF Performance Report, October 1999.

GEF (Global Environment Facility) 2000: Operational Program 12: integrated ecosystem management. April 2000.

GEF (Global Environment Facility) 2001a: For the analysis information on UNDP-GEF portfolio by focal areas (biodiversity) project descriptions from GEF homepage URL: http://www.undp.org/gef/portf/biolac.htm were used (01.06.2001).

GEF (Global Environment Facility) 2001b: For the analysis information on UNDP-GEF portfolio by focal areas (climate change) project descriptions from GEF homepage URL: http://www.undp.org/gef/portf/climate.htm were used (01.06.2001).

GEF (Global Environment Facility) 2001c: For the analysis information on UNDP-GEF portfolio by focal areas (global) project descriptions from GEF homepage URL: http://www.undp.org/gef/portf/global.htm were used (01.06.2001).

GEF (Global Environment Facility) 2001d: Project performance report 2000, GEF/C.17/8, April 10, 2001.

GEF (Global Environment Facility) 2001e: Biodiversity Program Study, GEF/C.17/Inf.4, April 13, 2001.

GEF (Global Environment Facility) 2001f: Operational Strategy of the Global Environment Facility.
URL: http://www.gefweb.org/html/operational_strategy.html

Giambelluca, T.W., Nullet, M.A., Ziegler, A.D., and Tran, L. 2000: Latent and sensible energy flux over deforested land surfaces in the eastern Amazon and northern Thailand. In: Singapore Journal of Tropical Geography 21 (2): 107 – 130

Giller, K.E., Beare, M.H., Lavelle, P., Izac, A-M. N. and Swift, M.J. 1997: Agricultural intensification, soil biodiversity and agroecosystem function. Applied Soil Biology 6: 3 - 16

Gillison, A.N. 1999: Aboveground Biodiversity Working Group Summary Report1996 – 1998. Alternatives to Slash and Burn Phase II. 4 – 13. ICRAF, Nairobi

Gitay, H., S. Brown, W. Easterling, B. Jallow 2001: Ecosystems and their goods and services. In. IPCC 2001b: Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change.

Gleixner G., Czimczik C. J., Kramer C., Lühker B., Schmidt M.W.I. 2000 Turnover and stability of soil organic matter. In: Schulze E-D (ed.): Global Biogeochemical Cycles in the climate system. Academic Press, San Diego.

Glowka, L., Burhenne-Guilmin, Synge, H., McNeely, J.A., Gündling, L. 1996: A Guide to the Convention of Biological Diversity, IUCN Gland and Cambridge, 2nd printing 1996.

Gorham, E. 1991: Northern peatlands: role in the carbon cycle and probable responses to climatic warming. Ecological applications 1 (2): 182-195.

Hadley Centre (2000): An update of recent research from the Hadley Centre http://www.metoffice.gov.uk/research/hadleycentre/pubs/brochures/B2000/forestation.html

Hall, S.J. and Matson, P.A. 1999: Nitrogen oxide emissions after nitrogen additions in tropical forests. Nature 400: 152-155

Hansen, J., M. Sato, A. Lacis, R. Ruedy, I. Tegen, and E. Matthews, 1998: Climate forcings in the Industrial Era. Proceedings of the. National. Academy of Science 95: 12753-12758

Harrison, J. and Collins, M. 2000: Harmonizing the information management infrastructure for biodiversity-related treaties. Paper presented at the UNEP workshop "Towards the harmonization of national reporting", Cambridge, UK, 30-31 October, 2000.

Hector, A., Schmid, B., Beierkuhnlein, C., Caldeira, M. C., Diemer, M., Dimitrakopoulos, P. G., Finn, J., Freitas, H., Giller, P. S., Good, J., Harris, R., Högberg, P., Huss-Danell, K., Joshi, J., Jumpponen, A., Körner, C., Leadley, P. W., Loreau, M., Minns, A., Mulder, C. P. H., O'Donovan, G., Otway, S. J., Pereira, J. S., Prinz, A., Read, D. J., Scherer-Lorenzen, M., Schulze, E.-D., Siamantziouras, A.-S. D., Spehn, E., Terry, A. C., Troumbis, A. Y., Woodward,

F. I., Yachi, S., and Lawton, J. H. 1999: Plant diversity and productivity experiments in European grasslands. Science 286: 1123 – 1127

Heimann, M., Weber, C., Duinker, J.C., Körtzinger, A., Mintrop, L., Buchmann, N., Schulze, E-D., Hein, M., Bondeau, A., Cramer, W., Lindner, M. und Esser, G. (1997) : Natürliche Senken und Quellen des atmosphärischen Kohlendioxids : Stand des Wissens und Optionen des Handelns. Studie im Auftrag des BMBF. Unpublished manuscript.

Henderson-Sellers, A. 1995: Human effects on climate through the large-scale impacts of land-use change. In: Henderson-Sellers (ed.): Future climates of the world: A modelling perspective. World survey of climatology Vol. 16, Elsevier Amsterdam, Lausanne, New York.

Henderson-Sellers, A. 1995 (ed.): Future climates of the world: A modelling perspective. World survey of climatology Vol. 16, Elsevier Amsterdam, Lausanne, New York.

Hill, M.O. and Wallace, H.L. 1989: Vegetation and environment in afforested sand dunes at Newborough, Anglesey. Forestry 62: 249-267.

Hoffmann, W.A. and Jackson, R.B. 2000: Vegetation-climate feedbacks in the conversion of tropical savanna to grassland. In: Journal of climate 13 (9): 1593 - 1602

Holbrook, W.S.; Hoskins, H.; Wood, W.T.; Stephen, R.A.; Lizarralde, D; 1996: Leg 164 Science Party: Methane hydrate and free gas on the Blake Ridge from vertical seismic profiling; Science (273): 1840-1843; 1996

Holland, E.A., Braswell B.H., Lamarque J.F., Townsend A., Sulzman J., Muller J.F., Dentener F., Brasseur G., Levy H., Penner J.E., and Roelofs G.J. 1997: Variations in the predicted spatial distribution of atmospheric nitrogen deposition and their impact on carbon uptake by terrestrial ecosystems. Journal of Geophysical Research - Atmosphere 40102: 15849-15866

Höper, H. 1998: Klimaveränderungen durch Landnutzungsänderungen. In: Lozán, J.L., Graßl, H. und Hupfer, P. (Hrsg.): Warnsignal Klima – Das Klima des 21. Jahrhunderts. Wissenschaftliche Auswertungen, Hamburg

Houghton, R.A., Hackler, J.L., and Lawrence, K.T. 1999: The US carbon budget: Contributions from land-use change. Science 285: 574-578.

