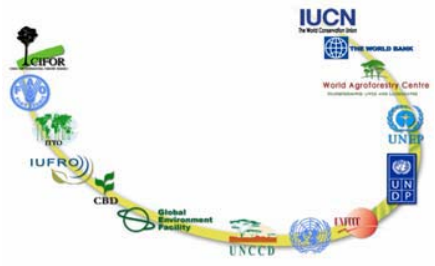
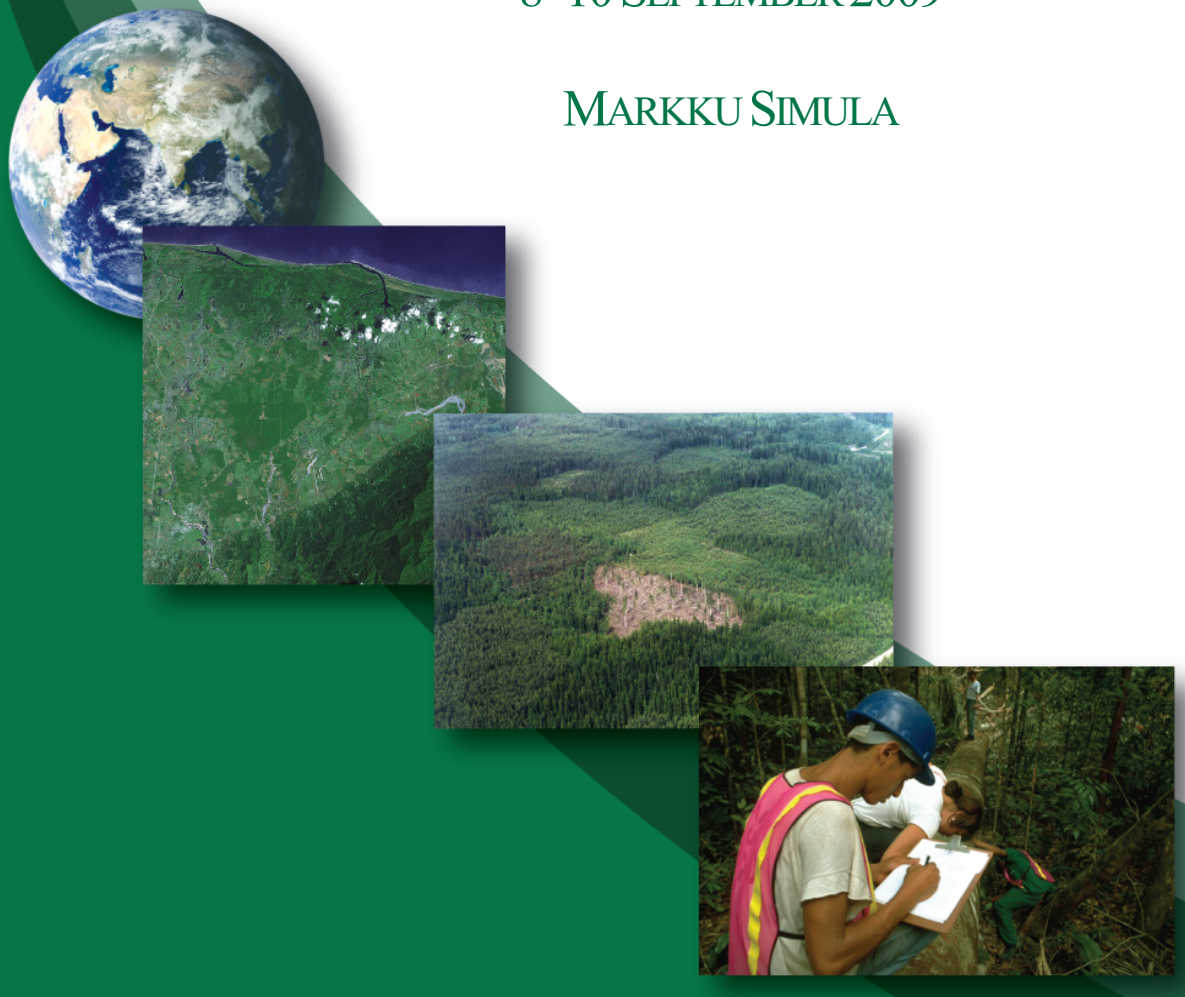
Forest Resources Assessment
Working Paper 154



TOWARDS DEFINING FOREST DEGRADATION: COMPARATIVE ANALYSIS OF EXISTING DEFINITIONS

ROME, ITALY
8–10 SEPTEMBER 2009

MARKKU SIMULA



October, 2009

Sustainably managed forests have multiple environmental and socio-economic functions which are important at the global, national and local scales, and they play a vital part in sustainable development. Reliable and up-to-date information on the state of forest resources - not only on area and area change, but also on such variables as growing stock, wood and non-wood products, carbon, protected areas, use of forests for recreation and other services, biological diversity and forests' contribution to national economies - is crucial to support decision-making for policies and programmes in forestry and sustainable development at all levels.

Under the umbrella of the Global Forest Resources Assessment 2010 (FRA 2010) and together with members of the Collaborative Partnership on Forests (CPF) and other partners, FAO has initiated a special study to identify the elements of forest degradation and the best practices for assessing them. The objectives of the initiative are to help strengthen the capacity of countries to assess, monitor and report on forest degradation by:

- Identifying specific elements and indicators of forest degradation and degraded forests;
- Classifying elements and harmonizing definitions;
- Identifying and describing existing and promising assessment methodologies;
- Developing assessment tools and guidelines

Expected outcomes and benefits of the initiative include:

- Better understanding of the concept and components of forest degradation;
- An analysis of definitions of forest degradation and associated terms;
- Guidelines and effective, cost-efficient tools and techniques to help assess and monitor forest degradation; and
- Enhanced ability to meet current and future reporting requirements on forest degradation.

The Global Forest Resources Assessment programme is coordinated by the Forestry Department at FAO headquarters in Rome. The contact person is:

Mette Løyche Wilkie
Senior Forestry Officer
FAO Forestry Department
Viale delle Terme di Caracalla
Rome 00153, Italy
E-mail: Mette.LoycheWilkie@fao.org

Readers can also use the following e-mail address: fra@fao.org
More information on the Global Forest Resources Assessment programme can be found at:
www.fao.org/forestry/fra

The coordinators of this work would like to acknowledge the financial contributions made by the Governments of Finland and Norway and by FAO, the GEF BIP programme and ITTO.

Forestry Department
Food and Agriculture Organization of the United Nations

Forest Resources Assessment Working Paper

Towards Defining Forest Degradation: Comparative Analysis of Existing Definitions

Markku Simula

October, 2009

Table of contents

Abbreviations and Acronyms

AHTEG	Ad Hoc Technical Expert Group
A/R	Afforestation and Reforestation
CDM	Clean Development Mechanism
C&I	Criteria and Indicators
CATIE	Centro Agronómico Técnico de Investigación y Enseñanza
CBD	Convention on Biological Diversity
CPF	Collaborative Partnership on Forests
CIFOR	Center for International Forestry Research
CO_2	Carbon dioxide
COMIFAC	Central African Forestry Commission
COP	Conference of the Parties
FAO	Food and Agriculture Organization of the United Nations
FMU	forest management unit
FRA	Forest Resources Assessment
GPG	Good Practice Guidance
GHG	Green House Gas
ha	hectare
IPCC	Intergovernmental Panel on Climate Change
ITTO	International Tropical Timber Organization
IUFRO	International Union of Forest Research Organizations
LADA	Land Degradation Assessment in Drylands
MAI	Mean Annual Increment
NLBI	Non-Legally Binding Instrument on All Types of Forests
OWL	other wooded land
REDD	Reduced Emissions from Deforestation and Forest Degradation
SBSTTA	Subsidiary Body for Scientific and Technological Advice
SFM	sustainable forest management
UK	United Kingdom
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
USDA	United States Department of Agriculture
yr	Year

ACKNOWLEDGEMENTS

This discussion paper was carried out under the overall supervision and guidance of Mette Loyche Wilkie, Senior Forestry Officer, Forest Assessment and Reporting Service of the FAO Forest Department. The work was carried out in close collaboration with Victoria Heymell, FAO Consultant on Forest Degradation who provided extensive support.

Comments on the draft report were received from Evisa Abolina, Jim Carle, Tim Chistophersen, Peter Csoka, Sonia Gautreau, Markku Kanninen, Timo Kuuluvainen, H. Gyde Lund, Eduardo Mansur, Christel Palmberg-Lerche, Maria Sanz-Sanchez, Ian Thompson, Francois Wencelius and Jenny Wong. Taoufik Aadel, Michael Kleine, Lars Marklund, Lars Laestadius, Masato Okayabashi and Esa Puustjärvi provided linguistic advice. Nicole Roux-Simula assisted in the production of the report.

The study benefited from the guidance of the members of the CPF Initiative on Assessment and Monitoring of Forest Degradation. The analytical framework was discussed in the CPF technical meeting held in Rome, 20 March 2009 and the draft paper was presented to the Technical Meeting on Assessment and Monitoring of Forest Degradation in Rome, 8 to 10 September 2009 and the comments made were considered in the finalization of the paper.

The author wants to express his sincere gratitude to all those who have helped in the preparation of this report. Special thanks go to the 45 national Forest Resources Assessment (FRA) respondents who provided information for the country survey.

EXECUTIVE SUMMARY

Forest degradation is a serious environmental, social and economic problem, particularly in developing countries. Yet it is difficult to define and assess. Forest degradation is viewed and perceived differently by various stakeholders who have different objectives. It is technically and scientifically difficult to define and its definition can have policy implications which further complicates reaching common operational approaches which are applicable both at international and country levels.

The objectives of this paper are (i) to review the existing international and national definitions for forest degradation, (ii) to analyze their elements and parameters, and (iii) to identify their commonalities and differences. The study is focused on international definitions developed under various initiatives but a review of national definitions has also been made.

The generic definition of forest degradation *(the reduction of the capacity of a forest to provide goods and services)* provides a common framework for all the international definitions and is also compatible with the ecosystem service approach. The most comprehensive international definitions have been developed by ITTO and CBD covering change in forest structure and dynamics, forest functions, human induced causes, and a reference state. In these definitions the spatial scale is stand or site level and the temporal scale usually long-term. The definition used by the Global Forest Resources Assessment 2000 (FRA 2000) covers many similar elements but it does not specifically address causes of deforestation. The definition developed by IPCC in the climate change context focuses on human induced changes in the carbon cycle in the long run but the definition has not been operationalized and has no formal status.

Only one third of the 45 countries surveyed have developed a national definition of forest degradation. Typical indicators in these definitions are stocking level, productivity, biomass density and species composition. Some countries have assessed degradation without developing an explicit definition. The analysis indicates that the elements of sustainable forest management may offer a suitable framework for assessing forest degradation as well as its causes and impacts.

In general, the review of existing definitions shows that many definitions are either very general or their focus is on reduction of productivity, biomass or biodiversity. Definitions that allude to multiple forest benefits may treat forest values in a comprehensive manner, but are more difficult to use for international purposes in a consistent, transparent manner. A particular issue is definition of suitable thresholds for degraded and non-degraded forests especially with regard to the international climate negotiations, the definition of forest may also have to be reconsidered.

Treatment of temporal changes in the forest is crucial for definitions of degradation. In order to not classify short-term changes in the forest growing stock which are part of sustainable forest management interventions as degradation, ITTO, CBD and IPCC have defined degradation appropriately incorporating the ‘long-term’ aspect, which is lacking in the FRA 2000 definition. However, none of the definitions specify what long term means.

The various international definitions of forest degradation leave several open issues which need to be addressed. Operational definitions of forest degradation for specific purposes should

provide, as appropriate: (i) identification of forest goods and services; (ii) a spatial context of assessment; (iii) a reference point; (iv) coverage of both process and state (degradation/degraded forest); (v) relevant threshold values; (vi) specification of reasons for degradation (human induced/natural) (when required by the use of definition; (vii) an agreed set of variables; and (viii) indicators to measure the change of a forest. Additional elements could be added or singled out, depending on the particular interests related to the use of definition.

Three commonly used proxy indicators may go a long way to represent a comprehensive initial approach for assessment of degradation which can be gradually expanded over time with improving information and accumulating experience. These include (a) reduction in biomass for the growing stock or the carbon stored; (b) reduction in biological diversity which can be associated with the occurrence of species and habitats; and (c) reduction in soil as indicated by soil cover, depth and fertility.

The following options for future action may be considered: (i) maintain the holistic generic definition of forest degradation to provide a common framework for definitions developed for particular purposes; (ii) maintain the understanding that forest degradation can be further defined for various specific purposes and that different indicators can be used for its assessment; (iii) for each purpose identify what needs to be known, by whom, and for what purpose the data should be used; (iv) recognize that, for international purposes, forest degradation needs to be geographically assessed at a higher than stand or site level with respective implications for international definitions while stand/site-level assessment is needed for taking local level corrective action; (v) allow scope for national interpretation of international definitions of forest degradation to ensure relevance and cost-efficiency, and to harness synergies; (vi) improve the existing definitions in view of greater clarity, consistency and compatibility with each other; and (vii) expand efforts to measure and assess forest degradation.

1. INTRODUCTION

1.1 Context

Forest and land degradation are serious problems, particularly in developing countries. In 2000 the total area of degraded forests and forest land in 77 tropical countries was estimated to be about 800 million hectares, of which degraded primary forest and secondary forest covered about 500 million hectares (ITTO 2002). Forest degradation is one of the major sources of greenhouse gas (GHG) emissions although its significance has not been estimated on a global scale. In the Brazilian Amazon forest, degradation is responsible for 20% of total emissions (Asner et al. 2005). In Indonesia, the forest stock has decreased by 6% per year in 1990-2005 and forest degradation is responsible for two thirds of this whereas deforestation represents only a third (Marklund & Schoene 2006). In Africa the annual rate of forest degradation is almost 50% of the annual rate of deforestation (Lambin et al. 2003)[1]. The background paper of the 2006 UNFCCC Workshop on Reducing Emissions from Deforestation in Developing Countries noted that GHG emissions from forest degradation to the atmosphere are as (or more) important than those from deforestation in some countries (UNFCCC 2006a). In spite of these estimates it is not always clear what is meant by forest degradation.

The Land Degradation Assessment in Drylands (LADA) project has revealed that there was an "absolute decline in biomass production" over 12% of the global land area from 1981 to 2003, with a strong negative change in an additional 1% of the land area. The areas affected are home to approximately one billion people, or 15% of the Earth's population. According to the *Global Environment Outlook 4*, as much as one third of the world's population is being affected disproportionately by land degradation. Areas of greatest concern that were identified include tropical Africa south of the Equator, south-east Africa, South-East Asia, south China, north-central Australia, Central America and the Caribbean, south-east Brazil, the Pampas, as well as boreal forests in Alaska, Canada and eastern Siberia. Land degradation is largely taking place in forest areas: about 25% of land degradation is associated with broad-leaved forests and 17% with boreal forests. Only 18% occurs on agricultural lands (UNEP 2007).

Forest degradation is viewed and perceived differently by various stakeholders who have different objectives (e.g., biodiversity conservation, carbon sequestration, wood production, soil conservation, cultural values or recreation). Lund (2009) found more than 50 different definitions related to forest degradation. This is reflected in the terms and definitions used which are targeted at different purposes. From the perspective of the international forest-related reporting, it would be desirable to have coherent, comparable and, if possible, harmonized definitions for such key terms as forest degradation. This continues to be a challenge, not least because national circumstances have implications for how international definitions can be applied. Therefore, there should at least be clarity about how various definitions compare with each other in order to facilitate their application in specific country conditions.

Past experience shows that the same terms and definitions will in some cases continue to be used for different purposes. A harmonization process can make these differences transparent, thereby

[1] Country examples as cited by Angelsen (2008).

improving understanding and facilitating reporting and other uses of definitions. However, it is important to respect the legitimacy of the objectives of the involved stakeholders in the process.

In improving the definitions, their rationale should be made clear. It is necessary to understand the context and objectives in order to avoid misinterpretation of forest-related definitions, as many of them are context specific. Internationally agreed definitions need to undergo complex and time-consuming consultation and negotiation that should be taken into account when considering any amendments. This calls for particular care in their formulation. There is a common understanding that unnecessary proliferation should be avoided as it tends to lead confusion among users (FAO 2002a; 2002b; 2005).

The United Nations Forum on Forests (UNFF) has called for greater harmonization of internationally applicable definitions related to forests to facilitate monitoring and reporting on progress towards the achievement of the global objectives on forests and sustainable forest management as agreed in the Non-Legally Binding Instrument on All Types of Forests (NLBI). Harmonization in this context does not mean standardization, i.e. the purpose is not necessarily to achieve common definitions but to improve consistency, compatibility and comparability among the existing ones (FAO 2002b).