Houghton, R.A. (1999): The annual net flux of carbon to the atmosphere from changes in land use 1850 – 1990. Tellus 50B: 298 - 313

IGBP Terrestrial Carbon Group 1998: The Terrestrial Carbon Cycle: Implications for the Kyoto Protocol. Science 280: 1393 – 1394

IGBP Secretariat (1997): Carbon in the Ocean. Poster presented at the United Nations General Assembly Special Session, New York 23-27 June 1997

IISD (International Institute for Sustainable Development) 2001: First session on the United Nations Forum on Forests: 11 – 22 June 2001. Earth Negotiations Bulletin, Vol.13 No. 73, UNFF-1, June 2001

Institut für Organischen Landbau der Universität Bonn 1994: Vergleich der

Klimarelevanz ökologischer und konventioneller Landwirtschaft. In: Enquete-Kommission Schutz der Erdatmosphäre 1994: Studienprogramm Landwirtschaft Teilband II, Bonn.

IPCC – Intergovernmental Panel on Climate Change 1996: Climate Change 1995 – Impacts, adaptations and mitigation of climate change: Scientific-technical analyses. Contribution of working group II to the second assessment report of the intergovernmental Panel on climate change. Cambridge, New York: Cambridge University Press.

IPCC 1996: Guidelines for national greenhouse gas inventories: Reference manual.

IPCC 2000: Land Use, Land-Use change , and Forestry, A special report of the IPCC, Cambridge University Press, Cambridge, UK.

IPCC 2001a: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)] Cambridge University Press, Cambridge UK and New York.

IPCC 2001b: Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [McCarthy, J.J., O.F. Canziani, N.A. Leary, D.J. Dokken, K.S. White (eds.)] Cambridge University Press, Cambridge UK and New York.

IPCC 2001c: Summary for Policymakers – A report of Working Group I to the Intergovernmental Panel on Climate Change. In: IPCC 2001a: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)] Cambridge University Press, Cambridge UK and New York.

IPCC 2001d: Climate Change 2001: Mitigation – Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge UK and New York.

ISCI (Intergovernmental Seminar on criteria and indicators for sustainable forest management) 1996: Presentation of the background document for the ISCI Seminar – achievements in the development of criteria and indicators for sustainable forest management. URL: http://www.mmm.fi/isci/presnet(html., 25.05.2001.

IUCN (The World Conservation Union) 1999: Report of the 11th Global Biodiversity Forum – Exploring synergies between the UNFCCC and the CBD, Buenos Aires, Argentina.

IUCN (The World Conservation Union) 2000: Carbon sequestration, biodiversity and sustainable livelihoods: the role of an ecosystem approach in balancing climate change, biodiversity and social objectives. Discussion paper, November 2000, available at http://iucn.org/themes/climate/carbonseq1-01.html from 18.05.01.

Kammann , C., Grünhage, L., Müller, C., Jacobi, S., Jäger, H.J. (1998): Seasonal variability and mitigation options for N_2O emissions from differently managed grasslands. Environmental Pollution 102 (Suppl. 1): 179 – 186.

Kasischke, E.S. and Stocks, B.J. 2000: Fire, climate change, and carbon cycling in the Boreal Forest. Ecological Studies 138, Springer Verlag New York, Berlin, Heidelberg

Keller, M 1994: Control of Soil-Atmosphere Fluxes of nitrous oxide and Methane. in: Zepp, R.G. (ed.) Climate-Biosphere Interactions. Biogenic Emissions and Environmental effects of climate change. New York, Chichester, Brisbane: John Wiley and Sons

Keller, M. and Reimers, W.A. 1994: Soil-atmosphere exchange of nitrous oxide, nitric oxide and methane under secondary succession of pasture to forest in the Atlantic lowlands of Costa Rica. Global Biogeochemical Cycles 8: 399-409

Khalil, M.A.K. and Rasmussen, R.A. 1992: The Global Sources of Nitrous Oxide. Journal of Geophysical research, Vol 97, No. D13: 14651-14660

Kilian, W. & die Mitarbeiter der Fachgruppe "Forst" des Fachbeirates für Bodenfruchtbarkeit und Bodenschutz beim Bundesministerium für Land- und Forstwirtschaft (o.J.): Die Düngung im Wald. Teil 2. Forstliche Bundesversuchsanstalt Österreichisches Waldforschungszentrum., http://www.fbva.bmlf.gv.at/inst3/publ/kilian/duenger/inhalt.html

Kleidon, A. and Heimann, M. 2000: Assessing the role of deep rooted vegetation in the climate system with model simulations: mechanism, comparison to observations and implications for Amazonian deforestation. In: Climate Dynamics 16 (2-3): 183 - 199

Kroeze, C. and Seitzinger, S.P. 1998: Nitrogen inputs to rivers, estuaries and continental shelves and related nitrous oxide emissions in 1990 and 2050 – a global model. Nutrient Cycling in Agroecosystems. 52 (2-3): 195-212

Kuhlbusch, T.A. 1994: Schwarzer Kohlenstoff aus Vegetationsbränden: eine Bestimmungsmethode und mögliche Auswirkungen auf den globalen Kohlenstoffzklus. Dissertation. Johannes-Gutenberg-Universität Mainz.

Langer, M.R., Silk, M.T. and Lipps, J.H. (1997): Global ocean carbonate and carbon dioxide production – the role of reef foraminifera. Journal of Foraminiferal Research 27 (4): 271 – 277

Leakey, R. and Lewin, R. 1995: The sixth extinction. New York: Doubleday

Leng, R.A. 1993: Quantitative ruminant nutrition - A green science. Australian Journal of Agricultural Research 44: 363-80.

Liaison Unit Vienna 2000: General information on the Ministerial Conferences on the Protection of Forests in Europe. URL: http://www.minconf-forests.net/Basic/FS-General-Information.html, 2001-05-17

Liu, S.G., Reiners, W.A., Keller, M., Schimel, D.S. 1999: Model simulation of changes in N2O and NO emissions with conversion of tropical rain forests to pastures in the Costa Rican Atlantic Zone. Global Biogeochemical Cycles 13(2): 663-677

Lloyd, J. 1999: The CO_2 dependence of photosynthesis, plant growth responses to elevated CO_2 concentrations and their interaction with soil nutrient status, II. Temperate and boreal forest productivity and the combined effects of increasing CO2 concentrations and increased nitrogen deposition at a global scale. Functional Ecology 13: 439-459.

Lozán, J.L., Graßl, H. und Hupfer, P. 1998 (Hrsg.): Warnsignal Klima – Das Klima des 21. Jahrhunderts. Wissenschaftliche Auswertungen, Hamburg

Maier-Reimer, E., Mikolajewicz, U. and Winguth, A. 1996: Future ocean uptake of CO2: Interaction between ocean circulation and biology. Climate Dynamics 12: 711 – 721

Marshall, V.G. 2000: Impacts of forest harvesting on biological processes in northern forest soils. Forest Ecology & Management. 133 (1-2): 43-60

Matson, P.A. and Vitousek, P.M. 1990: Ecosystem approach to a global nitrous oxide budget. BioScience 40: 667-672

Matson, P.A., W.H. McDowell, A.R. Townsend and P.M. Vitousek 1999: The globalization of N deposition: ecosystem consequences in tropical environments, Biogeochemistry 46: 67-83

Matthews, E., Payne, R., Rohweder, M., Murray, S. (2000): Pilot Analysis of Global Ecosystems – Forest Ecosystems. World Resources Institute, Washington, D.C.

McCann, K.S. (2000): The diversity-stability debate. Nature 405: 228 – 233.

McLean, R.F., A. Tysban, V. Burkett, J.O. Codignotto, D.L. Forbes, N. Mimura, R.J. Beamish, V. Ittekkot 2001: Coastal Zones and Marine Ecosystems. In: IPCC 2001: Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [McCarthy, J.J., O.F. Canziani, N.A. Leary, D.J. Dokken, K.S. White (eds.)] Cambridge University Press, Cambridge UK and New York.

MCPFE (Ministerial Conference on the Protection of Forests in Europe) 1998: Pan-European Operational Level Guidelines for Sustainable Forest Management. Annex 2 of the resolution L2. URL: http://www.minconf-forests.net/Basic/FS-MCPFE-Resolution.html, 2001-06-01

Ministry of Agriculture and Forestry / Finland 1996: Ed.: Granholm, H. Intergovernmental seminar on criteria and indicators for sustainable forest management. Background Paper.

Minkkinen, K. and Laine, J. 1998: Long-term effect of forest drainage on the peat carbon stores of pine mires in Finland. Canadian Journal of Forest Research, Vol. 28: 1267-1275.

Moberg, F. and Folke, C. (1999): Ecological goods and services of coral reef ecosystems. Ecological Economics 29: 215 – 233

Montreal Process Working Group 1998: Criteria and indicators for the conservation and sustainable management of temperate and boreal forests. Criteria 1-6.
URL: http://www.mpci.org/meetings/santiago/santiago6_e.html, 2001-05-29

Montreal Process Working Group 1998: The Montreal Process. What is the Montreal Process? Criteria & Indicators.
URL: http://www.mpci.org/whatis/criteria_e.html, 2001-05-04

Montreal Process Working Group 1998b: Forests for the future. Montreal Process criteria and indicators.
URL: http://www.mpci.org/meetings/future/broch_e.html#6, 2001-05-29

Mooney, H.A., Cushman, J.H., Medina, E., Sala, O.E., Schulze, E.-D. (1996) Functional roles of biodiversity: A global perspective. John Wiley, SCOPE Series 55

Mooney, H.A., Lubchenco, J., Dirzo, R. and Sala, O.E. (1995): Biodiversity and ecosystem functioning: Ecosystem analyses. In: Heywood,V.H. and Watson, R.T. (1995): Global Biodiversity Assessment. Cambridge: University Press.

Morrison, D.A., Buckney, R.T., Bewick, B.J., Cary, G.J. 1996: Conservation conflicts over burning bush in South Eastern Australia. Biological Conservation. 76 (2): 167-175

Mosier, A.R., Parton, W.J., Valentine, D.W., Ojima, D.S., Schimel, D.S., Heinemeyer, O. 1997: CH4 and N2O fluxes in the Colorado shortgrass steppe. 2. Long-term impact of land use change. Global Biogeochemical Cycles 11 (1): 29-42

Mosier, A. and Kroetze, C. (1998): A new approach to estimate emissions of nitrous oxide from agriculture and ist implications for the global N_2O budget. IGBP Newsletter 34: 8 – 13.

Mummey, D.L., Smith, J.L., Bluhm, G. 1998: Assessment of alternative soil management practices on N_2O emissions from US agriculture. Agriculture, Ecosystems & Environment 70 (1): 79-87

Mummey, D.L., Smith, J.L., Bluhm, G. 2000: Estimation of nitrous oxide emissions from US grasslands. Environmental management 25 (2): 169-175

Myers N., Mittermeier RA., Mittermeier CG., da Fonseca GAB., Kent J. 2000: Biodiversity hotspots for conservation priorities. Nature. 403: 853 – 858

Myers, N. 1990: The biodiversity challenge: expanded hotspot analysis. Environmentalist 10: 243 – 256.

Myers, N. 1997: The World`s forests and their ecosystem services. In: Daily, G. (ed.): Nature`s services. Societal dependence on natural ecosystems. Washington, Covelo: Island Press

Nabuurs, G.J., Dolman, A.J., Verkaik, E., Whitmore, A.P., Daamen, W.P., Oenema, O., Kabat, P., Mohren, G.M.J. 1999: Resolving issues on terrestrial biospheric sinks in the Kyoto Protocol. Wageningen: Dutch National Research Programme on Global Air Pollution and Climate Change

Nadelhoffer, K.J., Emmett B.A., and Gundersen P. 1999: Nitrogen deposition makes a minor contribution to carbon sequestration in temperate forests. Nature 398: 145-148

Naqvi, S.W.A., Jayakumar, D.A., Narvekar, P.V., Naik, H, Sarma, V.V.S.S., D´Souza, W. Joseph, S. and George, M.D. 2000: Increased marine production of N_2O due to intensifying anoxia on the Indian continental shelf. Nature 400: 346 – 349.

NCAE 1998: National Council for Agricultural Education: Global climate change and environmental stewardship by ruminant livestock producers; 1998

NCSP (National Communication Support Programme/ GEF) 2001: An adaptation policy framework: capacity building for stage II adaptation – a UNDP-GEF project, first order draft, May 2001.