Forest-related definitions for terms such as forest degradation which are outcomes of international processes are policy tools and can have major economic, social and environmental implications. Definitions do not only serve for reporting or monitoring purposes but they can also determine e.g., financial flows to forests and the allocation of support funds for various purposes (e.g. restoration of degraded forests, forest improvement, etc.). As an example, the definitions of afforestation and reforestation (A/R) of the Kyoto Protocol determine what activities can be financed through the Clean Development Mechanism (CDM). On a national level governments have to determine what forest degradation or a degraded forest mean in practical terms in order to plan and implement policies and programmes to prevent degradation and to restore and rehabilitate degraded forests and forest lands. Clarity on the issue is also needed among forest owners and managers to enable them to take corrective action at the field level.

Due to the specificity of various forest-related international instruments, definitions for key terms tend to differ. The associated problems are less serious with scientific and technical definitions which are typically determined explicitly in detail to be applicable for specific analytical or assessment purposes. Forest degradation is technically and scientifically difficult to define and its definition can have policy implications which further complicates reaching common approaches which are applicable both at international and country levels.

1.2 International Processes Related to Defining Forest Degradation

Forest degradation is covered in the first of the four global objectives on forests of the NLBI agreed to by members of the United Nations Forum on Forests. This objective includes “increasing efforts to prevent forest degradation”. Degradation is also related to the 2010 Target of the Convention of Biological Diversity (CBD) which includes an indicator on ecosystem fragmentation and connectivity both of which are related to forest degradation (CBD 2005).

Various other international organizations and processes have defined forest degradation from their own perspective. These include the Food and Agriculture Organization (FAO), the

International Tropical Timber Organization (ITTO), the Intergovernmental Panel on Climate Change (IPCC) and others. Forest degradation is part of the Bali Action Plan of the United Nations Framework Convention on Climate Change (UNFCCC) and it will likely be part of the future climate change mitigation mechanisms for reducing emissions from deforestation and forest degradation (REDD).

The First and Second Expert Meetings on Harmonizing Forest-related Definitions for Use by Various Stakeholders, jointly organized by FAO and the IPCC in collaboration with the Center for International Forestry Research (CIFOR), the International Union of Forest Research Organizations (IUFRO) and the United Nations Environment Programme (UNEP) in 2002 reflected on the definition of forest degradation (FAO 2002a; 2002b). The Second Meeting agreed on a common definition of forest degradation, defining it as "the reduction of the capacity of a forest to provide goods and services" (FAO 2002b). However, this is not an operational formulation and there exist numerous perceptions of what forest degradation entails and how it should be measured. As an example, the FAO Global Forest Resources Assessment has no indicators for direct measurement of forest degradation which illustrates serious difficulties in finding commonly applicable approaches (FAO 2006b).

1.3 Objectives

The purpose of this report is to assist stakeholders in making progress towards developing internationally applicable definitions for forest degradation which can be operationalized for specific purposes and which are clear, comparable, consistent, coherent and harmonized as appropriate. The aim is to identify how the present situation of proliferation of various definitions could be improved - not to seek for a commonly applicable operational definition for forest degradation through standardization. Harmonization is here understood as the process of making various definitions comparable and consistent with each other (Puustjärvi & Simula 2002a).

The specific objectives of the report are (i) to review the existing international and national definitions for forest degradation and degraded forests (considering multilingual aspects), (ii) to analyze their elements and parameters within a common framework, and (iii) to identify their commonalities and differences as well as options for improvement of their comparability, consistency and coherence.

1.4 Methodology and Data Sources

Drawing on the earlier work on harmonization of forest-related definitions[2] an analytical framework is developed for the comparative analysis of definitions of degradation and identification of related terms. The focus is in the identification of various components in different definitions and threshold values, whenever given. Options for rationalization of definitions related to forest degradation are identified and the approaches to be used are selected drawing on earlier experience.

As part of the process, a survey was carried out among the national contact points of the FAO Global Forest Resources Assessment (FRA) in 177 countries on the current practices to define and assess forest degradation. A qualitative and quantitative analysis of the 45 replies received was carried out and these countries represent 44.7% of the global forest area. The sample is not,

[2] Notably FAO (2002a; 2002b; 2005); Schoene et al (2007)

however, truly representative for the world's forests as many important forest countries did not reply (including Australia, Bolivia, Brazil, Canada, the Democratic Republic of Congo, India, Indonesia, Malaysia, Mozambique, Myanmar and Zambia among others). Therefore, the survey results have to be interpreted with care. Reasons for the low response rate (26%) could include lack of relevance or applicability of the term degradation in the national context, lack of national definitions, limited qualified human resources and others.

The information was completed by multilingual data search from available documentary and internet sources. IUFRO's SILVAVOC data base was also used. The country survey data and other information from literature studies were incorporated into the comparative international level analysis on differences and commonalities.

A comparative analysis of the existing definitions and their components by various international processes and organizations is then carried out. Definitions for degradation and related key terms are decomposed into elements based on which comparisons are made including threshold values as applicable.

2. ANALYTICAL FRAMEWORK

2.1 Purposes of Definitions of Forest Degradation

The following purposes of definitions of forest degradation and related terms can be identified:

- Monitoring of the status and change in the degree of forest degradation including provision of associated goods (wood, fibre, non-wood forest products) services such as carbon emissions and sequestration, maintenance of biodiversity, degradation of land, soil and water resources, provision of recreation opportunities, and the environmental and socio-economic impacts of forest degradation;
- Reporting to international conventions and processes on the status and quality of forest resources in a country and compilation of international and regional level summaries;
- Design and implementation of policies, programmes and forest management measures to take preventive and corrective action through restoration of degraded forests, rehabilitation of degraded forest lands and sustainable forest management;
- Design and implementation of payment mechanisms or other incentives schemes for forest environmental services such as carbon offsets and conservation easements.

Several criteria have been proposed for forest-related definitions (cf. FAO 2002a; Schoene et al. 2007) and specifically for forest degradation (cf. IPCC 2003):

<u>General criteria of forest related definitions:</u>

- Clear, concise, objective and unambiguous in the context used;
- Information-rich, predictive, useful and effective for the intended use and not driven by exceptions;
- Making use of synergies among various purposes;
- Consistent over time and harmonized over space (and international processes);

- Seamless and consistent with other forest related definitions[3] as well as non-forest definitions to allow their consistent use in various international fora[4];
- Practical and easily applicable in all countries so that data collection, meaningful reporting and verification are possible;
- Cost-efficient: constructed or harmonized in such a way that the current requirements for data collection and reporting by countries are reduced;
- Compatible with and building on related assessment and reporting procedures;
- Easily adapted to national systems.

Specific criteria for definition of forest degradation:

- Comprehensive to allow consideration of all forest products and services;
- Relate to human-induced and natural changes in forests, as appropriate;
- Contain clear terms which are supported by applicable variables and indicators (or their proxies if necessary) that are measurable and detectable;
- Consider different time scales (temporal and long-term variation);
- Availability of technically and economically feasible options for measurement and assessment;
- Provision of reference points such as time frames, thresholds and levels of absolute or relative changes as appropriate;
- Allowance for different levels of resilience among forest types.

It is apparent that not all the criteria may be met at the same time and therefore prioritization is likely to be needed.

2.2 Process and Status Variables Related to Change in Forests

Degradation is a change process within the forest which negatively affects the characteristics of the forest (**Figure 1**). The combination of various forest characteristics ("forest quality") can be expressed as the structure or function which determine the capacity to supply forest products and/or services (cf. FAO 2001). Taking place within the forest, degradation is different from deforestation which denotes change process from 'forest' to 'non-forest'. According the classification used by the FAO Global Forest Resources Assessment, 'non-forest' can be 'other wooded land'[5] or 'other land'[6].

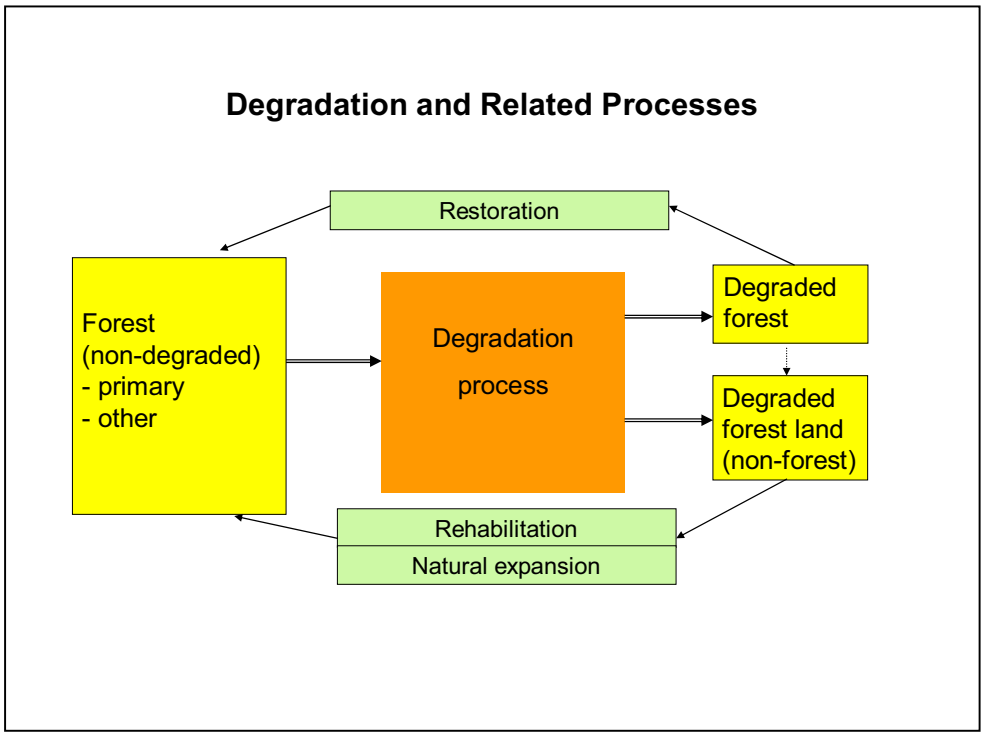
[3] E.g. deforestation

[4] E.g. UNFCCC, UNFF, CBD, CCD, FAO, ITTO, etc.

[5] Land not classified as "forest", spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds *in situ*; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use (FAO 2006b).

[6] All land that is not classified as "forest" or "other wooded land".

Figure 1 **Degradation and Related Processes**



Degradation is typically caused by disturbances which vary in terms of the extent, severity, quality, origin and frequency (FAO 2006; Schoene et al. 2007). The change process can be natural (caused by fire, storm, drought, snow, pest, disease, atmospheric pollution, change in temperature) or it can be human induced (e.g. unsustainable logging, excessive fuelwood collection, shifting cultivation, unsustainable hunting, overgrazing). The latter can be intentional (direct) through e.g. excessive logging, overgrazing, too short fallow period, or it can be unintentional (indirect) e.g. through spreading of invasive alien species or pestilence, road construction opening up a previously inaccessible area for encroachment, etc. (Lund, pers. comm.). There are also other indirect underlying reasons for degradation such as poverty and lack of alternative economic opportunities, inappropriate policies, lack of clearly established tenure rights, institutional weaknesses, lack of financial resources, corruption, and various economic, technological, cultural and demographic factors.

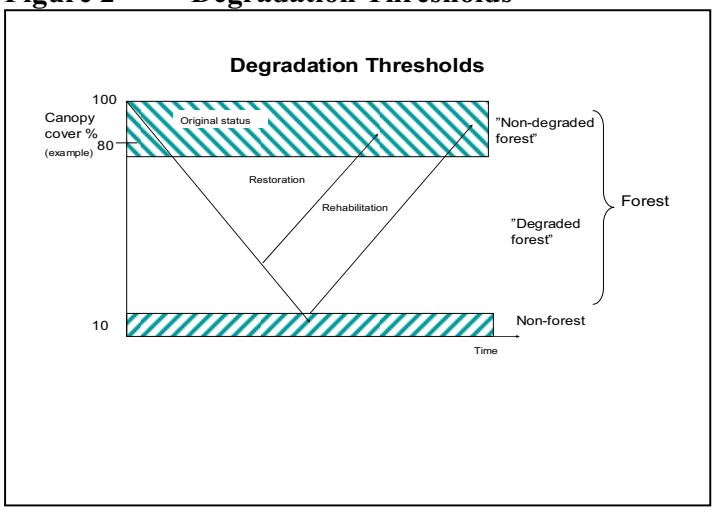
Natural and human-induced degradation are often dependent on each other as human action can influence the vulnerability of the forest to degradation from natural causes (e.g. reduced stocking level due to harvesting can lead to increased sensitivity to wind damage) but natural damage can also lead to increased human induced disturbance (e.g. natural forest fire can lead to encroachment by shifting cultivators). Separation of natural and human-induced causes is difficult in situations where abiotic and biotic factors are triggered by extreme weather events and climate change causing a greater frequency, scale and impact of forest degradation. The impacts can have varying temporal and spatial scales and they depend on the type and characteristics of the forest. However, definitions which are used for performance-based compensation for forest services

(e.g. carbon offsets) call for separation of human-induced and natural causes to avoid payment for non-action.

Forest degradation is usually associated with a reduction of vegetative cover, especially trees (Lund 2009) with the notable exceptions of the "empty forest" syndrome caused by excessive hunting and creaming (high grading) of commercially valuable timber species. Changes are continuously taking place also in non-degraded forest due to natural processes or human intervention. When these changes pass a threshold, a forest becomes degraded. If the negative process continues, at certain point the threshold of deforestation is passed and the area can no more be classified as forest (even though administratively it may still be considered forest land). Degradation is not necessarily a precursor to deforestation; forests can remain degraded for a long time and never become completely deforested (Angelsen 2008). Change can also be abrupt when a forest is converted into other uses without going through the gradual degradation process. At any stage the degradation process can be halted or reversed by forest improvement (aggradation) or other management interventions (Figure 2). Degraded forest may be restored through silvicultural measures or degraded forest land (non-forest) can be rehabilitated through e.g. reforestation and both types of intervention can result in a "non-degraded" forest during the course of time.

The process of forest degradation can be abrupt (e.g. due to excessive logging) or a slow gradual process which can take long time periods (e.g. due to fuelwood collection, inappropriate high grading or excessive hunting). The former type, if significant, is easily detectable by remote sensing while a change in the latter is often difficult to capture even by field observation as it implies a long-term loss of biomass, productivity or species composition that is difficult to assess, especially the impacts on soils, water, nutrients, biodiversity and the landscape.

Figure 2[7] Degradation Thresholds



Human-induced degradation often occurs in small clearings in the canopy and gradual losses of biomass below the canopy which are not detectable by using standard optical remote sensing

[7] Note the selected variable is just an example for illustration purposes

methods due to problems of resolution or lack of visibility or possibility to differentiate such changes by computerized data processing (DeFries et al 2007). Even though the technologies are rapidly evolving in this field their costs remain an obstacle. Field surveys are usually needed and tend to be time consuming and costly, especially in remote areas. This bottleneck could be overcome by involving local communities and smallholders in collecting ground level data (Skutsch 2008). However, sufficient training and capacity building should be provided to ensure necessary accuracy when involving local communities in data gathering.

The threshold between non-degraded and degraded forest establishes how far the change process in the former has to proceed before the forest becomes degraded. In the same way the threshold between forest and non-forest define beyond which point the forest degradation process continues as land degradation. Stakeholders have different views on these two types of threshold of which only the second one is presently defined at international level (by FAO and UNFCCC for the Kyoto Protocol)[8].

In the past degradation has often been associated with loss of forest productivity. This is a narrow interpretation as it is possible to have productivity impairment without substantial loss of carbon stock or biodiversity. On the other hand, it is possible to have carbon loss (e.g. through thinning) without productivity impairment. Any change in species composition or forest structure is not necessarily a sign of degradation but may on the contrary be associated with forest improvement. The same holds true with sustainable forest management operations such as thinning and regeneration cuttings which, while reducing the canopy cover for a period, do not reduce the productivity or carbon storage capacity of the forest, and in fact may increase it in the medium or long term. Thus, overstorey reduction alone may not entail forest degradation (IPCC 2003). However, the above interpretation depends on how forest degradation is defined.