Neue, H. 1993: Methane emission from rice fields: Wetland rice fields may make a major contribution to global warming. BioScience 43 (7): 466-73.

Nevison, C.D., Weiss, R.F.., Erickson, D.J. 1995: Global oceanic emissions of nitrous oxide. Journal of Geophysical Research-Oceans. 100 (C8): 15809-15820

Nicholson, S. 2000: Land surface processes and Sahel climate. Reviews of Geophysics 38 (1): 117-139

Nilsson, S. and Schopfhauser, W., 1995: The Carbon-Sequestration Potential of a Global Afforestation Program. Climatic Change 30: 267-293.

Norse, E.A., Rosenbaum, K.L., Wilcove, D.S., Wilcox, B.A., Romme, W.H., Johnston, D.W., and Stout, M.L. (1986): Conserving biological diversity in our national forests. The Wilderness Society, Washington D.C.

Olsen, D.M., and Dinerstein, E (1997): The Global 200: A representation approach to conserving Earth's distinctive ecoregions. World Wildlife Fund, Washington, D.C.

Panayotou, T. and Ashton, P.S. 1992: Not by timber alone. Washington, D.C: Island Press.

Parish, F. and Looi, C.C. 2000: Wetlands, biodiversity and climate change – Options and needs for enhanced linkages between the Ramsar Convention on Wetlands, Convention on Biological Diversity and UN Framework Convention on climate change. Global Environment Network.

Phillips OL., Malhi Y., Higuchi N., Laurance WF., Nunez PV., Vasquez RM., Laurance SG., Ferreira LV., Stern M., Brown S., Grace J. 1998: Changes in the carbon balance of tropical forests: evidence from long-term plots. Science. 282: 439 - 442

Pielke, R.A. and Vidale, P.L. 1995: The boreal forest and the polar front. Journal of Geophysical Research – Atmospheres 100 (D12): 25775 25758

Pielke, R.A., Avissar, R., Raupach, M, Dolman, A.J., Zeng, X. and Denning, A.S. 1998: Interactions between the atmosphere and terrestrial ecosystems: influence on weather and climate. In: Global Change Biology 4: 461 - 475

Pitman, A., Pielke, R. Sr., Avissar, R., Claussen, M., Gash, J. and Dolman, H. 1999: The role of the land surface in weather and climate: does the land surface matter? In: IGBP Newsletter 39: 4 – 10.

Plant, R.A.J. and Boumann, B.A.M. (1999): Modeling nitrogen oxide emissions from current and alternative pastures in Costa Rica. Journal of Environmental Quality 28 (3): 866 - 872

Postel, S.L. and Carpenter, S. (1997): Freshwater ecosystem services In: Daily, G. (ed.): Nature's Services: Social Dependence on Natural Ecosystems. Island Press, Washington, D.C.

Prasad, S.S. 1997: Possible sources of nitrous oxide. Journal of Geophysical Research 102D: 21527-21537.

Ramsar 2000: The list of wetlands of international importance; 7th July 2000; Gland (Switzerland) 2000

Reale, O. and Shukla, J. 2000: Modeling the effects of vegetation on Mediterranean climate during the Roman classical period: Part II, Model. In: Global and Planetary Change 25 (3-4): 185 – 214

Reid, W. and Miller, K., 1989: Keeping Options Alive: The Scientific Basis for Conserving Biodiversity. World Resources Institute, Washington DC.

Reynolds, J.F., Virginia, R.A., Schlesinger, W.H. 1996: Defining Functional Types for Models of Desertification, 195 - 216, in: Plant functional types (IGBP 1996)

Roura-Carol, M., Freeman, C. 1999: Methane release from peat soils: effects of Sphagnum and Juncus. Soil Biology and Biogeochemistry 31: 323-325.

Sahin, V. and Hall, M.J. 1996: The effects of afforestation and deforestation on water yields. Journal of Hydrology 178 (1-4): 293-309

Sala, O. and Paruelo, J.M. 1997: Ecosystem services in grasslands. In: Daily, G. (ed.): Nature`s services. Societal dependence on natural ecosystems. Washington, Covelo: Island Press

Sala, O.E., Chapin, F.S., Armesto, J.J., Berlow, E., Bloomfield, J., Dirzo, R., Huber-Sanwald, E., Huenneke, L.F., Jackson, R.B., Kinzig, A., Leemans R., Lodge, D.M., Mooney, H.A., Oesterheld, M., Poff, N.L., Sykes, M.T., Walker, B.H., Walker, M., Wall, D.H. 2000: Global biodiversity scenarios for the year 2100. Science. 287 (5459): 1770-1774

Salonius, P.O. 1981: (Metabolic capabilities of forest soil microbial populations with reduced species diversity. Soil Biology and Biochemistry 13: 1 – 10

Saugier, B., and J. Roy, 2000: Estimations of global terrestrial productivity: converging towards a single number?, In: Roy, J., Saugier, B. and Mooney, H.A (ed.): Global terrestrial productivity: past, present and future. Academic Press, San Diego

Scherer-Lorenzen, M. 1999: Effects of plant diversity on ecosystem processes in experimental grassland communities. Bayreuther Forum Ökologie 75: 1-245.

Schlesinger, W.H. (1997): Biogeochemistry: An Analysis of Global Change, 2nd Edition, Academic Press, San Diego

Schneider, Th.W. 1995: Kriterien und Indikatoren für eine nachhaltige Bewirtschaftung der Wälder. In AFZ/Der Wald, 4/1995, S.184-187.

Schneider, Th.W., Honerla, S. 1996: Stand der internationalen Aktivitäten zum Thema „Wälder". In AFZ/Der Wald, 22/1996, S. 1240-1242.

Schneider, Th.W. 1997: Der internationale Dialog zum Thema „Wälder". In AFZ/Der Wald 14/1997 S.762-765.

Schulze E.-D., Lloyd, J., Kelliher, F.M., Wirth, C.,. Rebmann, C., Lühker, B., Mund, M., Knohl, A., Milyukova, I.,M., Schulze, W., Ziegler, W., Varlagin, A.,B., Sogachev, A. F., Valentini, R., Dore, S., Grigoriev, S., Kolle, O., Panfyorov, M. I., Tchebakova, N., Vygodskaya, N. N. 1999: Productivity of forests in the Eurosiberian boreal region and their potential to act as a carbon sink – a synthesis. Global Change Biology. 5(6): 703-722

Schulze, E.-D. and Heimann, M. 1998: Carbon and Water Exchange of Terrestrial Ecosystems. In: Galloway, J.N. and Mellilo, J. (ed.): Asian Challange in the Context of Global Change. Cambridge: Cambridge University Press.

Schulze, E-D. 2000: Human influence of global biogeochemical cycles. Unpublished presentation, Jena

Seitzinger, S.P. and Kroeze, C. 1998: Global distribution of nitrous oxide: Production and N inputs in freshwater and coastal marine ecosystems. Global Biogeochemical Cycles. 12 (1):93-113

Shukla, J., Nobre, C., Sellers, P. 1990: Amazon deforestation and climate change. Science 247: 1322 – 1325

Smith, S.E., Martin, A. 2000: Achieving sustainability of biodiversity conservation of a GEF thematic area. GEF monitoring and Evaluation Working Paper 1, July 2000.

Stern, L.A.; Kirby, S.H., Durham, W.B. 1996: Peculiarities of methane clathrate hydrate formation and solid-state deformation, including possible superheating of water ice; Science (273): 1843 ff.

Süßer, M. (1997): Begleitvegetation in Pinus radiata-Plantagen in der IX. Region Chiles. Unpublished thesis, University of Bayreuth

Tilman, D., Wedin, D, Knops, J. 1996: Productivity and sustainability influenced by biodiversity in grassland ecosystems. Nature 379: 718 – 720

Trexler, M. and Haugen, C., 1995: Keeping it Green: Tropical Forestry Opportunities for Mitigating Climate Change. World Resources Institute. Washington.

UNEP – United Nations Environmental Programme 2000: Global Environmental Outlook 2000. UNEP, Nairobi.

UNEP/CBD/COP/5/10: Progress report on the implementation of the programmes of work on the biological diversity of inland water ecosystems, marine and coastal biological diversity, and forest biological diversity (Implementation of decisions IV/4, IV/5, IV/7), Nairobi, 6.3.2000.

UNEP/CBD/COP/5/13: Progress report on the mechanisms for implementation, Nairobi 21.12.1999.

UNEP/CBD/COP/5/23: Annex III: Decisions adopted by the COPT to the CBD at its 5th meeting, Nairobi, 22.06. 2000.

UNEP/CBD/SBSTTA/2/3: Identification, monitoring and assessments of components of biological diversity and processes which have adverse impacts, Montreal, 9.08.1996.

UNEP/CBD/SBSTTA/3/Inf.5: Report of the meeting of the Liaison Group on forest biological diversity. Third Meeting, Montreal, 14.07.1997.

UNEP/CBD/SBSTTA/5/5: Alien Species: Guiding Principles for the Prevention, Introduction and Mitigation of Impacts. 22.10.1999.

UNEP/CBD/SBSTTA/5/8: Forest biological diversity: status and trends and identification of options for conservation and sustainable use, Montreal, 25.10.1999.

UNEP/CBD/SBSTTA/5/13: Sustainable use of the components of biological diversity. Montreal, 12.11.1999

UNEP/CBD/SBSTTA/6/3: Assessment processes – progress report on ongoing assessment processes, Montreal, 15.11.2000.

UNEP/CBD/SBSTTA/6/6: Invasive alien species: Progress report on matters identified in decision V/5, paragraphs 5, 11 and 14, and an analysis of national reports. 30.11.2000.

UNEP/CBD/SBSTTA/6/11: Biological diversity and climate change, including cooperation with the UNFCCC. Montreal, 21.12.2000.

UNEP/ FAO 2000: Technical guidelines for the assessment and measurement of criteria and indicators for sustainable forest management in Dry Zone Africa. UNEP / FAO, Rome.

VanKleve, K., Chapin, F.S.III, Dryness, C.T., Viereck, L.A. 1991: Element cycling in taiga forests: state-factor control. BioScience 41: 78 – 88

Vavilov, N.I. 1926: Geographical regularities in the distribution of the genes of cultivated plants. Bulletin of applied botany 17 (3): 411 – 428

Wardle, D. A., Huston, M. A,. Grime, J, P.Berendse, F,. Garnier, E, Lauenroth, W. K., Setala, H. and Wilson S. D. (2000): Biodiversity and Ecosystem Function: an Issue in Ecology. Bulletin of the Ecological Society of America 81 (3), 235 - 240

WBGU (Wissenschaftlicher Beirat Globale Umweltveränderungen) 1998a: Die Anrechnung biologischer Quellen und Senken im Kyoto-Protokoll: Fortschritt oder Rückschlag für den globalen Umweltschutz? Sondergutachten Bremerhaven.

WBGU (Wissenschaftlicher Beirat Globale Umweltveränderungen) 1998b: Welt im Wandel – Wege zu einem nachhaltigen Umgang mit Süßwasser. Berlin, Heidelberg, New York: Springer

WBGU (Wissenschaftlicher Beirat Globale Umweltveränderungen) 2000: Welt im Wandel - Schutz und nachhaltige Nutzung der Biosphäre - Jahresgutachten 1999. Berlin, Heidelberg, New York: Springer.

Weitz, A.M., Veldkamp, E., Keller, M. Neff, J. and Crill, P.M. 1998: Nitrous oxide, nitric oxide, and methane fluxes from soils following clearing and burning of tropical secondary forest. Journal of Geophysical Research, Vol. 103, No D21: 28047-28058

Wie, H.L. and Fu, C.B. 1998: Study of the sensitivity of a regional model in response to land cover change over Northern China. In: Hydrological Processes 12 (13 – 14): 2249 – 2265

Wiersum, K.F. 1984: Surface Erosion under Various Tropical Agroforestry Systems, in Proceedings, Symposium on Effects of Forest Land Use on Erosion and Slope Stability. Eds. C. L. O'Loughlin and A.J. Pearce.Vienna: International Union of Forestry Research Organizations;Hawaii: East-West Center.World Commission on Dams 2000: Dams and development – a new framework for decision-making, London.

World Commission on Dams 2000: Dams and development – a new framework for decision-making. November 2000, Earthscan, London.

World Resources Institute 2000: World Resources 2000 – 2001: People and ecosystems: The fraying web of life. Washington, D.C.: World Resources Institute

WWF 2000: "Sinks in the CDM? Implications and loopholes. WWF discussion paper, Brussels.