There are complex interdependencies or trade-offs between various aspects of forest degradation. Disturbance factors creating degradation can be selective impacting on some specific forest characteristics (e.g. unsustainable logging reducing biodiversity) or comprehensive impacting all the forest services or values (e.g. devastating forest fire). Some forest goods and services are positively correlated (e.g. growing stock and carbon stock up to a limit) or negatively correlated (e.g. biodiversity and timber production beyond a certain level of management intensity).

As an example, intensive forest management for timber production may result in an increase in carbon stock but loss of biodiversity if necessary precautions are not taken. On the other hand, restrictive protection of a forest area means loss of production of timber and non-timber forest products and some services (e.g. ecotourism) while the impact on the carbon stock can be either positive or negative. While some interdependencies appear general (e.g. growing stock and carbon stock), other trade-offs are highly specific to forest type and location and they tend to be complex, often non-linear and poorly known.

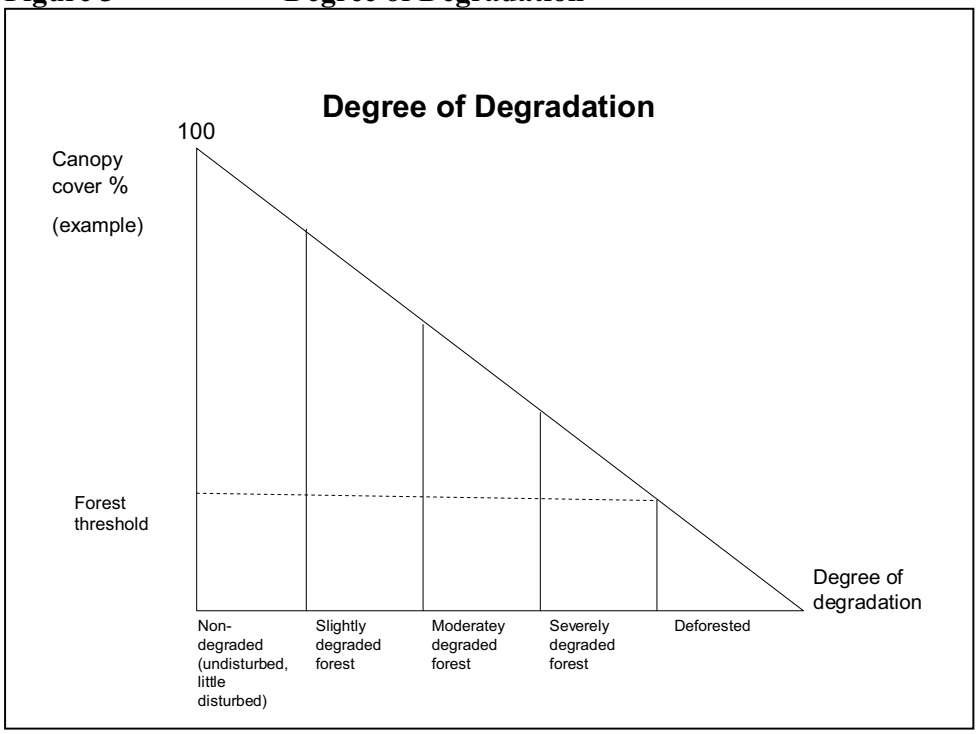
There is often a need to distinguish the status of degraded forests in terms of degree of degradation (e.g. slightly/moderately/severely degraded). This may be needed e.g. for monitoring of changes during the degradation process, identification of priority areas for preventive or corrective action. Any specific definition including threshold values will determine the

[8] See FAO (2002a) for detailed discussion on the definition of forest.

boundaries between non-degraded and degraded forest, and degraded forest and deforested area (non-forest) (**Figure 3**). Degradation therefore involves a much broader and diverse land cover change than deforestation.[9] Measuring the degree of degradation can be complex due to the multifaceted nature of the process.[10] **Figure 3** illustrates the issue using only one possible measure (canopy cover) as a criterion and a theoretical example of qualitative classification of degree of degradation.

Since forests are renewable, degradation can usually be reversible although restoration and rehabilitation may take a long time (cf. **Figure 2**). However, degradation is sometimes irreversible, resulting in an irretrievable loss of some forest ecosystem functions (Lund 2009). Reversibility is linked to the concept of resilience, i.e. ability to recover[11].

Figure 3 Degree of Degradation



The degradation process has direct and indirect human-related causes which are often referred to as drivers. Their analysis can be difficult as the change in the forest can be gradual spreading over a long time period and the process is often very complex as illustrated by **Figure 4**. Direct human-induced causes include unsustainable logging, excessive harvesting of non-timber forest products, hunting or collection of fuelwood, charcoal production, as well as large-scale and open forest fires, subcanopy fires often associated with shifting cultivation and grazing (temporary

[9] Technically, a forest cover change would be termed 'degradation' if canopy cover dropped from e.g., 100% to 85%, or 50% to 40%, or 90% to 35%. In reality, reported degradation will be limited by the technical capacity to sense and record the change in canopy cover, so that small changes will likely not be apparent unless they produce a systematic pattern in the imagery (UNFCCC 2006a).

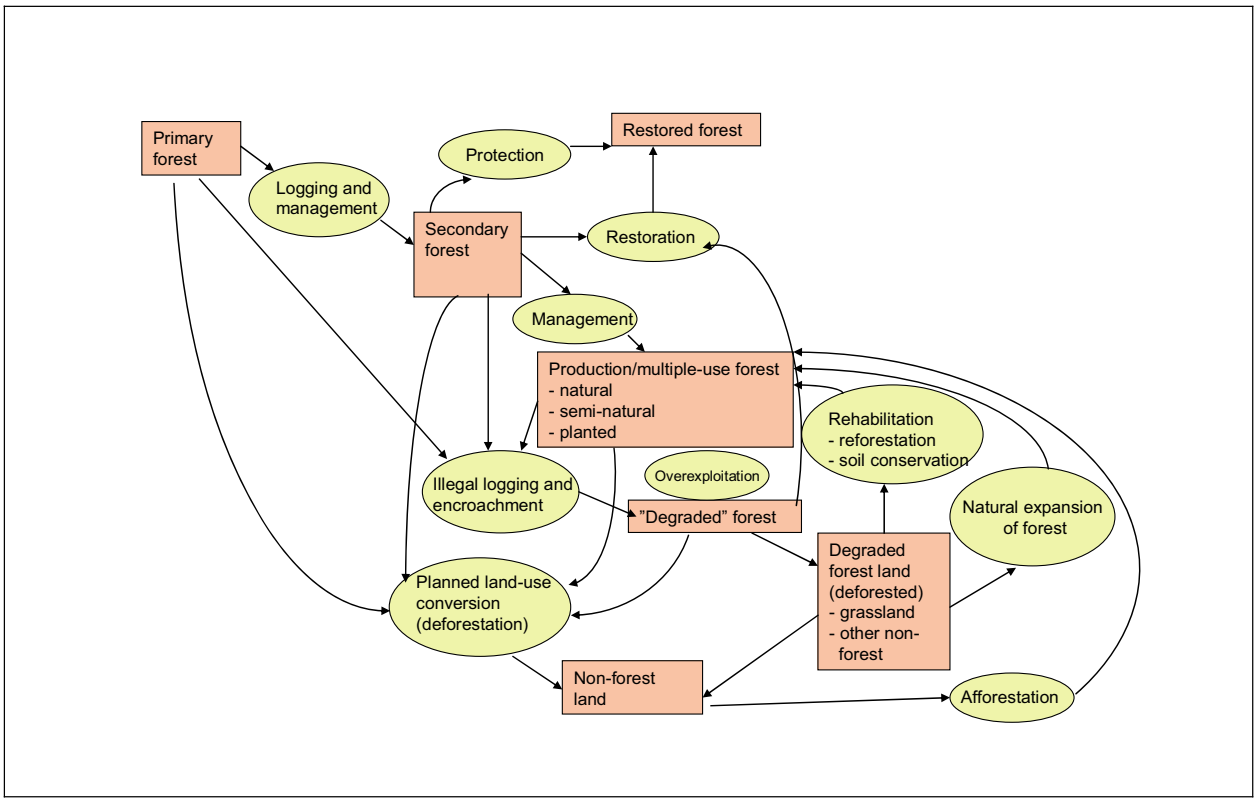
[10] However, professional judgment based on field observation can often easily establish whether a forest area is slightly or severely degraded without detailed definitions.

[11] The concept of elasticity is also sometimes used in this context (e.g. ITTO 2002).

conversion of forest to other land use) (cf. GOFC-GOLD 2008). Indirect causes are not illustrated in Figure 4 as their impact mechanisms take different forms[12].

Geist and Lambin (2002) used 152 case studies to show that at the regional scale, tropical deforestation is driven by the interactions of many different causes. The most prominent *underlying* causes of human induced deforestation and degradation were found to be economic factors, institutions, national policies, and remote influences that drive *proximate* causes of agricultural expansion, wood extraction, and infrastructure extension. At the global scale, agricultural expansion was, by far, the leading land-use change associated with nearly all deforestation cases studied, whether through forest conversion for permanent cropping, cattle ranching, shifting cultivation or colonization agriculture. Analysis on the causes of forest degradation was less explicit than on deforestation. As a general conclusion, country and local situations vary extensively and each case requires specific analysis of direct and indirect drivers of the degradation process.

Figure 4 Simplified Illustration of Human-induced Forest Degradation



Note: The figure does not attempt to depict all processes.

As a whole, forest degradation is a complex, multifaceted phenomenon which is highly location specific and does not easily lend itself for generalizations. Degraded forest is a confusing term

[12] See page 7 for discussion on direct and indirect causes of degradation.

and varying definitions have added to the confusion. Furthermore, some existing definitions are not necessarily suitable even for their intended purposes when applied operationally.

2.3 Options for Rationalization of Definitions of Forest Degradation

There are various ways to rationalize existing definitions of forest degradation to improve their transparency and identify possibilities for their improvement in view of comparability, coherence and consistency. These options have been discussed in detail by Puustjärvi & Simula (2002a; 2002b) and will be reviewed only briefly here with regard their applicability for forest degradation.

(a) Decomposition into elements of a definition

In this approach individual definitions are decomposed into their individual elements which offer a basis for comparison and identification of commonalities and differences. When this is combined with adjustment of data, monitoring and reporting can be rationalized. In this situation various definitions can be applied in parallel but collection of data on each individual component or sub-component of the definitions is necessary. This approach has been successfully applied for analytical comparison of parallel definitions and can also result in practical recommendations for indicators to be included and adjustment of data (FAO 2002b).

(b) Theoretical elimination

In this approach information on correlation (and trade-offs) between individual components is used so that those elements describing the same feature can be reduced. Only one measure or indicator can serve for the use of parallel definitions. This approach is constrained by reliable information on correlation and trade-offs between variables related to forest degradation and the problem of non-linearity of their relationship.

(c) Clustering

In this approach the components of definitions describing similar aspects are grouped together for which one single measure would be applied. This approach could help reduce data needs for assessing degradation but requires that identification of feasible clusters is possible. This approach is close to theoretical elimination.

(d) Elements of sustainable forest management (SFM)

This approach draws on the agreed seven thematic elements of SFM[13] (United Nations 2007) which have been elaborated in terms of Criteria & Indicators (C&I) under various regional processes[14]. The SFM elements provide a common framework for identification of forest characteristics and services which may be used in the identification of relevant components of forest degradation. The various C&I sets represent an important forest policy instrument which was developed mainly for monitoring and reporting on the status of forest management and the progress in the achievement of the SFM goal. C&I can be applied at national, sub-national and

[13] The elements are (i) extent of forest resources; (ii) forest biological diversity; (iii) forest health and vitality; (iv) productive functions of forest resources; (v) protective functions of forest resources; (vi) socio-economic functions of forests; and (vii) legal, policy and institutional framework.

[14] FAO (2003)

forest management unit (FMU) levels. Due to their nature and holistic approach, the C&I frameworks may be a useful tool for assessment of forest degradation.

(e) Composite measures

Composite measures by means of indices or similar measures can be elaborated by weighting individual components of forest degradation. This kind of approach could be eventually used for assessment purposes to reduce the number of variables to be reported. The Second Expert Meeting (FAO 2002b) did not consider this approach feasible as weighting requires subjective judgment. The other reason is that too much information is lost in the weighting process and the measurement outcome becomes difficult to interpret.

(f) Valuation of forest goods and services

In this approach the various goods and services of forest ecosystem would be identified (**Box 2.1**) and valued in monetary terms using relevant methods. The results could then be aggregated into one total value. This approach would suffer from the same weaknesses as the composite measures as well as difficulties and resource requirements to value non-monetary goods and services in monetary terms.

In the following, decomposition (a) is chosen as the basic approach due to its proven feasibility for analytical comparisons. Theoretical elimination (b) will be tried when applicable. The suitability of SFM elements (d) will be discussed from the perspective of assessment rather than as a tool of rationalization of definitions. Clustering (c), composite measures (e) and the valuation approach (f) will not be tried due to difficulties in their application at an international level and lack of generally applicable data for valuation of forest goods and services. Weighting of individual components in the composite measures would also imply value judgment of various forest benefits which is not relevant in the context of this discussion paper.

Box 2.1 Scope of Ecosystem Services

The Millennium Ecosystem Assessment defines ecosystem services as the benefits that people obtain from ecosystems. These include *provisioning, regulating* and *cultural* services that directly affect people as well as the *supporting* services necessary to maintain other services:

- Provisioning services: products obtained from ecosystems, e.g. food, water, fibre, fuel, genetic resources.
- Regulating services: regulation of floods, drought, air quality, erosion, climate, disease, and natural hazards.
- Cultural services: recreational, spiritual, religious, and other nonmaterial benefits.
- Supporting services: necessary for the production of all other ecosystem services; includes soil formation, photosynthesis, nutrient cycling, water cycling, and provisioning of habitat.

Source: http://www.millenniumassessment.org//en/Products.Synthesis.aspx

2.4 Related Terms

Degradation cannot be defined independently from how non-degraded and degraded forests are defined. In addition there are a number of other associated terms which are related to various relevant aspects of forest characteristics and benefits. These are summarized in **Box 2**. The definition of forest has major implications for defining degradation as it also delimits when land is no more considered forest[15]. Within the current forest definitions, degradation of other wooded land (OWL) falls under the concept of land degradation. Some terms are hierarchical; e.g. in the climate context forest (or carbon) enhancement has been sued to cover various forest improvement methods and sustainable forest management for enhanced carbon stock. Some of these terms are discussed in section 3.2 while others have been reviewed elsewhere (FAO 2002a; 2002b; 2005).

Box 2.2 Selected Related Terms

Forest • Forest • Forest type - Primary forest - Secondary forest - Modified natural forest - Semi-natural forest - Planted forest • Other wooded land • Other land Processes • Disturbance • Land degradation • Improvement • Restoration • Rehabilitation (incl. Afforestation/Reforestation) • Forest enhancement	Degradation status • Undegraded/undisturbed • Degraded forest (degrees of degradation) • Degraded forest land (deforested land) Carbon stock/flow • Biomass • Soil Biodiversity • Fragmentation • Connectivity • Species diversity Other • Permanence • Resilience/reversibility/ecological integrity • Reference status • Cause: human induced/natural

2.5 Level of Assessment of Degradation

Assessment and continuous monitoring of forest degradation are necessary to plan corrective action and to allocate scarce resources for priority areas and actions. For this purpose information is needed on the extent, severity and quality of degradation and associated drivers and impacts. However, as Lanly (2003) has pointed out the current situation is not satisfactory due in particular to the imprecision and multiple, and often subjective, interpretations of the term and the gradation it implies. As pointed out in section 2.2, drivers and impacts of human-induced degradation are often related to socio-economic factors and therefore their assessment is quite different from that of degradation and thereby influences the level of assessment.

How degradation is defined has implications for the level of assessment, choice of indicators and assessment methodology. Depending on the purpose, assessment of degradation can take place at different levels:

[15] This is particularly the case with the forest definition of the CDM which has been challenged for use under REDD (e.g. Sasaki & Putz 2009).

- global/regional/sub-regional
- national
- sub-national
- landscape/watershed
- forest management unit (FMU)
- stand/site

The first three are administrative units. The interest at this level is to obtain information on the overall status or change in forest degradation in a designated area. Typically this information is used for policy and programme design. Landscape or watershed level is associated with specific ecosystem functions (biodiversity, water supply, etc.) and often corrective action is planned and implemented at this level.

Forest management unit is a decision-making unit on forest operations involving planning, implementation and control through a systematic comprehensive approach. The size of FMU may vary from a few hectares to a few hundred thousand hectares depending on the situation. An FMU is always composed of a varying number of stands (or compartments) which represent the basic planning unit for management operations (e.g. restoration, rehabilitation, harvesting). FMU is often also a tenure unit and typically managed either by private forest owner, public agency, private company, forest community, or contracted forest manager. It is at this level that sustainability of forest management and, as part of it, forest degradation are typically assessed in practice.