Zheng, W.Z. and Ni, Y.Q. 1999: A numerical experiment study for the effects of the grassland desertification on summer drought in North China. In: Advance in Atmospheric Sciences 16 (2): 251 - 262

11 Annex 1 – Relevant Articles of the United Nations Framework Convention on climate change and the Kyoto Protocol

11.1 UN Framework Convention on Climate Change

Article 2 (Objective)

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

Article 3 (Principles)

In their actions to achieve the objective of the Convention and to implement its provisions, the Parties shall be guided, INTER ALIA, by the following: [...]

> **(3)** The Parties should take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out co-operatively by interested Parties.
>
> **(4)** The Parties have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change.

Article 4 (Commitments)

4.1 All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:

> **(a)** Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties;

(b) Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change;

(c) Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors;

(d) Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems;

4.2 The developed country Parties and other Parties included in Annex I commit themselves specifically as provided for in the following:

(a) Each of these Parties shall adopt nationall policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs. These policies and measures will demonstrate that developed countries are taking the lead in modifying longer-term trends in anthropogenic emissions consistent with the objective of the Convention, recognizing that the return by the end of the present decade to earlier levels of anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol would contribute to such modification, and taking into account the differences in these Parties' starting points and approaches, economic structures and resource bases, the need to maintain strong and sustainable economic growth, available technologies and other individual circumstances, as well as the need for equitable and appropriate contributions by each of these Parties to the global effort regarding that objective. These Parties may implement such policies and measures jointly with other Parties and may assist other Parties in contributing to the achievement of the objective of the Convention and, in particular, that of this subparagraph;

(b) In order to promote progress to this end, each of these Parties shall communicate, within six months of the entry into force of the Convention for it and periodically thereafter, and in accordance with Article 12, detailed information on its policies and measures referred to in subparagraph (a) above, as well as on its resulting projected anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for the period referred to in subparagraph (a), with the aim of returning individually or jointly to their 1990 levels these anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal

Protocol. This information will be reviewed by the Conference of the Parties, at its first session and periodically thereafter, in accordance with Article 7;

4.4 The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.

4.8 In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on:

(d) Small island countries;

(e) Countries with low-lying coastal areas;

(f) Countries with arid and semi-arid areas, forested areas and areas liable to forest decay;

(g) Countries with areas prone to natural disasters;

(h) Countries with areas liable to drought and desertification;

(i) Countries with areas of high urban atmospheric pollution;

(j) Countries with areas with fragile ecosystems, including mountainous ecosystems;

(k) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products; and

(l) Land-locked and transit countries.

Further, the Conference of the Parties may take actions, as appropriate, with respect to this paragraph.

4.9 The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology.

Article 5

The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.

Article 6

In the implementation of their commitments under paragraph 2 above, a certain degree of flexibility shall be allowed by the Conference of the Parties to the Parties included in Annex I undergoing the process of transition to a market economy, in order to enhance the ability of these Parties to address climate change, including with regard to the historical level of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol chosen as a reference.

11.2 Kyoto Protocol

Article 3.1 (Quantitative limitation or reduction commitment)

The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

Article 3.3 (afforestation, reforestation and deforestation)

The net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period, shall be used to meet the commitments under this Article of each Party included in Annex I. The greenhouse gas emissions by sources and removals by sinks associated with those activities shall be reported in a transparent and verifiable manner in accordance with Articles 7 and 8.

Article 3.4 (Additional activities)

Prior to the first session of the Conference of the Parties serving as the meeting of the Parties to this Protocol, each Party included in Annex I shall provide, for consideration by the Subsidiary Body for Scientific and Technological Advice, data to establish its level of carbon stocks in 1990 and to enable an estimate to be made of its changes in carbon stocks in subsequent years. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, decide upon modalities, rules and guidelines as to how, and which, additional human-induced activities related to changes in greenhouse gas emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories shall be added to, or subtracted from, the assigned amounts for Parties included in Annex I, taking into account uncertainties, transparency in reporting, verifiability, the methodological work of the Intergovernmental Panel on Climate Change, the advice provided by the Subsidiary Body for Scientific and Technological Advice in accordance with Article 5 and the decisions of the Conference of the Parties. Such a decision shall apply in the second and subsequent commitment periods. A Party may choose to apply such a decision on these additional human-induced activities for its first commitment period, provided that these activities have taken place since 1990.

Article 3.7 (Accounting)

In the first quantified emission limitation and reduction commitment period, from 2008 to 2012, the assigned amount for each Party included in Annex I shall be equal to the percentage inscribed for it in Annex B of its aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A in 1990, or the base year or period determined in accordance with paragraph 5 above, multiplied by five. Those Parties included in Annex I for whom land-use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990 emissions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from land-use change for the purposes of calculating their assigned amount.

Article 6 (Joint Implementation)

6.1 For the purpose of meeting its commitments under Article 3, any Party included in Annex I may transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy, provided that:

(a) Any such project has the approval of the Parties involved;

(b) Any such project provides a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur;

(c) It does not acquire any emission reduction units if it is not in compliance with its obligations under Articles 5 and 7; and

(d) The acquisition of emission reduction units shall be supplemental to domestic actions for the purposes of meeting commitments under Article 3.

6.2 The Conference of the Parties serving as the meeting of the Parties to this Protocol may, at its first session or as soon as practicable thereafter, further elaborate guidelines for the implementation of this Article, including for verification and reporting.

6.3 A Party included in Annex I may authorise legal entities to participate, under its responsibility, in actions leading to the generation, transfer or acquisition under this Article of emission reduction units.

6.4 If a question of implementation by a Party included in Annex I of the requirements referred to in this Article is identified in accordance with the relevant provisions of Article 8, transfers and acquisitions of emission reduction units may continue to be made after the question has been identified, provided that any such units may not be used by a Party to meet its commitments under Article 3 until any issue of compliance is resolved.

Article 12 (Clean Development Mechanism)

12.1 A clean development mechanism is hereby defined.

12.2 The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.

12.3 Under the clean development mechanism:

> **(a)** Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and
>
> **(b)** Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

12.4 The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.

12.5 Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:

> **(a)** Voluntary participation approved by each Party involved;
>
> **(b)** Real, measurable, and long-term benefits related to the mitigation of climate change; and
>
> **(c)** Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

12.6 The clean development mechanism shall assist in arranging funding of certified project activities as necessary.

12.7 The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.

12.8 The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

12.9 Participation under the clean development mechanism, including in activities mentioned in paragraph 3(a) above and in the acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.

12.10 Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.

Article 17 (Emission Trading)

The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading. The Parties included in Annex B may participate in emissions trading for the purposes of fulfilling their commitments under Article 3. Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under that Article.

12 Annex 2 - Relevant Articles of the Convention on Biodiversity Conservation

Article 1. Objectives

The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

Article 3. Principle

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Article 6. General Measures for Conservation and Sustainable Use

Each Contracting Party shall, in accordance with its particular conditions and capabilities:

(a) Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, inter alia, the measures set out in this Convention relevant to the Contracting Party concerned; and

(b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.

Article 7. Identification and Monitoring

Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10:

(a) Identify components of biological diversity important for its conservation and sustainable use having regard to the indicative list of categories set down in Annex I;

(b) Monitor, through sampling and other techniques, the components of biological diversity identified pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use;

(c) Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques; and

(d) Maintain and organize, by any mechanism data, derived from identification and monitoring activities pursuant to subparagraphs (a), (b) and (c) above.

Article 8. In-situ Conservation

Each Contracting Party shall, as far as possible and as appropriate:

(a) Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity;

(b) Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measures need to be taken to conserve biological diversity;

(c) Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use;

(d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;

(e) Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas;

(f) Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, inter alia, through the development and implementation of plans or other management strategies;

(g) Establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to human health;

(h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;

(i) Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components;

(j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices;

(k) Develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations;

(l) Where a significant adverse effect on biological diversity has been determined pursuant to Article 7, regulate or manage the relevant processes and categories of activities; and

(m) Cooperate in providing financial and other support for in-situ conservation outlined in subparagraphs (a) to (l) above, particularly to developing countries.

Article 10. Sustainable Use of Components of Biological Diversity

Each Contracting Party shall, as far as possible and as appropriate:

(a) Integrate consideration of the conservation and sustainable use of biological resources into national decision-making;

(b) Adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity;

(c) Protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements;

(d) Support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced; and

(e) Encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources.

Article 11. Incentive Measures

Each Contracting Party shall, as far as possible and as appropriate, adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity.

Article 12. Research and Training

The Contracting Parties, taking into account the special needs of developing countries, shall:

(a) Establish and maintain programmes for scientific and technical education and training in measures for the identification, conservation and sustainable use of biological diversity and its components and provide support for such education and training for the specific needs of developing countries;

(b) Promote and encourage research which contributes to the conservation and sustainable use of biological diversity, particularly in developing countries, inter alia, in accordance with decisions of the Conference of the Parties taken in consequence of recommendations of the Subsidiary Body on Scientific, Technical and Technological Advice; and

(c) In keeping with the provisions of Articles 16, 18 and 20, promote and cooperate in the use of scientific advances in biological diversity research in developing methods for conservation and sustainable use of biological resources.

Article 14. Impact Assessment and Minimizing Adverse Impacts

1. Each Contracting Party, as far as possible and as appropriate, shall:

(a) Introduce appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimizing such effects and, where appropriate, allow for public participation in such procedures;

(b) Introduce appropriate arrangements to ensure that the environmental consequences of its programmes and policies that are likely to have significant adverse impacts on biological diversity are duly taken into account;

(c) Promote, on the basis of reciprocity, notification, exchange of information and consultation on activities under their jurisdiction or control which are likely to significantly affect adversely the biological diversity of other States or areas beyond the limits of national jurisdiction, by encouraging the conclusion of bilateral, regional or multilateral arrangements, as appropriate;

(d) In the case of imminent or grave danger or damage, originating under its jurisdiction or control, to biological diversity within the area under jurisdiction of other States or in areas beyond the limits of national jurisdiction, notify immediately the potentially affected States of such danger or damage, as well as initiate action to prevent or minimize such danger or damage; and

(e) Promote national arrangements for emergency responses to activities or events, whether caused naturally or otherwise, which present a grave and imminent danger to biological diversity and encourage international cooperation to supplement such national efforts and, where appropriate and agreed by the States or regional economic integration organizations concerned, to establish joint contingency plans.

2. The Conference of the Parties shall examine, on the basis of studies to be carried out, the issue of liability and redress, including restoration and compensation, for damage to biological diversity, except where such liability is a purely internal matter.

Article 16. Access to and Transfer of Technology

1. Each Contracting Party, recognizing that technology includes biotechnology, and that both access to and transfer of technology among Contracting Parties are essential elements for the attainment of the objectives of this Convention, undertakes subject to the provisions of this Article to provide and/or facilitate access for and transfer to other Contracting Parties of technologies that are relevant to the conservation and sustainable use of biological diversity or make use of genetic resources and do not cause significant damage to the environment.

2. Access to and transfer of technology referred to in paragraph 1 above to developing countries shall be provided and/or facilitated under fair and most favourable terms, including on concessional and preferential terms where mutually agreed, and, where necessary, in accordance with the financial mechanism established by Articles 20 and 21. In the case of technology subject to patents and other intellectual property rights, such access and transfer shall be provided on terms which recognize and are consistent with the adequate and effective protection of intellectual property rights. The application of this paragraph shall be consistent with paragraphs 3, 4 and 5 below.

3. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, with the aim that Contracting Parties, in particular those that are developing countries, which provide genetic resources are provided access to and transfer of technology which makes use of those resources, on mutually agreed terms, including

technology protected by patents and other intellectual property rights, where necessary, through the provisions of Articles 20 and 21 and in accordance with international law and consistent with paragraphs 4 and 5 below.

4. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, with the aim that the private sector facilitates access to, joint development and transfer of technology referred to in paragraph 1 above for the benefit of both governmental institutions and the private sector of developing countries and in this regard shall abide by the obligations included in paragraphs 1, 2 and 3 above.

5. The Contracting Parties, recognizing that patents and other intellectual property rights may have an influence on the implementation of this Convention, shall cooperate in this regard subject to national legislation and international law in order to ensure that such rights are supportive of and do not run counter to its objectives.

Article 17. Exchange of Information

1. The Contracting Parties shall facilitate the exchange of information, from all publicly available sources, relevant to the conservation and sustainable use of biological diversity, taking into account the special needs of developing countries.