Most of the available definitions of forest degradation refer to or imply assessment at stand level[16]. This approach suffers from the lack of broader geographic perspective although in assessment it can be scaled up by simply adding the polygons that are degraded together within a landscape context.[17] An FMU or a watershed as a whole may be well managed even though there are some small areas of degraded forest. Such areas can also be valuable for some forest functions[18]. The need for a broader perspective is particularly important when carbon emissions or biodiversity are considered because carbon stocks and biodiversity should also be assessed at higher than site or stand levels.

[16] E.g. FAO (2001); ITTO (2002); CBD (2005)
[17] Thompson, pers.comm.
[18] E.g. open patches and edges between closed forest and open patches are habitats for some biodiversity components.

3. INTERNATIONAL DEFINITIONS OF FOREST DEGRADATION AND RELATED TERMS

3.1 Forest Degradation and Degraded Forest

The main definitions of forest degradation by relevant international bodies are presented in **Box 3**. The generic definition of the Second Expert Meeting on Harmonizing Forest-related Definitions for Use by Various Stakeholders (FAO 2002b) provides a common framework for all the international definitions and is also compatible with the ecosystem service approach (**Box 2.1**).

3.1.1 FAO/FRA

The FRA 2000 definition elaborates the general approach by specifying that the structure or function of the stand or site must be affected for the reduction of capacity to provide goods and services. This definition is also consistent with FAO/FRA definition of 'forest' focusing on stand or site.

The FRA 2000 definition in **Box 3.1** is an improved version of the earlier working definition: "changes within the forest class (e.g. from closed to open forest) which negatively affect the stand or site and, in particular, lower the production capacity, are termed forest degradation" (FAO 2000). Production capacity is now explicitly expressed in broader terms than timber only unlike having been implied in the previous definition. The current definition also narrows down the negative effect on the structure and function of the stand or site.

Box 3.1 International Definitions of Forest Degradation/Degraded Forest

Organization	Definition
Second Expert Meeting (FAO 2002b)	The reduction of the capacity of a forest to provide goods and services.
FRA 2000 (FAO 2001)	Changes within the forest which negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or services.
ITTO (2002; 2005)	**Forest degradation** refers to the reduction of the capacity of a forest to produce goods and services (ITTO 2002). Capacity includes the maintenance of ecosystem structure and functions (ITTO 2005) A **degraded forest** delivers a reduced supply of goods and services from a given site and maintains only limited biological diversity. It has lost the structure, function, species composition and/or productivity normally associated with the natural forest type expected at that site. (ITTO 2002). Explanatory notes ((ITTO 2002; 2005): Forests that have been altered beyond the normal effects of natural processes are categorized as either degraded primary forest, secondary forest, or degraded forest land: (i) **degraded primary forest:** primary forest in which the initial cover has been adversely affected by the unsustainable harvesting of wood and/or non-wood forest products so that its structure, processes, functions and dynamics are altered beyond the short-term resilience of the ecosystem; that is, the capacity of these forests to fully recover from exploitation in the near to medium term has been compromised; (ii) **secondary forest:** woody vegetation regrowing on land that was largely cleared of its original forest cover (i.e. carried less than 10% of the original forest cover). Secondary forests commonly develop naturally on land abandoned after shifting cultivation, settled agriculture, pasture, or failed tree plantations; (iii) **degraded forest land:** former forest land severely damaged by the excessive harvesting of wood and/or non-wood forest products, poor management, repeated fire, grazing or other disturbances or land-uses that damage soil and vegetation to a degree that inhibits or severely delays the re-establishment of forest after abandonment.
CBD (2005; 2001)	*A degraded forest* delivers a reduced supply of goods and services from the given site and maintains only limited biological diversity. Such a forest may have lost its structure, species composition or productivity normally associated with the natural forest type expected at that site. (UNEP/CBD/COP/6/INF/26). A *degraded forest* is a secondary forest that has lost, through human activities, the structure, function, species composition or productivity normally associated with a natural forest type expected on that site. Hence, a degraded forest delivers a reduced supply of goods and services from the given site and maintains only limited biological diversity. Biological diversity of degraded forests includes many non-tree components, which may dominate in the undercanopy vegetation. (UNEP/CBD/SBSTTA/7/INF/3) *Degradation* is **…** any combination of loss of soil fertility, absence of forest cover, lack of natural function, soil compaction, and salinization that either impedes or retards unassisted forest recovery through secondary succession. Reduction of forest cover, forest degradation and its fragmentation leads to forest biodiversity loss by reducing available habitat of forest-dependent species and indirectly through disruption of major ecological processes such as pollination, seed dispersal, and gene flow. Forest fragmentation may also hamper the ability of plant and/or animal species to adapt to global warming as previously connected migration routes to cooler sites disappear. In certain forest types, fragmentation may also exacerbate the probability of forest fires, which further affects biological diversity in negative ways. (UNEP/CBD/SBSTTA/11/INF/2)
IPCC (2003)	A direct human-induced long-term loss (persisting for X years or more) of at least Y% of forest carbon stocks [and forest values] since time T and not qualifying as deforestation or an elected activity under Article 3.4 of the Kyoto Protocol.
IUFRO (2000)	Damage to the chemical, biological and/or physical structure of a soil (soil degradation) and to the forest itself (forest degradation), as a result of incorrect use or management, and which, if not ameliorated, will reduce or destroy the production potential of a forest ecosystem (in perpetuity). Explanatory note: External factors, e.g. air pollution, can also contribute. (Source: Nieuwenhuis 2000)

The FRA 2000 definition does not contain an explicit reference state but a comparison with a past situation is implicit. The definition does not contain an element of resilience and it does not separate human-induced and naturally caused degradation. The definition is generic covering all types of forests and all kinds of degradation.

3.1.2 ITTO

The Guidelines of the International Tropical Timber Organization (ITTO) for the Restoration, Management and Rehabilitation of Degraded and Secondary Tropical Forests provides the most elaborated definition of degraded forests. It (ITTO 2002) is similar to the definition for degraded (tropical) forest used by the Convention on Biological Diversity. The elements of structure and function are present as in the case of the FRA 2000 definition. In addition, the ITTO definition makes a special reference to species composition and productivity, the latter being covered in the FRA 2000 and CBD definition by 'supply of products and services'.

In its explanatory note the ITTO (2002) applies the term "secondary forest" which is used to describe forest conditions other than those found in protected or managed primary forests. The definition excludes planted forests which are covered by the FRA 2000 definition as they can also be 'degraded'. In terms of degree of degradation, the ITTO Guidelines distinguishes three categories based on the intensity of disturbance and these are described in detail. Salient features of each category are summarized below.

(i) Degraded primary forest suffers from slight to moderate intensity disturbance within the range of common natural disturbances[19]. Degraded primary forest may have been subject to excessive wood exploitation, overharvesting of non-wood forest products, destructive natural disturbances such as forest fires and storms or overgrazing. The forest structure is not significantly damaged, but in case of overgrazing poor understorey development and absence of young age classes of the canopy species may occur. Light demanding species regenerating after the disturbance are usually similar to those in the original forest stand.

(ii) Secondary forest suffers from disturbance of severe intensity caused by clearing of at least 90% of the original forest cover due to clear-cutting, burning and subsequent abandonment of an area or catastrophic large-scale natural disturbances (e.g. fires, flooding, storms and landslides). Regrowing forest differs in species composition and in physiognomy from primary forest, and the species present are highly light-demanding.

(iii) Degraded forest land is a result of drastic and repeated intensive disturbance with complete removal of the forest stand, loss of topsoil and change in microclimate due to repeated overuse, repeated fire, grazing, or ecological mismanagement of fragile soils, soil erosion, etc. In degraded forest land forest vegetation is lacking; single or small groups of pioneer trees and shrubs may or may not occur.

In comparison FRA 2000 defines primary forest as "naturally regenerated forest of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed" (FAO 2001). This implies that, if visible and disturbed ecological processes, human activities can lead to re-classification of an area as 'non-primary' forest. In the case of ITTO (point (i) above) primary forest remains primary in spite of "moderate" intensity of disturbance ("managed primary forest"). There is a difference in the two approaches which may not necessarily be significant in practice but their harmonization would be beneficial.

[19] Note that this is not fully consistent with ITTO definition in Box 3.1.

The ITTO definition of degraded forest includes a reference state ("normally associated with the natural forest type expected at that site") which is not mentioned in the FRA 2000 definition. The explanatory note elaborates further: "beyond the normal effects of natural processes." This raises the issue of whether natural disturbances (fire, storm, snow, etc.) are considered "normal" or not, particularly in extreme cases. Elimination of possible inconsistency in the explanation could be beneficial.

Resilience is part of the definition of degraded primary forest but it is qualified as "the short-term resilience of the ecosystem; that is, the capacity of these forests to fully recover from exploitation in the near to medium term"[20]. The concept is not included in other categories of degraded areas but it would be relevant also for secondary forests which may have different degrees of degradation.

Like the FRA 2000 definition of degradation, the ITTO definition implies a stand or site level focus but the Guidelines deal equally with the landscape level as it is recognized that many features of degradation are particularly relevant at higher than stand level.

The ITTO Guidelines clearly separate the concept of degraded forest (which can be restored to non-degraded state) and degraded forest land which has lost forest cover (below the threshold) and may or may not be rehabilitated (to become again any kind of forest). Rehabilitation is not possible if "natural regeneration is inhibited or severely delayed" in which case the area may be classified into other land cover categories (e.g. barren land). The situation is complicated as there are various national definitions and practices to define forest land which has lost its canopy cover using technical or administrative criteria.[21]

Both FRA 2000 and ITTO lump together both natural and human-induced reasons unlike IPCC (cf. section 3.1.4). In the first case this is due to difficulties in national reporting to FRA and in the case of ITTO the focus of the Guidelines is rather on restoration and rehabilitation than addressing direct causes of degradation.

3.1.3 CBD

The CBD COP-6 definition (CBD 2005) of forest degradation is consistent with the generic definition (FAO 2002b) and the FRA 2000 definition but, instead of "structure and composition", it specifies the impact of degradation on "structure, species composition or productivity". The reference state is similar to that in the ITTO definition. The CBD definition is explicit on the level of biodiversity maintained on the site ("maintain only limited biodiversity") as the ITTO definition. Neither of the two definitions refers to the nature of direct causes of forest degradation. The CBD and ITTO definitions can be considered harmonized with each other.

In the earlier SBSTTA-7 (2001) elaboration, degraded and secondary forests are considered synonymous terms which is different from ITTO's approach in which also primary forest can be degraded without being secondary forest. The SBSTTA definition specifies human activities as a

[20] Thompson et al. defined resilience as the capacity of an ecosystem to return to a former state after a disturbance sufficiently large to alter the system in some way (e.g. fire).

[21] Forest vocation land (in Spanish 'tierra con vocación forestal') is an administrative concept in forest legislation of many Latin American countries.

necessary condition to forest to be considered "degraded". Otherwise the SBSTTA definition is fully consistent with the CBD COP-6 version. In addition to tree components, it also emphasizes the consideration of biodiversity in the understorey vegetation.

CBD's Inter-Sessional (Second) Meeting of the AHTEG on the Review of Implementation of the Programme of Work on Forest Biological Diversity in 2005 stated that (forest) degradation is a loss process covering a combination of several environmental components (soil fertility and compaction, forest cover, natural function, salinization) and qualifying it to impeding or retarding natural recovery ("unassisted forest recovery through secondary succession"). This interpretation which goes well beyond the succinct COP-6 definition can be problematic as it implies degradation in areas which have lost forest cover and are no more classified as forest. It is neither clear whether the list of environmental components is to be considered comprehensive.

3.1.4 UNFCCC/IPCC

Any program to reduce the impact of deforestation and degradation on the global climate depends upon accurate and precise estimates of emissions resulting from such land use changes and how the emissions change over time. There are three principal aspects to this estimation:

1. Change in forest and vegetation cover[22]
2. Change in carbon stocks
3. Estimation of emissions and removals

Forest and forest degradation are not defined for reporting under the UNFCCC. Forest degradation has been explored in the context of the Kyoto Protocol and its definition of forest[23]. Several COP decisions, SBSTA sessions, workshops, have referred to or dealt with forest degradation under the auspices of the UNFCCC but no agreed definition exists.

At its seventh session in 2001, the Conference of the Parties (COP) of the UNFCCC, in decision 11/CP.7 on land use, land-use change and forestry, invited IPCC to develop definitions for direct human-induced degradation of forests and devegetation of other vegetation types. Subsequently a workshop organized by IPCC considered five possible definitions of forest degradation based on existing and proposed definitions (**Box 3**) and the workshop's conclusion is provided in Box 3.2 but the proposed definition has no formal status.

The IPCC workshop considered various options in terms of their methodological implications for land area identification, emission estimation and general aspects. Options 3 and 5 explicitly link the definition with (a change in) carbon stocks which is the main focus of the UNFCCC. Broader holistic definitions (options 1, 2 and 4) have difficulties for operationalization due to land area identification and thereby for quantification and monitoring of carbon stocks.

---

[22] Change mentioned in (1) and (2) might be also due to forest adaptation to climate change, not only due to degradation; a change does not necessarily mean that forest is becoming degraded; it can also be a positive change.

[23] Forest is a minimum area of land of 0.05 – 1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10 – 30% with trees with the potential to reach a minimum height of 2 – 5 metres at maturity *in situ*. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high portion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10 – 30 per cent or tree height of 2 – 5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest (UNFCCC 2002).

It is apparent from the alternative definitions in Box 3.2 how specific terms and phrases may affect the implementation of emissions inventory and reporting. Key concepts that appear in these definitions include (cf. IPCC 2003a):

- *Canopy change*: Changes in forest structure that are not directly related to observable changes in canopy cannot be detected by remote sensing. Remote sensing remains one of the most efficient means of detecting activities across broad spatial extents that impact forests. Only option 1 makes a reference to crown cover.
- *Carbon stocks*: Estimating emissions from changes in forest structure involves an assessment of carbon pools as elaborated in Chapter 3 of the *GPG-LULUCF* (IPCC 2003a). For inventory and reporting on emissions, reference to carbon stocks is probably necessary if reliable proxies are not available. For example, production impairment is not sufficient as such a change may or may not be associated with discernable carbon stock changes.
- *Biomass*: Defining forest degradation based on changes in biomass may be the most straightforward to implement and can be directly related to estimates of all relevant forest carbon pools.
- *Exclusion of deforestation*: It is important to ensure that the definition of forest degradation does not include deforestation as defined in the Marrakech Accords[24].
- *Source of degradation:* To maintain consistency with other definitions applied to the Kyoto Protocol, forest degradation should be limited to direct human-induced processes, activities, and practice[25].

Furthermore, the workshop (IPCC 2003a) concluded that forest degradation, being limited to forests, therefore embodies a concept of a minimum area[26]. However, activities that cause forest degradation may occur in isolated portions of a forest, so it might be helpful to clarify the minimum area impacted by activities within a forest in defining forest degradation. As the gradual aspect of degradation process is difficult to detect through available remote sensing methods, the workshop report concluded that the possible usefulness of a minimum area requires further consideration.

---

[24] This implies adoption of the forest definition for CDM of the Marrakech Accords which also applies to Annex I countries' reporting for the LULUFC sector under the Kyoto Protocol.

[25] However, limiting to direct human-induced can lead to problems. When an area has had the tree cover reduced by a catastrophic event, a loss of carbon could not be reported. Since the degradation was not human-induced, then there would be no need to track the area. If the same area was then reforested by tree planting or seeding, that would count as an increase in carbon stock. Since there was no loss reported but the reforestation activity was reported, this could lead to a result that there has been an increase of forest area (Lund, pers. comm.).

[26] See footnote 17

Box 3.2 Alternative Definitions of Direct Human-Induced Forest Degradation and their Methodological Implications

Optional definition	Methodological implications
(1) A direct human-induced loss of forest values (particularly carbon), likely to be characterised by a reduction of tree crown cover. Routine management from which crown cover will recover within the normal cycle of forest management operations is not included.	Land Area Identification - Use of "crown cover" leads to readily identifiable land areas for monitoring and verification purposes. - Not all losses of forest values result in tree crown cover loss. Emissions Estimation - It is difficult to identify and separate routine or normal management operations. General - "Forest values" go beyond those relevant to emissions reporting and might be relatively difficult to define and quantify. - This definition restricts changes to those that are direct human-induced
(2) Changes within the forests that negatively affect the structure or function of the stand and site, and thereby lower the capacity to supply products and/or services. (FAO 2001; UNEP/CBD/COP /6/INF/26)	Land Area Identification - It is not technically feasible to implement identification of land areas. Emissions Estimation - Change in structure or function may not be accompanied by change in carbon stock. General - *Degradation* as defined may not be human-induced. - "Products and/or services" go beyond those values relevant to emissions reporting. - This definition includes changes that may be temporary.
(3) Direct human-induced activity that leads to a long-term reduction in forest carbon stocks.	Land Area Identification - This definition provides no basis for identifying land areas affected by *degradation*. Emissions Estimation - This definition explicitly links to change in carbon stocks. General - This definition specifies change in carbon stock is direct human-induced, long-term and not temporary. "Long-term" requires interpretation.
(4) The long-term reduction of the overall potential supply of benefits from the forest, which includes carbon, wood, biodiversity and any other product or service.	Land Area Identification - This definition provides no basis for identifying areas affected by *degradation*. Emissions Estimation - Consideration of forest values beyond carbon stocks is required. General - This definition follows recommendations from the FAO's second expert - meeting on harmonizing forest-related definitions for use by various - stakeholders (FAO 2002b) - It is impossible to quantify/verify a reduction in "potential supply of benefits". - This definition represents a broad set of values that would encourage a comprehensive treatment of forest values. - Comprehensive treatment going beyond those relevant to emissions reporting might be relatively difficult to define and quantify. - This definition does not specify it is direct human-induced.
(5) The overuse or poor management of forests that leads to long-term reduced biomass density (carbon stocks).	Land Area Identification - Determining overuse and poor management practices creates difficulty in identifying those areas to be reported and in estimating emissions. Emissions Estimation - This definition only explicitly links to change in "biomass" carbon stocks. General - This definition parallels the definition of "degraded forest" in the *IPCC Guidelines*. - This definition specifies change in carbon stock is direct human-induced, and long-term, not temporary. "Long-term" requires interpretation. - "Overuse" and "poor management" imply direct human-induced

Source: IPCC 2003a

With the exception of the FAO definition (option 2), the reduction in forest carbon stocks features in all the five options in Box 3.2. In fact none of them fully meets the desired characteristics of a definition of forest degradation that can be effectively operationalized for reporting emissions. This led the IPCC workshop to choose a framework for a definition stated in Box 3.1. In terms of changes in carbon stocks, degradation represents a measurable, sustained, human-induced decrease in canopy cover with measured cover remaining above the threshold of the definition of forest. However, it would remain to specify an area threshold if desired, as well as time and carbon loss thresholds in order to operationalize the chosen definition of forest degradation.

In its decision 2/CP.13, the Conference of Parties to the Convention, at its thirteenth session in 2007, requested its Subsidiary Body for Scientific and Technological Advice (SBSTA) "to undertake a programme of work on methodological issues related to a range of policy approaches and positive incentives that aim to reduce emissions from deforestation and forest degradation in developing countries". As a follow-up, a workshop on this subject was held in Tokyo in June 2008. The meeting agreed that addressing emissions from forest degradation was more difficult than addressing emissions from deforestation. It was also noted that there are different types of forest degradation and some may be easier to measure than others (UNFCCC/SBSTA 2008)[27].

Several ideas have been proposed for the consideration of definition and measurement of forest degradation but no conclusion apart from calling for further work has been achieved as yet demonstrating the technical and policy complexities of the issue. In view of the difficulties encountered, it has been noted that consideration of definitional issues may not be required, depending on the assessment approaches used. Approaches that focus on the estimation of carbon stocks across a certain area of land and which would directly estimate the decrease or increases of carbon stocks over time may not depend on precise definitions of degradation (UNFCCC 2007).

The Informal Meeting of Experts on Methodological Issues Relating to Reducing Emissions from Forest Degradation in Developing Countries in October 2008 did not make a definitional recommendation but concluded that stratification of forests based on drivers of forest degradation or on types of human impacts can facilitate the sampling design for estimating changes in carbon stocks in forests (UNFCCC 2008b). This would, however, imply that degraded forests can be identified. In addition, such approaches would also imply that the geographic level of assessment would probably be higher than "stand" or "site", e.g. a forest management unit, a landscape, a watershed or any other appropriate sub-national unit.

Currently, detailed information on any prior state of vegetation cover, such as canopy cover, tree heights, forest fragmentation or parcel sizes is missing for large parts of the world (Indonesia, 2002). Information on growth, yield, wood density, biomass functions and sequestration potential is also lacking for many areas (Rakonczay 2002). Remote sensing with a resolution necessary for quantifying such parameters can be economically infeasible (Dutschke 2002). However, field surveys are likely to be even more expensive, particularly in remote areas or other areas with difficult access. Hence, expert judgment may have to substitute for firm data which represents a source of uncertainty.

[27] Subsequently, the Ad Hoc Working Group on Long-term Cooperative Action under the Convention considered the issues relating to REDD+ in para 1 b iii of the BAP in April 2009 (FCCC/AWGLCA/2009/5).

The IPCC Good Practice Guidance (GPG) (IPCC 2003b) applicable in all UNFCCC member countries provides methodologies that can be used for estimating and monitoring emissions and carbon stock changes from forest degradation as part of GHG inventory of emissions and carbon stocks. It includes all land with woody vegetation consistent with thresholds used to define forest land in the national GHG inventory, sub-divided into managed and unmanaged, and also by ecosystem type as specified in the IPCC Guidelines. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category. Forest degradation occurs within what is defined as "forest land" but it may also include land areas which may be temporarily without sufficient forest cover if such lands are under (management) systems which are expected to bring the forest back to the area in a way which meet the threshold values[28]. Where there are emissions from forests due to a decrease in canopy cover that does not qualify as deforestation (does not lead to loss of canopy cover below the 'forest' threshold), it is termed as degradation. Therefore, estimations of degraded areas will be affected by the definition of a "degraded forest", which is not standardized (UNFCCC 2006a).

The methodologies of the IPCC Guidelines can be applied consistently over time and under different national circumstances. Reliable and transparent results from application of these methods are often hampered by lack of data on both change in forest cover and, more critically, by change in carbon stocks (UNFCCC 2006a). Therefore, the Guidelines encourages countries to specify national definitions and report any threshold parameter values used in the definitions, use detailed ecosystem classifications in the calculations and in reporting broad specified categories to ensure consistency and comparability of national data across countries. As regards national forest definitions, many countries are reporting using the FRA 2000 definition as it is well established and widely used internationally (Sanz-Sanchez, pers.comm.). Nevertheless, the IPCC Guidance (IPCC 2003b) enables countries to take a progressive approach, improving as much as possible through time but there is also a perceived need to develop some basic set of guidance for monitoring of forest degradation to allow all countries to participate on a similar foundation (UNFCCC 2009b).

For measurement purposes it would probably be ideal if degradation could be established as a measurable sustained decrease in canopy cover (with canopy cover remaining greater than the minimum to qualify for forest). However, degradation affects all the five land use carbon pools (UNFCCC 2006a).

3.1.5 IUFRO

The IUFRO definition (Box 3.1) is not a result of political negotiation which makes it different from the other international definitions. It represents, however, a common view of the term degradation from the scientific perspective being identified in the subject field of soil sciences. Therefore, forest degradation is taken as a sub-concept for degradation.

The definition refers to human induced degradation and it is focused on reduction of the production potential but it is unclear whether services are included. The scope is explicitly a forest ecosystem making the definition different from the other international approaches. This may limit the applicability of the definition for policy purposes.

[28] The IPCC GPG Guidelines focus on spatial changes between six land categories of which 'forest land' is one and estimation of carbon pools on them.

3.2 Related Terms

3.2.1 Degraded Land

Land degradation acts synergistically with forest degradation. Land degradation often follows deforestation and forest degradation[29]. It is a massive environmental problem with catastrophic results affecting humanity today. It is most commonly associated with soil erosion, nutrient depletion, water scarcity and disturbances in biological cycles, but can also be the result of chemical contamination and salinity.

The Land Degradation Assessment in Drylands (LADA) project is identifying those areas that have been particularly affected over the past 25 years. The key indicators used are net primary productivity or biomass production and the methodology relies heavily on satellite measurements of the normalized difference vegetation index or greenness index. Another variable used is rain-use efficiency, which is net primary productivity per unit of rainfall. The purpose is to identify areas with a declining trend in net primary productivity and declining rain-use efficiency (UNEP 2007).

The three key variables used by the LADA project are highly relevant to forest degradation as underlying measures but they are not sufficient for assessing forest degradation due to the broad range of products and services generated by forests.

3.2.2 Forest Disturbance

Disturbance has been defined as an environmental fluctuation and destructive event that affects forest health, structure, and/or changes resource or physical environment at any spatial or temporal scale.[30] Disturbance includes biotic agents such as insects and diseases and abiotic agents such as fire, pollution and extreme weather conditions (FAO 2006a; 2006b; White and Pickett 1985). The definition excludes human induced disturbances but in many other contexts disturbance is used as a generic term covering both natural and human induced events (e.g. ITTO 2002; UNEP/CBD/SBSTTA 2001).

Natural disturbances can be differentiated by their quality, severity, extent and frequency and they are observed at various temporal and spatial scales. Compared to unmanaged natural forest, disturbance variation tends to be reduced in managed forest in which human intervention changes the structure and composition of the forest towards a specific objective (often including also actions targeted at reducing threat to natural disturbances). In the boreal zone this usually leads towards increased homogeneity of the forest area and thereby less diversity (Kuuluvainen 2009) which may also be the case in managed natural forests for timber production in other biomes. The impacts depend however on many biological and socio-economic factors.

3.2.3 Forest Fragmentation and Habitat Connectivity

Only CBD has provided a definition for forest fragmentation**:**

> *Fragmentation is the subdivision of a habitat or land cover type either by a natural disturbance (e.g., fires, windthrows) or by human activities (e.g. roads, agriculture). (UNEP/CBD/SBSTTA 2001).*

---

[29] Cf. section 1.1.

[30] Usually the impact of disturbance is perceived negative but in natural forests it can also be part of succession.

Deforestation and forest degradation have altered many of the world's tropical forest landscapes to such a degree that at the very most only 42% of remaining forest cover (or 18% of original forest cover) in the tropics is still found in large, contiguous tracts. The forest estate of eight ITTO producer countries now exists only as fragmented, mostly modified and sometimes degraded blocks. This means that at least 830 million hectares of tropical forest are confined to fragmented blocks, of which perhaps 500 million hectares are either degraded primary or secondary tropical forest and can be considered part of modified forest landscapes (ITTO/IUCN 2005)[31]. Habitat fragmentation has been recognized as a major threat to tropical forest ecosystems.

Fragmentation is an aspect of forest degradation as it is largely caused by the same factors. However, in addition to natural disturbance (e.g., fires, windthrows), shifting cultivation, etc. it is influenced by land use change and habitat loss, e.g. the clearing of natural vegetation for agriculture or road construction, which often leads to previously continuous habitats to become divided into separate fragments. Forest fragments in human-dominated landscapes tend to be below one hectare in size (Laurance 2005).

The effects of fragmentation will depend on the size of the fragments; on what is in the fragments, their evolution before fragmentation (if one is interested in maintaining e.g. species diversity, this could/would refer to the number, or percentage, of the original ones found in the (larger) area); and on what is happening outside the fragments.[32] It is well documented that the negative effects of habitat fragmentation are strong enough to promote local as well as regional extinction of canopy and emergent trees in neotropical forests. However, forest fragmentation does not occur alone but is always associated with other human-induced threats to trees, such as logging, forest burning and hunting of key vertebrate seed dispersers within forest remnants. This association occurs because forest resources are, at least during a certain period, the main income source for local human populations (Tabarelli et al. 2004).

Fragmentation has a major impact on biodiversity, increasing isolation of habitats, endangering species of plants, mammals and birds, and modifying species' population dynamics. It may also hamper the ability of plant and/or animal species to adapt to global warming as previously connected migration routes to cooler sites disappear. In certain forest types, fragmentation may also exacerbate the probability of forest fires, which further affects biological diversity in negative ways. (UNEP/CBD/SBSTTA/11/INF/2).

As a result of fragmentation, fluxes of radiation, wind, water and nutrients across the landscape are altered significantly. Small fragments of habitat can only support small species populations, which tend to be vulnerable to extinction. Species, which are specialized to particular habitats, and species, whose dispersal ability is weak, suffer from fragmentation more than generalist species with good dispersal ability. On the other hand, fragmentation may at times have a positive effect on e.g. intra-specific diversity of higher species (increasing variation in sub-populations through diverging selection in sub-populations, and keeping them apart is a proven way to increase intra-specific variation in tree improvement strategies, for example).[33]

---

[31] In 2000, FAO identified a total of 223 million ha of such forests in the pan-tropics (FAO 2001).

[32] Palmberg-Lerche, pers. comm.

[33] Ibid.

Fragmentation is therefore associated with a decrease in patch size and increasing isolation between habitat patches. Also, the size of core areas decreases and the size of edge areas increases. The effects of habitat fragmentation on species diversity vary among different habitats and taxa.

As a related concept, habitat connectivity refers to the functional connections among habitat patches (Rouget et al., 2003). The disruption of landscape connectivity may have substantial consequences for the distribution and persistence of species. A simple index of connectivity can be calculated as the relationship between the largest size patch and total area of a cover type.

Landscape connectivity is a term that emerged in the early 1980s, and encompasses two related aspects. The first aspect is structural connectivity, which is defined as the degree to which patches are connected through corridors. Structural connectivity can be measured through metrics that are independent of any particular species, and landscapes are defined in terms of their 'porosity' and 'permeability' (Taylor et al. 2006).

The second aspect is functional connectivity, which is defined as the degree to which the landscape configuration of the matrix, patches, and corridors enables the movement of species and the functioning of ecological processes (Tischendorf & Fahrig, 2000; Taylor et al.1993). Structural connectivity is generally easier to measure than functional connectivity (Taylor et al. 2006). Focusing on structural connectivity may be appropriate at regional and continental scales, but for national-scale and landscape-scale initiatives, a focus on functional connectivity is more appropriate and likely to result in better conservation planning. Functional connectivity focuses on a specific set of focal species and ecological systems and lends itself to assessment within an ecological network (CBD 2009).

Location-specific information related to connectivity and fragmentation is available on a number of biomes, including in particular on forests. Interpretation of the patterns of forest cover change requires consideration of the distribution of forest types as well as the characteristics of forest species present and their ability to cope with fragmentation or deforestation. To quantify the spatial patterns of forest cover change, different spatial indices (or metrics) have been developed in the recent years. The main aspects that these attempt to capture are a loss of total habitat area, an increase of patch abundance and density, a decrease of patch size, a reduction in core area, and an increase in patch edges.

The current availability of forest cover datasets is sufficient to allow the assessment of forest fragmentation at global and country level. Therefore, fragmentation can be used as an indicator of ecosystem integrity for forests (CBD 2005). However, available estimates cover a wide range (e.g. FAO 2001; ITTO/IUCN 2005) which suggests that further work is likely to be needed in this area.

3.2.4 Forest Improvement, Forest Restoration and Rehabilitation

These three directly human–induced processes are targeted at stopping the degradation process and creating an improvement in forest characteristics (structure and function). These activities typically also lead to carbon stock accretion within the forests. Definitions are provided in FAO (2002b) and ITTO (2002).

In addition to direct measures of restoration and rehabilitation, there is evidence on indirect human-induced improvement in the degraded forest if the degradation process can be halted. Biomass growth may be enhanced as a consequence of higher temperatures, nitrogen deposition, altered disturbance- and competition regimes, and raised CO_2 levels in the ambient air. This can result in carbon sequestration with an estimated magnitude of 0.05 to roughly 0.5 t C/ha yr-1 in tropical forests (Laurance 2005) which is not negligible for net emissions. Growing stocks and carbon stocks may also accrue within many logged-over or secondary tropical forests as a result of the natural biomass growth through ageing.

4. NATIONAL DEFINITIONS OF FOREST DEGRADATION AND THEIR OPERATIONALIZATION

A special survey was carried out as part of this report in order to understand how countries have defined forest degradation and related terms in their specific contexts, how degradation has been assessed and what indicators have been used in its measurement (cf. section 1.3).

4.1 National Definitions of Forest Degradation

Only one third of the responding 45 countries reported to have a definition for forest degradation/degraded forest and these are reproduced in Annex 1. Different strategies have been adopted with regard to defining forest degradation in the national context:

(a) Some use international definitions like FRA 2000 (5 references) or IUCN (1), some others use those developed regionally by such organizations as COMIFAC (1), CATIE (1) and the ASEAN Expert Group (1).
(b) Some countries have developed their own definitions which may be legally or otherwise recognized (Argentina, Mongolia, Iran, Turkey, Iceland).
(c) Some countries use different vegetation categories in classification and degradation is (usually implicitly) considered as a change from a class to another; the criteria applied are canopy cover and tree height (Mali, Mexico and Croatia).
(d) Without using a specific definition for degradation, several countries use various indicators of its measurement and may even set threshold values to identify degraded areas, typically related to timber production productivity or stocking level.
(e) Some countries do not have definitions for degradation but they define associated terms such as secondary forest, degraded forest land, etc. As a whole, 44% of the replying countries have some definitions for associated terms.

Typical indicators referred to in definitions of degradation/degraded forest are:

- Stocking level (6 countries; 4 in Europe and 2 in Asia)
- Productivity (7 countries; 5 in Europe, 1 in Asia and 1 in South America)
- Biomass density (3; two in Africa and 1 in South America)
- Canopy cover (4; two in Asia and 1 in South America and Europe, each)
- Species composition (2; one in Asia and South America, each)
- Structure (1 in South America)
- Number of trees per ha (1 in Oceania[34])

[34] Coconut plantation

Most replying countries focused on timber production aspects (i.e. stocking level, productivity, biomass density). Argentina appears to have the most comprehensive system of definitions related to degradation which is included in the national legislation. Their definition specifies loss/reduction of biomass, structure, species composition, function, productivity, and capacity to provide goods and services.

Local conditions appear to have a strong influence on the specific indicators used (explicitly or implicitly) when defining forest degradation or degraded forest. For example, in the Russian Federation the focus is given to the sanitary condition of the forest and in Iceland the indicator is vitality of trees undergoing regeneration. Only one country (Mongolia) gave emphasis on socio-economic aspects in the context of degradation.

The most common reference level appears to be what is expected on the site. The most frequent aspect referred to is the stocking level, canopy cover or growth rate. A qualitative element is used e.g. in Sweden ("satisfactory"/unsatisfactory").

Some respondents have not clearly separated the causes for degradation and deforestation. Some countries specifically referred to fragmentation (rather than degradation) which also typically involves some land conversion.

4.2 Extent of Degradation

Sixteen countries (about a third of the responding countries) were able to provide quantitative estimates on the degree of degradation (Annex 2). However, not all of these countries had provided a definition of forest degradation/degraded forest. In absolute terms, the largest degraded areas are reported by the Russian Federation, Mali, Turkey, Mexico and Mongolia[35].

There is a significant variation in the share of degraded areas in the total forest area. The highest shares are found in Mali (98%), Niger (83%) and Ghana (69%) but also in Turkey and Tonga almost a half of the total forest area is reported as degraded. The lowest levels are found in Europe where several countries reported zero or negligible shares of degraded forest; unproductive lands are not usually considered degraded as the reason for unproductiveness is typically natural site conditions. However, in this region degradation is reported to be also a significant problem in many other countries (e.g. Iceland, Croatia, Russia and Latvia). In addition to Europe, a very low share of degraded forest in the total forest area is reported in Chile (0.1%).

4.3 Causes of Degradation

There are major difference between regions and countries with regard to causes of forest degradation (Annex 3). This is an area where there is most information as 80% of the responding countries provided explanations either in terms of percentage of each cause, their order of importance, or just listing the main reasons. Causes of degradation cover in most cases both biotic and abiotic reasons or are generic ("outside influences", "external factors"). Depending on local conditions, some countries reported only one cause (e.g. in the Czech Republic air pollution and in Finland errors in forest management which have led to loss of productivity). A total of

[35] Due to lack of response from several important forest countries, the results should not be interpreted beyond the sample of replying countries.

about 20 different reasons were identified in country replies. The reported data is summarized below by regions:

In Africa there are four main reasons but their importance varies between countries: (i) illegal logging, (ii) fire, (iii) fuelwood collection, and (iv) shifting cultivation. In the Sahel countries, grazing, drought and fuelwood collection are the key factors. Three countries identified mining but its contribution to the total degraded area was in the range of 5%. Biotic factors are less important than in many other regions. Land occupation and development projects are not reported to be among the main causes, with few exceptions. In Somalia lack of security in forest areas was a major reason.

In Latin America the situations also vary between countries but the main reasons are broadly the same as in Africa. In Ecuador illegal logging is paramount but it is also important elsewhere. Paraguay suffers from excessive fuelwood collection while in Peru shifting cultivation is the main reason with mining also being a significant factor.

In Asia, fire, excessive logging and pests as well as diseases and insect attacks are the key common factors. Illegal logging is a particular problem in Mongolia which also suffers from grazing pressure like Iran. Erosion and drought are key problems in Cyprus and Turkey. Together with Iran, Turkey also suffers from impacts of mining. In Turkey unauthorized land occupation and in Iran fuelwood collection are specific key problems.

In Europe there are three main reasons for forest degradation: fire, pests and diseases, and wind damage. There is also pressure from land occupation and development activities which sometimes result in degradation of adjacent forest areas. There is little reference to air pollution in Central European countries as the main reason for degradation unlike a couple of decades ago.

In the Pacific Islands wind, coastal erosion, fuelwood, development projects, and pests and diseases were reported as the main causes of degradation.

In general, with progress in development, the traditional underlying reasons like poverty (mentioned only by two countries in Africa) and associated factors start to gradually lose their importance through a shift towards permanent agriculture and due to increasing urbanization. At the same time, other problems tend to arise like the impacts of road construction and other development projects. Building secondary homes, recreation and tourism were mentioned as causes of forest degradation in some developed countries. Country situations appear to be nuanced and general regional-level conclusions should be interpreted with care.

4.4 Related Terms

4.4.1 Unproductive Forest

Eleven countries (24%) use this term and two more countries apply the concept of poorly stocked forest. The criteria for defining unproductivity vary including stock density which may be measured by m3/ha, number of trees per ha (Brunei), or basal area (Sweden), MAI (less than 1 m3/ha/yr in Iran and Germany but the latter has also other qualifications), and forest with timber of desired species (Ghana). In Finland unproductivity is expressed in relative terms with regard to production of productive stands in similar site (60% is the threshold).

4.4.2 Damaged and Devastated Forest

These two concepts were mentioned by two countries. Damaged forest represents a partial or complementary loss of growth potential of a stand (Latvia) or a forest prevented from natural development of the ecosystem (Slovenia). Devastated forest is prevented from the performance of forest functions due to measures which are inappropriate on the site (Slovenia).

4.4.3 Secondary Forest

The term is used at least in nine responding countries (20% of the total) but not all have defined it. The general feature is natural or aided regeneration after a drastic disturbance. Some countries specify that the disturbance has involved total removal of natural forest and some others specify partial removal or damage. There are various additional interpretations of the details of the term secondary forest. For instance, Peru emphasizes the successive character of secondary forest; Iran considers only natural regeneration, while in Nepal secondary forest can also be planted. In Turkey instability of the forest vis-à-vis threats of decay or insect damage is mentioned. It appears that it will be difficult to harmonize the term secondary forest on an international level.

4.4.4 Forest Rehabilitation and Restoration

In general rehabilitation refers to action targeted at establishment of adequate tree cover in degraded forest lands (typically by replanting), while restoration (applied in six countries) is a term used mainly for degraded forests to recover their ecological functions or integrity. Restoring the forest cover can take place through reforestation, natural regeneration or assisted natural regeneration.

There is some inconsistency in general interpretation of the two terms. One country incorporates restoration into rehabilitation while two countries apply restoration in the broad sense including also rehabilitation in it.

Forest restoration generally focuses on broad concepts such as ecosystem services (Mexico), functional capacity of forests (Romania), biodiversity (Costa Rica), or a broader range of forest goods and services (Ghana).

Part of the inconsistency in the use of these two terms can be due to language reasons but there are also clearly different interpretations of the terms on an international level. The definitions of the ITTO Guidelines for the Restoration, Management and Rehabilitation of Degraded and Secondary Tropical Forests (2002) offers a suitable basis for a systematic use of the term forest rehabilitation for degraded forest lands and the term forest restoration for degraded forests.

4.4.5 Forest Fragmentation

Six countries report to have definitions for forest fragmentation of which two (Cyprus and Turkey) report to use the international CBD definition. Even though the wording of national definitions may vary the meaning still tends to be similar. For instance, in Ghana fragmentation is “breaking of contiguous forest into fragments that are separated by non-forested areas”. Costa Rica relies on Bennet (2004) who elaborated the concept as “dynamic process which creates significant changes in the habitat in a landscape over time. This involves complete elimination of large segments of vegetation leaving large numbers of small segments which are separated from each other”. The same idea is contained in the USDA Forest Service definition: “loss of open

space occurs when forests and rangelands are divided into small isolated parcels, most commonly by subdivision and development." Argentina links the definition with the loss of forest cover and refers to the modification of the natural structure of the landscape which generally implies loss of spatial continuity of forests.

The CBD definition of forest fragmentation offers a suitable basis for international harmonization of the term forest fragmentation in spite of slightly different interpretations and areas of emphasis in national definitions.

4.4.6 Habitat Connectivity

Only four countries reported on connectivity. Ghana, Costa Rica and Romania refer to ecological corridors in this context. The Costa Rican law on biodiversity provides the most elaborated definition which includes the following elements: delimited area the purpose of which is to provide connectivity between landscapes, ecosystems and habitats, be they natural or modified, to ensure the maintenance of biodiversity and the ecological and evolutionary processes. Such areas can be specially administered, nucleus zones, buffer zones, or areas of multiple uses, which all can provide social concentration spaces for inversion in the conservation and sustainable use of biodiversity.

In the United Kingdom research has been carried out to define a suitable habitat connectivity indicator which will form one of the country's 18 biodiversity indicators (Box 4.1). The indicator is species specific which limits its applicability.

There is again a good basis to use the CBD definition as the basis for international harmonization of habitat connectivity. For national monitoring purposes, relatively simple approaches could be in many countries useful rather than building on detailed and complex definitions.

Box 4.1 Habitat Connectivity Indicator (UK)

The proposed indicator accounts for edge impacts (i.e. negative effects of adjoining land cover that differs from the habitat of interest) by applying an internal edge buffer, weighted by the intensity of surrounding land cover, to remove a strip of habitat from the area of interest. The indicator then calculates the probability of movement within and between the remaining habitat patches. These potential movements are weighted by the area of the patch, with more potential movements from larger patches; a negative exponential dispersal curve (indicating that the majority of movements are near existing patches); and a least-cost distance measure (which indicates greater potential movement through permeable, ecologically similar, landscape features, as opposed to intensive, urban features). The methods of assigning potential negative edge impacts and landscape permeability is currently based on expert opinion about how species move and use habitats, and they are important as they enable a representation of functional connectivity, or how species might interact with landscape features. This has advantages over some of the other available methods of connectivity assessment, which are restricted to physical connectedness between similar habitat types, but they do not reflect how species respond to landscapes. The proposed connectivity indicator can be presented fairly easily as it is probabilistic with a range from 0 (no connectivity) to 1 (full connectivity).

Source: Watts et al. (2008)

4.5 Indicators of Forest Degradation

Based on the survey results it is not possible to establish a clear-cut picture of the use of various indicators to assess forest degradation. One third of the responding countries reported to have no specific indicators in use. The others list a whole range of (possible) indicators but it is not clear to what extent they are used in practice. Among the 20 indicators listed those mentioned more than once include:

- Stock density (8 countries)
- Forest/canopy cover (6)
- Disappearance of biodiversity/species (6)
- Occupancy/dominance of invasive/introduced species (3)
- Erosion (3)
- Wildlife habitats (2)
- Timber and NTFP production/value (2)

Other indicators mentioned once include soil fertility, species composition, areas affected by fire, fragmentation, presence of pioneer species/indicator species, and water quality. Several indicators are related to information already collected as part of national forest inventories or biodiversity assessments. Some are difficult or costly to measure in practice and probably remain areas for future work (e.g. aesthetic values, wildlife risk, soil properties, soil structure).

While all the identified indicators can be useful in assessing degradation, they do not represent a comprehensive systematic approach. An example of such a comprehensive approach is Costa Rica's indicators for assessment of conservation status but even in this case actual assessment of many indicators is likely to be a challenge (Box 4.2).

At least three countries (Croatia, Mexico and Brunei) apply a transition matrix between forest types, development classes or age categories as a basis to determine the process of change in the forest and other woodlands. This can provide a comprehensive approach for monitoring of degradation based on the information of forest inventories.

Box 4.2 Indicators of Conservation Status in Costa Rica

- Presence of key species
- Species composition
- Presence of indicator species (negative/positive)
- Degree of disturbance: fragmentation of habitat
    * Type and quantity of matrix
    * Degree of interconnection
    * Size and number of fragments
- Diversity
- Most important ecological relationship of the system if affected
- Distribution of tree population by genetic origin
- Quality
- Volume (local and regionally)

Source: SINAC-MINAE. 2002.

There appears to be a general view among respondents that different indicators may be used for (i) (natural/seminatural) production forests, (ii) protected areas, and (iii) planted forests. In production forests stocking density, age structure and species composition are typically used as indicators.

Mongolia is the only country which has developed a methodology for forest degradation accounting in monetary terms[36].

[36] Also some other countries have done similar assessments. For instance, China has carried out studies on

Most respondents recognized that both natural and human induced degradation need assessment. Concerning the latter type, attention in several developing countries is given to illegal logging and charcoal production. There are somewhat different interpretations on what kind of human intervention should be considered causing degradation. Even though not explicit in many replies, it appears that there is a common view that human intervention causes degradation if it affects the functionality of forests. There is also a common view that temporal changes such as thinnings or selective cuttings are not *per se* to be considered degradation. Five countries, all with natural tropical forests, considered clear-cutting as degradation, in one case including in plantations.

The Nordic countries appear to apply a largely similar approach recognizing the site specificity of all forest activities and referencing degradation (in this case unproductiveness) to what should be considered satisfactory (or expected) status in a site. This is a useful approach as it avoids potentially misleading generalizations.

As a conclusion, there is a wide variation in degradation indicators between countries. In general, there appears to be a lack of a systematic comprehensive approach for assessment which could be built on national forest inventories.

4.6 SFM Elements as a Framework for Assessment of Forest Degradation

The views on the suitability of the C&I sets as a framework for assessment of forest degradation differed. While in general, the C&I were considered an appropriate tool for this purpose, a number of country respondents37 had reservations as the C&I have been elaborated for a broader purpose and many identified indicators cannot measure the process or degree of degradation. Many respondents appeared to mix assessment of (i) the causes of degradation, (ii) the status of degradation and (iii) the impacts of degradation without considering differentiation between these three aspects.

The country replies resulted in a broad range of suggestions for factors (indicators) to be considered if the SFM Criteria framework of the NLBI is applied. These are summarized in Annex 4 which shows that

(i) There are a small number of key commonly supported indicators under each SFM criterion but there is also a wide range of individual suggestions.

(ii) There is a strong overlap between the criteria on Extent of Forest Resources, the Productive Functions of the Forest and the Carbon Cycle (carbon stocks).

(iii) Two indicators could be applied under three Criteria: (i) growing stock for Extent of Forest Resources, Productive Function of the Forest and Contribution to Carbon Cycle, and (ii) species composition for Extent of Forest Resources, Biological Diversity, and Productive Functions of the Forest

(iv) Many indicators proposed by respondents are difficult to apply in practice.

(v) With few exceptions, indicators proposed under Socio-economic Functions of Forests do not assess status of degradation but rather its consequences.

---

economic costs of environmental degradation (Economy 1997; Yu-shi et al. 1997)

37 Referring to the C&I developed under the Montreal Process and the Pan-European MCPF process

(vi) Many respondents lacked clarity on how to classify their proposals for indicators under the individual SFM Criteria[38].

The menu proposed by the responding countries provides a useful input for consideration of development of commonly applicable indicators for forest degradation but this remains an area for further work on an international level.

4.7 Linguistic Aspects

Multilingual aspects are important for correct use and interpretation of agreed international definitions. Even within the same language there can be problems due to regional and national differences in the use of technical terms. No major significant problems were found in the literature survey in the main languages.[39] The country survey replies suggested that there can be linguistic problems in understanding and translating the terms forest degradation and degraded forest[40]. Box 4.3 provides an example of the term degradation into selected languages. A broader review of unofficial translations of forest degradation (Annex 5) indicates that 'degradation'-based versions appear in many languages. However, in countries where forest degradation does not occur or is a minor issue, there are not necessarily exact national terms for it, let alone definitions, and therefore substitutes are being used (e.g. unproductiveness). In addition, a number of languages apply indigenous words. National legal framework is another possible reason for different interpretations (e.g. degraded forest land/forest vocation land without forest cover).

Box 4.3 Equivalent Terms of Degradation in Selected Languages

French:	dégradation
Spanish:	degradación
Portuguese:	degradação
German:	Degradation
Italian:	degradazione
Hungarian:	degradáció
Japanese:	dojou rekka

Source: www.iufro.org/silvavoc

In the main languages there was less consistency in interpreting some of the related terms (e.g. secondary forest, forest rehabilitation) for which national interpretations may also be influenced by linguistic factors. For instance, it may not be possible to directly translate forest improvement into some languages (e.g. French, Spanish).

As a conclusion, terms in different languages can be interpreted as equivalent if the concepts to be conveyed exactly coincide, but this cannot be assumed and users must carefully choose the correct term that precisely conveys the desired concept (Helms et al. 2003).

[38] Clear errors have not been reported in Annex 4.

[39] Carried out on English, French, Spanish and Portuguese literature

[40] The Third Expert Group on Harmonizing Forest-Related Definitions by Use of Various Stakeholders (FAO 2005) considered multilingual aspects (French, Russian, Arabic). The identified problematic terms were not related to forest degradation.

5. COMPARATIVE ANALYSIS OF DEFINITIONS RELATED TO FOREST DEGRADATION

5.1 Comparison of Definitions

A comparison of international and national definitions (Table 5.1) reveals that there is a strong element of commonality between the FRA 2000, ITTO and CBD definitions having a broad scope within the context of sustainable forest management. The IPCC approach is quite different being crafted from the perspective of GHG emissions only. National definitions[41] represent a mixture of broad and narrow approaches, in the latter case the focus being on the productivity aspect.

In the international definitions forest structure appears in four cases (FRA, ITTO, CBD and IUFRO) and species composition in two (ITTO and CBD). However, structure is not defined and it has various possible dimensions (age, tree diameter, tree size, development class, canopy structure, etc.). This is likely to need further clarification, e.g. in explanatory notes.

The CBD definition includes in addition forest function and ITTO forest dynamics. The national definitions cover all these except forest dynamics and include several elements not included in the international definitions (stocking level, age structure, biomass density, sanitary condition).

Regarding forest functions the notions of supply capacity, forest goods and services appear almost in all definitions with the exception of IPCC and IUFRO. This approach is also common in the national definitions. CBD and ITTO make special reference to productivity and the former also to biodiversity. The IPCC definition is limited to contribution to the carbon cycle which makes it different from the others even though biomass density was one common element in the national definitions.

Ecosystem resilience and degree of degradation are explicitly included only in the ITTO definition. CBD considers degraded and secondary forest as largely synonymous while ITTO is more nuanced separating degraded primary forest from secondary forest (cf. Box 3.1).

Most definitions specify degradation being due to human-induced causes. The FRA 2000 definition is an exception; being comprehensive it does not differentiate causes. The ITTO and CBD definitions imply human induced reasons. In the national definitions there is in many cases limitation to natural causes only.

Reference state is natural forest in the case of ITTO and CBD definitions. FRA 2000 implies comparison with a previous date and the IPCC definition is explicit on the period, however without determining the date/length of the period. In national definitions various options occur and a common interpretation appears to be "what is expected on the site in similar conditions".

Spatial scale is stand or site in the FRA, ITTO and CBD definitions. The IPCC definition does not include land area identification. As discussed in section 3.1.4, stand or site may not be appropriate for carbon stock or flow monitoring and both CBD and ITTO also recognize need for

[41] Includes elements in various national definitions of the country survey.

landscape level assessment in explanatory texts. In general, national definitions do not include specification of spatial scale.
Temporal scale is long-term in the IPCC, ITTO and CBD definitions but it is not defined what it means in practice. The difficulty to define temporal scale has led FRA 2000 and possibly also IUFRO to leave out this element in the definition. This may be explained by the fact that long-term impairment can realistically only be assessed *ex post*, after a given observation period. This complicates operationalization as degradation may not be measurable during a short assessment period.

Exclusion of non-forest areas is generally implicit in definitions of forest degradation. However, the IPCC's framework definition excludes deforestation and activities under Art. 3.4 of the Kyoto Protocol. Planted forest is excluded from the ITTO definition (even though restoration and rehabilitation often involve replanting in different forms).

5.2 Discussion

In general, the review of existing definitions shows that many definitions are either very general or their focus is on reduction of productivity, biomass or biodiversity. All the existing definitions of forest degradation are compatible within the generic common definition. The ITTO definition is probably the most comprehensive one but the CBD definition is quite close to it. The IPCC definition is narrower in scope focusing on the carbon aspect. None of the definitions includes relative levels of resilience in different forest types which was identified as a definitional criterion.[42]

Definitions that allude to multiple forest benefits may treat forest values in a comprehensive manner, but are more difficult to use for international purposes in a consistent, transparent manner. Forest degradation defined by loss of potential supply of "goods and services" or "benefits" requires subjective decisions to determine whether an area has been subjected to degradation. Furthermore, reductions in potential supplies of benefits can be achieved by legislation or regulation (for example, by restricting access to the services a forest can provide). Therefore, such definitions can imply that forests might be degraded (or the reverse) by rule, without any corresponding biological or physical changes (IPCC 2003a).

[42] With the exception of ITTO on degraded primary forest, see Box 3.1. Thompson et al. (2009) include an in-depth analysis of the concept of resilience.

Table 5.1 Comparison of Elements in the Definitions of Forest Degradation/Degraded Forest

Notes: 1) Threshold >10%, 2) Implicit a past date, 3) FAO suggested earlier 10 years, 4) Ecosystem structure and function, 5) In the case of secondary forest only, 6) Explicit in the 2001 CBD definition, 7) Production potential, 8) What is expected on site

Element	FRA 2000 (FAO 2001)	ITTO (2002; 2003)	CBD (2001; 2005)	IPCC (2003a)	IUFRO	National definitions
Change within the forest						
• Canopy cover	(1)					
• Stocking level						
• Structure						
• Age structure						
• Species composition						
• Biomass density						
• Dynamics						
• Function						
• Sanitary condition						
Functions						
• Goods/products						
• Services						
• Carbon cycle						
• Biodiversity						
Other functions						
• Productivity					(7)	
• Capacity to supply						
• Ecosystem services		(4)				
Ecosystem resilience						
Degree of degradation						
Causes						
- Human induced		(5)	(6)			
- Natural						
• Indeterminate (both)						
Reference state						
• Natural forest						
• Previous	(2)					
• Other						(8)
Spatial scale						
• Stand/site						
• FMU						
• Landscape						
Referenced forest types		Degraded primary forest Secondary forest Degraded forest land	Secondary forest			
Temporal scale						
• Short term						
• Long term						
• Undefined						
• Duration years	(3)					
Exclusion						
• Deforestation (non-forest)						
• Activities under Art. 3.4 of the Kyoto Protocol						
• Planted forest						
• Degraded forest land (non-forest)						

The issue of thresholds between non-degraded forest, degraded forest and non-forest needs consideration, particularly in the context of the possible REDD arrangement which as a potential powerful policy instrument is expected to have significant impact on forest conservation[43]. The currently applied thresholds for forest (Table 5.2) could lead to different outcomes in terms of addressing forest degradation and deforestation.[44] The higher is the threshold between forest and non-forest, the earlier the degradation process changes into deforestation. Were the REDD mechanism not to cover halting degradation, higher thresholds (than e.g. those in Table 5.2) could be justified as they would avoid that the degradation process would continue until it reaches the lower threshold thereby making the area eligible for REDD financing.

Table 5.2 Thresholds of International Forest Definitions

Indicator	FAO (2006b)	UNFCCC/Kyoto Protocol (UNFCCC 2002)
Minimum area, ha	>0.5	>0.5-1.0
Minimum crown cover, %	10	10-30
Minimum tree height (potential to reach), m	5	>2-5

From climate integrity point of view (the main objective of the UNFCCC), it is crucial to have a monitoring system for land-use based emissions and sequestration that covers all the relevant land-uses independently of how they are classified or defined. In other words, although the threshold value between forest and non-forest may become a key issue, the whole problem can be avoided if in REDD schemes carbon pools are monitored and reported in all the land-use classes ("wall-to-wall") which is already the case of Annex 1 country LULUCF reporting under the UNFCCC. If this is not achieved, the problem of forest definition and its thresholds becomes important, and it will_almost certainly lead to major leakage, when countries start tweaking the threshold values between forest and non-forest lands, i.e. national definitions of forest. This risk for leakage also justifies why REDD should include reduced emissions from degradation. If REDD is only focusing on deforestation, there will be a huge leakage; e.g. if oil palm plantations are defined as "forest", the conversion of rain forest into an oil palm plantation (loss of about 100-150 Mg C per ha) would not be accounted.[45] Oil palm plantations like other tree crop plantations which are classified under agricultural land are specifically excluded from the FRA 2000 definition while the Kyoto Protocol definition of forest is limited to tree cover and forest activities, not including a land use element[46].

Most definitions of forest degradation refer to or imply application for natural forest. It is apparent that planted forests would require differentiated criteria. In practice, this may not be easy as planted components are common in modified natural forests in many countries. In the case of planting with exotic species degradation is obviously easier to define. On the other hand, such planted forests are perceived as degraded or non-forests by some stakeholders. Consideration is needed for treatment of replacing existing degraded natural forests with planted forests in different situations.

---

43 Cf. section 2.2.

44 See e.g. Sasaki & Putz (2009)

45 Kanninen, pers.comm.

46 The IPCC (1996) Guidelines includes land use change element for reporting.

Treatment of temporal changes in the forest is crucial for definitions of degradation. Reductions in crown cover or growing stock that cause short-term carbon emissions, i.e. sustainable selection, thinning or shelterwood cuttings do not degrade a forest if properly designed and carried out. On the contrary, these measures, when properly carried out, can improve forest condition. Felling during forest harvesting may damage or destroy additional trees in the above-ground biomass which are not removed. Unless Reduced Impact Logging (RIL) is applied, typical stand damages in conventional logging in many developing countries range from 10% to 70% of the residual trees (FAO 2004), depending on logging intensity. Site damage in the form of soil compaction, soil disturbance, or erosion will also release greenhouse gases from other carbon pools (Schoene et al. 2007).

The issue of temporary changes needs to be addressed in applying direct estimation of changes in carbon stocks in an existing stand or site, to avoid that lands under forest management on which carbon stocks vary (e.g. due to selection cutting, thinning, etc.) are not considered by rule as degradation. In order to not exclude short-term changes in the forest growing stock which are part of sustainable forest management interventions, ITTO, CBD and IPCC have defined degradation incorporating the 'long-term' aspect which is lacking in the FRA 2000 definition. However, none of the definitions specify what long term means. While restriction of forest degradation to situations exhibiting long-term effects is helpful to exclude annual variability and normal management, it requires that long-term effects be specified.[47] Furthermore, operationalization of definitions may require prediction or estimation of whether observed changes would persist for a specified duration which represents a source of uncertainty (IPCC 2003a).

Some stakeholders do not share inclusion of the notion of 'long-term' as they insist on any (incl. short-term) reduction in the growing stock to be considered degradation. This may have two possible motives: (i) use all REDD forests for conservation only (no timber harvesting), and (ii) reduction of illegal logging. Such a one-sided approach would obviously be detrimental for the economic benefits of the forest sector in many developing countries.

The short-term view on forest changes among many stakeholders derives from the general dominant perception that a forest stand is the basic unit of decision-making in conserving or enhancing forest carbon. However, forest management decisions are based on planning which concerns a territorially designated unit which may be a holding, a forest estate or another type of forest management unit (watershed, landscape etc.)[48]. These units typically consist of at least dozens of stands with different ages or other structural characteristics. The mixture of individual stands is under a constant change due to biological processes and management interventions where stock reduction in a year may take place in some stands while in the others the carbon stock is increased as a result of biological growth. It is the territorial entity for which management objectives are set and which as a whole should be managed and assessed for such objectives as supply of forest goods and services in appropriate combinations in the local conditions.

---

47 FAO has earlier considered an unstocked area non-forest if it is not expected to revert to trees within a period of 10 years (FAO 2000).

48 See section 2.2 for further discussion on this.

There is a common perception that any compensation for environmental services including reduced or avoided degradation should be related to a change in (projected) human action[49]. If the use of degradation definition requires separation of human-induced causes (e.g. for carbon accounting under REDD), the human induced aspect needs to be incorporated. There are, however, practical difficulties in separation of human and natural causes (direct and indirect) causes (including those which are not within the forest sector) as many of them are interrelated (cf. chapter 2). The country survey showed that human causes are typical in developing countries but in developed countries the main causes are natural covering both discrete events and slow, chronic degradation. The difficulties of separation have led FRA 2000 not to differentiate between causes in its definition.

The various international definitions of forest degradation (and improvement) leave several open issues related to scope of goods and services, the land area identification, time scale, causes and possible threshold values. Therefore, operational definitions of forest degradation for specific purposes should provide, as appropriate

- identification of forest goods and services
- a spatial context of assessment (land area identification)
- a reference point;
- cover both process and state (degradation/degraded forest)
- relevant threshold values
- specification of reasons for degradation (human induced/natural) (when required by the use of definition
- an agreed set of variables; and
- indicators (and their proxies if necessary) to measure the change of a forest (ecosystem)

Additional elements could be added or singled out, depending on the particular interests related to the use of definition. It is important to initiate/expand assessment efforts independently from eventual development of formal international-level definitions of forest degradation.

As regards variables and indicators it is recognized that, due to persistent data problems, the use of proxies (e.g., canopy cover percentage) will continue, but their appropriateness should be validated in view of providing relevant information on the specific aspects of degradation. For measurement purposes it would probably be ideal from the cost-efficiency perspective if degradation could be established as a measurable sustained decrease in canopy cover (with canopy cover remaining greater than the minimum to qualify for forest). However, remote sensing methods need to be complemented by other methods (biometric field observations, biodiversity assessment, rapid rural assessments, etc.) to capture the targeted aspects of losses in forest goods and services and to fill data gaps.

The international and national definitions share the concept of losing structural characteristics of forests but only few definitions specify what is meant by forest structure in this context. This has been interpreted as an implicit reference to the growing stock (Bahamondez et al. in prep.) which

[49] This may also include restraining from utilization of a forest which would take place in the absence of compensation.

may be used as a proxy for several purposes. A broader approach is however likely to be necessary and three commonly used proxy indicators have been proposed by Lund (2009):

- Reduction in biomass for the growing stock or the carbon stored which can be associated with the reduction of canopy cover and/or number of trees per unit area[50]
- Reduction in loss of biological diversity which can be associated with the occurrence of species (dominant and non-dominant) and habitats
- Reduction in soil as indicated by soil cover, depth and fertility

These may go a long way to represent a comprehensive initial approach for assessment degradation. Relatively simple indicators would be needed for forest structure changes which indicate degradation and biodiversity (and resilience) in different forest types.

Finding a feasible approach for operationally incorporating forest degradation in the international climate regime is a pressing challenge. However, it is possible that stand level-related definitional issues can be largely avoided if the approach is to directly estimate reduction in the carbon stocks across a designated forest area rather than searching for an operational definition for stand-level degradation for assessment of carbon pools. This would also be in line with the conclusion of the Second Expert Meeting on Harmonizing Forest-Related Definitions for Use by Various Stakeholders (FAO 2002b) which suggested the use of the term "stock reduction" in the context of carbon monitoring in forests remaining forests even though the spatial aspect was not explicitly mentioned. However, a number of other issues still need to be addressed:

(a) How to deal with natural disturbances?
(b) How to distinguish between natural and non-natural disturbances and what are the monitoring implications?
(c) Is it possible to reconstruct historical trends/rate with existing data? (UNFCCC 2009b)

The question on common or country-specific definitions needs consideration. The use of common definitions would improve consistency and comparability among countries (FAO 2002a). Using national definitions for forest and forest degradation would be consistent with current and earlier practices for the preparation of national GHG inventories (as reported to the UNFCCC) This would enable Parties to include or exclude various relevant elements in their approach for estimating reduced emissions from forest degradation. However, the national survey carried out for this report indicated that relatively few countries have operational definitions for forest degradation and therefore further international guidance and capacity building support is likely to be helpful.

5.3 Options for Future Action

The following options for future action may be considered:

1. Maintain the holistic generic definition of forest degradation to provide a common framework for definitions developed for particular purposes.

[50] Degradation does not necessarily lead to loss of biomass even if the growing stock may decrease.

2. Maintain the understanding that forest degradation can be further defined for various specific purposes and that different indicators can be used for its assessment.
3. For each purpose identify what needs to be known, by whom, and for what purpose the data should be used in order to develop appropriate indicators.
4. Recognize that for international purposes forest degradation needs to be geographically assessed at a higher than stand or site level with respective implications for international definition while stand/site-level assessment is needed for taking local level corrective action; this approach would focus on assessment of the forest degradation (or improvement) process over time without *a priori* specification of the temporal scale in the definition.
5. Allow scope for national interpretation of international definitions of forest degradation to ensure relevance and cost-efficiency and to harness synergies.
6. Improve the existing definitions in view of greater clarity, consistency and compatibility with each other.
7. Expand efforts to measure and assess forest degradation

REFERENCES

Angelsen, A. (ed.) 2008. Moving Ahead with REDD Issues, Options and Implications. CIFOR. Bogor. http://www.cifor.cgiar.org/publications/pdf_files/Books/BAngelsen0801.pdf

Asner, G. P., Knapp, D.E., Broadbent, E.P., Oliviera, P., Keller, M. & Silva, J.. 2005. Selective logging in the Brazilian Amazon. Science 310: 480-482.

Bennet, A. 2004. Linkages in the Landscape: the Role of Corridors and Connectivity in Wildlife Conservation, IUCN, Gland.

CBD. 2001. Review of the Status and Trends of, and Major Threats to, the Forest Biological Diversity. AHTEG on Forest Biological Diversity. Montreal, 12-16 November 2001 UNEP/CBD/SBSTTA/7/INF/3.

CBD. 2004. Indicators for Assessing Progress towards the 2010 Target: Connectivity/Fragmentation of Ecosystems. UNEP/CBD/SBSTTA/10/INF/20 http://www.cbd.int/doc/meetings/sbstta/sbstta-10/information/sbstta-10-inf-20-en.pdf) -

CBD. 2005. Report of the Inter-Sessional (Second) Meeting of the AHTEG on the Review of Implementation of the Programme of Work on Forest Biological Diversity. Montreal, 28 November - 2 December 2005. UNEP/CBD/SBSTTA/11/INF/2. http://www.cbd.int/doc/?mtg=sbstta-11

CBD. 2009. Report of the Expert Workshop on Integrating Protected Areas into Wider Land and Seascapes and Sectors. http://www.cbd.int/doc/meetings/pa/ewsipals-01/official/ewsipals-01-03-en.pdf

Crooks, K.R. & Sanjayan, M. 2006. Connectivity Conservation. Cambridge University Press. Cambridge, UK.

DeFries, R., Achard, F., Brown, S., Herold, M., Murdiyarso, D., Schlamadinger B. & de Souza, C. Jr. 2007 Earth Observations for Estimating Greenhouse Gas Emissions from Deforestation in Developing Countries. Environmental Science and Policy 10 (4): 385-394.

Dutschke, M. 2002. Sustainable Forestry Investment under the Clean Development Mechanism: the Malaysian case. HWWA Discussion Paper 198. http://ageconsearch.umn.edu/bitstream/26286/1/dp020198.pdf

Economy, E. 1997. The Case Study of China - Reforms and Resources: The Implications for State Capacity in the PRC. Occasional Paper of the Project on Environmental Scarcities, State Capacity, and Civil Violence (Cambridge: American Academy of Arts and Sciences and the University of Toronto). http://www.library.utoronto.ca/pcs/state/china.htm

FAO. 2000. FRA 2000: On Definitions of Forest and Forest Change. Forest Resources Assessment. Working Paper 33. Rome. 13 p.

FAO. 2001. Global Forest Resources Assessment FRA 2000 – Main report. Rome. http://www.fao.org/forestry/fra2000report/en/

FAO. 2002a. Proceedings: Expert Meeting on Harmonizing Forest-related Definitions for Use by Various Stakeholders. Rome, 23-25 January 2002. WMO/ CIFOR/FAO/IUFRO/UNEP. Rome.

FAO. 2002b. Proceedings: Second Expert Meeting on Harmonizing Forest-related Definitions for Use by Various Stakeholders. Rome,. 11-13 September 2002, WMO/ IPCC/CIFOR/FAO/IUFRO/UNEP. Rome. http://www.fao.org/docrep/005/y4171e/y4171e00.htm

FAO. 2003. Report International Conference on the Contribution of Criteria and Indicators for Sustainable Forest Management: The Way Forward (CICI-2003). 3 - 7 February 2003, Guatemala City, Guatemala.

FAO. 2004. Reduced Impact Logging in Tropical Forests. Forest Harvesting and Engineering Working Paper No. 1. Rome.

FAO. 2005. Proceedings: Third Expert Meeting on Harmonizing Forest-related Definitions for Use by Various Stakeholders. Rome, 17-19 January 2005. ITTO/IPCC/UNEP/FAO/CIFOR/IUFRO. Rome. ftp://ftp.fao.org/docrep/fao/008/j4959e/j4959e.pdf

FAO. 2006a. Choosing a Forest Definition for the Clean Development Mechanism. Forests and Climate Change Working Paper 4. http://www.fao.org/forestry/media/11280/1/0/

FAO. 2006b. Global Forests Resources Assessment 2005. FAO Forestry Paper 147. Rome.

Geist, H.J. and Lambin, E.F. 2002. Proximate Causes and Underlying Driving Forces of Tropical Deforestation. Bioscience 52: 143-150. http://www.freenetwork.org/resources/documents/2-5Deforestationtropical.pdf

GOFC-GOLD. 2008. Reducing Greenhouse Gas Emissions from Deforestation and Degradation in Developing Countries: a Sourcebook of Methods and Procedures for Monitoring, Measuring and Reporting. GOFC-GOLD Report version COP13-2. GOFC-GOLD Project Office, Natural Resources Canada, Alberta, Canada.

Hawthorne, W.D. & Abu-Juam, M. 1995. Forest Protection in Ghana (with particular reference to vegetation and plant species). IUCN Forest Conservation Programme 14. Gland.

Helms, J. A., Prüller, R., Haddon, B, D. & Lund, H. G. 2003. The Need to Say What You Mean and Mean What You Say. Presented at the IUFRO Conference on Information Interoperability and Organization for National and Global Forest Information Services. September 17-19, 2003. A Satellite Event of the XII World Forestry Congress, Quebec City, Quebec, Canada. www.iufro.org/download/file/318/.../archive-interoperability-full.doc

Indonesia. 2002. Views from Parties on issues related to modalities for the inclusion of afforestation and reforestation project activities under the Clean Development Mechanism in the first commitment period. FCCC/SBSTA/2002/MISC.22/Add.3. Submission to the UNFCCC Secretariat.

IPCC. 1996. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Houghton, J.T., Meira Filho, L.G., Lim, B., Tréanton, K., Mamaty, I. Bonduki, Y., Griggs, D.J. and Callander B.A. (Eds.). IPCC WGI Technical Support Unit, Bracknell, UK. http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html

IPCC. 2003a. Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types. Penman, J., Gytarsky, M., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, T., Tanabe, K. and Wagner, F. (eds.), IPCC-IGES, Kanagawa. IPCC National Greenhouse Gas Inventories Programme, Japan. http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/degradation_contents.html

IPCC. 2003b. Good Practice Guidance on Land Use, Land-Use Change and Forestry. Eggleston, H.S., Buendia, L., Miwa, K., Ngara, T. and Tanabe, K. (eds.). National Greenhouse Gas Inventories Programme. Institute for Global Environmental Strategies (IGES). Japan.

IPCC. 2007: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA. http://www.ipcc.ch/ipccreports/ar4-wg3.htm

ITTO. 2002. ITTO Guidelines for the Restoration, Management and Rehabilitation of Degraded and Secondary Tropical Forests. ITTO Policy Development Series No. 13. Yokohama. http://219.127.136.74/live/Live_Server/154/ps13e.pdf

ITTO 2005. Revised ITTO Criteria and Indicators for the Sustainable Management of Tropical Forests Including the Reporting Format. ITTO Policy Development Series No 15. Yokohama. http://219.127.136.74/live/Live_Server/963/ps15e.pdf

ITTO/IUCN.2005. Restoring Forest Landscapes. An introduction to the art and science of forest landscape restoration. ITTO Technical Series 23. Yokohama. http://219.127.136.74/live/Live_Server/1064/ts23e.pdf

Kanninen, M., Director of Environmental Services and Sustainable Use of Forests, CIFOR, Bogor, Indonesia.

Kuuluvainen, T. 2009. Forest Management and Biodiversity Conservation Based on Natural Ecosystem Dynamics in Northern Europe: the Complexity Challenge. Ambio (in press).

Lanly, J.-P. 2003. Les facteurs de déforestation et de dégradation des forêts. XII World Foresty Congress. Invited paper. http://www.fao.org/docrep/article/wfc/xii/ms12a-e.htm

Lambin, E.F., Geist, H.J. & Lepers, E. 2003 Dynamics of Land-use and Land-cover Change in Tropical Regions. Annual Review of Environmental Resources 28: 205-241.

Laurance, W. F. 2005.Forest-climate Interactions in Fragmented Tropical Landscapes. In: Tropical forests and global atmospheric change. Malhi, Y. and Phillips, O. eds. p.31-38. http://www.pubmedcentral.nih.gov/picrender.fcgi?artid=1693331&blobtype=pdf

Lund, H.G. 2009.What Is a Degraded Forest. Forest Information Services. Gainesville, VA, USA. http://home.comcast.net/~gyde/2009forestdegrade.doc .

Lund, H.G. Forest Inventory Specialist. Personal communication.

Marklund, L.G. & Schoene, D. 2006 Global Assessment of Growing Stock, Biomass and Carbon Stock. Forest Resources Assessment Programme Working Paper 106/E, Rome.

Nieuwenhuis, M. 2000.Terminology of Forest Management. IUFRO World Series Vol. 9-en. IUFRO 4.04.07 SilvaPlan and SilvaVoc. www.iufro/science/special/silvavoc.

Palmberg-Lerche, C. Forest Management and Genetic Resources Specialist

Puustjärvi. E. & Simula, M. 2002a. Development of Common Framework for Forest-Related Definitions. In FAO 2002b pp. 23-80. http://www.fao.org/docrep/005/y4171e/Y4171E06.htm

Puustjärvi. E. & Simula, M. 2002b. Forest Related Definitions – Issues and Development Needs. In FAO (2002a) pp. 15-72.

Puustjärvi. E. & Simula, M. 2005. Definitions Related to Classification of Forests and Their Management Status. In FAO (2005) pp. 19-50.

Roslesinforg. 2008. The Basic Parameters of Forest Activity for 1988, 1992-2007.

Rouget, M., Cowling R.M., Pressey R.L. & Richardson D.M. 2003. Identifying Spatial Components of Ecological and Evolutionary Processes for Regional Conservation Planning in the Cape Floristic Region, South Africa. Divers Distrib (9):191–210.

Sanitary and Pathological Condition of Forest Lands for 2007. www.rosleshoz.gov.rn./activity/pathology/reports

Sanz-Sanchez, M. Programme Officer. UNFCCC Secretariat.

Sasaki, N. & Putz, F.E. 2009. Critical Need for New Definitions of "Forest" and "Forest Degradation" in Global Climate Change Agreements. Conservation Letters. (in press) http://www3.interscience.wiley.com/journal/122515795/abstract?CRETRY=1&SRETRY=0

Schoene, D., Killmann, W. von Luepke, H. & Loyche Wilkie, M. 2007. Definitional Issues Related to Reducing Emissions from Deforestation in Developing Countries. FAO Forests and Climate Change Working Paper 5. Rome. http://www.fao.org/docrep/009/j9345e/j9345e00.htm

SINAC-MINAE. 2002. Metodología para la evaluación económica de daños ambientales en Costa Rica. http://www.inbio.ac.cr/ES/es/biod/estrategia/Paginas/PDF/Ambiente/IFVEDA.pdf

Skutsch, M. 2006. Can Carbon Income Combat Forest Degradation. Community Forest Management for Climate Mitigation and Poverty Alleviation. Rationale and Case Studies. Technology and Sustainable Development, University of Twente, the Netherlands.

Tabarelli, M, Cardoso da Silva, J. & Gascon, C. 2004. Forest Fragmentation, Synergisms and the Impoverishment of Neotropical Forests. Biodiversity Conservation 13(7): 1419-1425.

Taylor, P.D., Fahrig, L., Henein, K. & Merriam, G. 1993. Connectivity Is a vital Element of Landscape Structure. Oikos 68:571-572.

Taylor, P.D., Fahrig, L. & With, K.A. 2006. Landscape Connectivity: A Return to the Basics. In Crooks & Sanjayan 2006; pp. 29-43.

Tischendorf, L. & Fahrig, L. 2000. How Should We Measure Landscape Connectivity. Landscape Ecology 15:633-641, 2000.

Thompson, I. Canadian Forest Service. Personal communication.

Thompson, I., Mackey, B., McNulty, S. Mosseler, A., & Mulongoy, K. A. Synthesis on the Biodiversity-Resilience Relationship in Forest Ecosystems. Manuscript draft.

UNEP. 2007. Global Environment Outlook (GEO 4) — Environment for Development. Valetta, Malta. http://www.unep.org/geo/geo4/report/GEO-4_Report_Full_en.pdf

UNEP/CBD/SBSTA. 2001. Main Theme: Forest Biological Diversity. Report of the Ad Hoc Technical Expert Group on Forest Biological Diversity. Seventh Meeting, Montreal, 12-16 November 2001. (www.biodiv.org/programmes/areas/forest/definitions.asp)

UNFCCC. 2002. Report of the Conference of the Parties on Its Seventh Session, Held at Marrakesh from 29 October to 10 November 2001. FCCC/CP/2001/13/Add. 1.

UNFCCC, 2003. Modalities and Procedures for Afforestation and Reforestation Activities under the Clean Development Mechanism in the First Commitment Period of the Kyoto Protocol. Decision 19/CP.9, Decision CMP1 (Land use, land-use change and forestry) UNFCCC/SBSTA 19, 2003. http://www.ciesin.columbia.edu/repository/entri/docs/cop/Kyoto_COP001_005.pdf

UNFCCC. 2006a. Background Paper for the Workshop on Reducing Emissions form Deforestation in Developing Countries. Part I Scientific, socio-economic, technical and methodological issues related to deforestation in developing countries. Secretariat Working paper No. 1 (a) (2006) 17 August 2006. Workshop on reducing emissions from deforestation in developing countries. 30 August – 1 September 2006, Rome, Italy. http://unfccc.int/files/methods_and_science/lulucf/application/pdf/part_i_scientific_issues.pdf

UNFCCC. 2006b. Issues Relating to Reducing Emissions from Deforestation in Developing Countries and Recommendations on Any Further Process. Submissions from Parties. FCCC/SBSTA/2006/MISC.5. http://unfccc.int/resource/docs/2006/sbsta/eng/misc05.pdf

UNFCCC, 2006c. Reducing Emissions from Deforestation in Developing Countries: Draft conclusions proposed by the Chair, FCCC/SBSTA/2006/L.8. http://www.rainforestcoalition.org/documents/SBSTA24Conclusionl08.pdf

UNFCCC. 2007. Report on the Second Workshop on Reducing Emissions from Deforestation in Developing Countries. FCCC/SBSTA/2007/3.

UNFCCC. 2008a. Informal Meeting of Experts on Methodological Issues Relating to Reducing Emissions from Forest Degradation in Developing Countries. Chair's Summary of Key Messages from the Meeting. 20-21 October 2008, Bonn, Germany.

UNFCCC. 2008b. Report on the Workshop on Methodological Issues Relating to Reducing Emissions from Deforestation and Forest Degradation in Developing Countries. FCCC/SBSTA/2008/11. http://unfccc.int/resource/docs/2008/sbsta/eng/11.pdf

UNFCCC. 2009a. Fulfilment of the Bali Action Plan and Components of the Agreed Outcome. Part II. Ad hoc Working Group on Long-Term Cooperative Action under the Convention. Fifth Session. Bonn, 29 March to 8 April 2009. FCCC/AWGLCA/2009/4(Part II). http://www.ipu.org/splz-e/cop15/070309-p02.pdf

UNFCCC. 2009b. Report on the Expert Meeting on Methodological Issues Relating to Reference Emission Levels and Reference Levels. Thirtieth session. Bonn, 1–10 June 2009. FCCC/SBSTA/2009/2 http://unfccc.int/resource/docs/2009/sbsta/eng/02.pdf

UNFCCC/SBSTA, 2004. Land-use, Land-use Change and forestry, Decision11/CP.7, UNFCCC/SBSTA (Marrakech Accords). http://unfccc.int/resource/docs/cop7/13a01.pdf#page=54

United