2. Such exchange of information shall include exchange of results of technical, scientific and socio-economic research, as well as information on training and surveying programmes, specialized knowledge, indigenous and traditional knowledge as such and in combination with the technologies referred to in Article 16, paragraph 1. It shall also, where feasible, include repatriation of information.

Article 18. Technical and Scientific Cooperation

1. The Contracting Parties shall promote international technical and scientific cooperation in the field of conservation and sustainable use of biological diversity, where necessary, through the appropriate international and national institutions.

2. Each Contracting Party shall promote technical and scientific cooperation with other Contracting Parties, in particular developing countries, in implementing this Convention, inter alia, through the development and implementation of national policies. In promoting such cooperation, special attention should be given to the development and strengthening of national capabilities, by means of human resources development and institution building.

3. The Conference of the Parties, at its first meeting, shall determine how to establish a clearing-house mechanism to promote and facilitate technical and scientific cooperation.

4. The Contracting Parties shall, in accordance with national legislation and policies, encourage and develop methods of cooperation for the development and use of technologies, including indigenous and traditional technologies, in pursuance of the objectives of this Convention. For this purpose, the Contracting Parties shall also promote cooperation in the training of personnel and exchange of experts.

5. The Contracting Parties shall, subject to mutual agreement, promote the establishment of joint research programmes and joint ventures for the development of technologies relevant to the objectives of this Convention.

Article 20. Financial Resources

1. Each Contracting Party undertakes to provide, in accordance with its capabilities, financial support and incentives in respect of those national activities which are intended to achieve the objectives of this Convention, in accordance with its national plans, priorities and programmes.

2. The developed country Parties shall provide new and additional financial resources to enable developing country Parties to meet the agreed full incremental costs to them of implementing measures which fulfil the obligations of this Convention and to benefit from its provisions and which costs are agreed between a developing country Party and the institutional structure referred to in Article 21, in accordance with policy, strategy, programme priorities and eligibility criteria and an indicative list of incremental costs established by the Conference of the Parties. Other Parties, including countries undergoing the process of transition to a market economy, may voluntarily assume the obligations of the developed country Parties. For the purpose of this Article, the Conference of the Parties, shall at its first meeting establish a list of developed country Parties and other Parties which voluntarily assume the obligations of the developed country Parties. The Conference of the Parties shall periodically review and if necessary amend the list. Contributions from other countries and sources on a voluntary basis would also be encouraged. The implementation of these commitments shall take into account the need for adequacy, predictability and timely flow of funds and the importance of burden-sharing among the contributing Parties included in the list.

3. The developed country Parties may also provide, and developing country Parties avail themselves of, financial resources related to the implementation of this Convention through bilateral, regional and other multilateral channels.

4. The extent to which developing country Parties will effectively implement their commitments under this Convention will depend on the effective implementation by developed country Parties of their commitments under this Convention related to financial resources and transfer of technology and will take fully into account the fact that economic and social development and eradication of poverty are the first and overriding priorities of the developing country Parties.

5. The Parties shall take full account of the specific needs and special situation of least developed countries in their actions with regard to funding and transfer of technology.

6. The Contracting Parties shall also take into consideration the special conditions resulting from the dependence on, distribution and location of, biological diversity within developing country Parties, in particular small island States.

7. Consideration shall also be given to the special situation of developing countries, including those that are most environmentally vulnerable, such as those with arid and semi-arid zones, coastal and mountainous areas.

Article 21. Financial Mechanism

1. There shall be a mechanism for the provision of financial resources to developing country Parties for purposes of this Convention on a grant or concessional basis the essential elements of which are described in this Article. The mechanism shall function under the authority and guidance of, and be accountable to, the Conference of the Parties for purposes of this Convention. The operations of the mechanism shall be carried out by such institutional structure as may be decided upon by the Conference of the Parties at its first meeting. For purposes of this Convention, the Conference of the Parties shall determine the policy, strategy, programme priorities and eligibility criteria relating to the access to and utilization of such resources. The contributions shall be such as to take into account the need for predictability, adequacy and timely flow of funds referred to in Article 20 in accordance with the amount of resources needed to be decided periodically by the Conference of the Parties and the importance of burden-sharing among the contributing Parties included in the list referred to in Article 20, paragraph 2. Voluntary contributions may also be made by the developed country Parties and by other countries and sources. The mechanism shall operate within a democratic and transparent system of governance.

2. Pursuant to the objectives of this Convention, the Conference of the Parties shall at its first meeting determine the policy, strategy and programme priorities, as well as detailed criteria and guidelines for eligibility for access to and utilization of the financial resources including monitoring and evaluation on a regular basis of such utilization. The Conference of the Parties shall decide on the arrangements to give effect to paragraph 1 above after consultation with the institutional structure entrusted with the operation of the financial mechanism.

3. The Conference of the Parties shall review the effectiveness of the mechanism established under this Article, including the criteria and guidelines referred to in paragraph 2 above, not less than two years after the entry into force of this Convention and thereafter on a regular basis. Based on such review, it shall take appropriate action to improve the effectiveness of the mechanism if necessary.

4. The Contracting Parties shall consider strengthening existing financial institutions to provide financial resources for the conservation and sustainable use of biological diversity.

Article 22. Relationship with Other International Conventions

1. The provisions of this Convention shall not affect the rights and obligations of any Contracting Party deriving from any existing international agreement, except where the exercise or those rights and obligations would cause a serious damage or threat to biological diversity.

2. Contracting Parties shall implement this Convention with respect to the marine environment consistently with the rights and obligations of States under the law of the sea.

Article 26. Reports

Each Contracting Party shall, at intervals to be determined by the Conference of the Parties, present to the Conference of the Parties, reports on measures which it has taken for the implementation of the provisions of this Convention and their effectiveness in meeting the objectives of this Convention.

Annex I

IDENTIFICATION AND MONITORING

1. Ecosystems and habitats: containing high diversity, large numbers of endemic or threatened species, or wilderness; required by migratory species; of social, economic, cultural or scientific importance; or, which are representative, unique or associated with key evolutionary or other biological processes;

2. Species and communities which are: threatened; wild relatives of domesticated or cultivated species; of medicinal, agricultural or other economic value; or social, scientific or cultural importance; or importance for research into the conservation and sustainable use of biological diversity, such as indicator species; and

3. Described genomes and genes of social, scientific or economic importance.

13 Annex 3 – Relevant Articles of the Ramsar Convention on Wetlands

Article 3.1: The Contracting Parties shall formulate and implement their planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory.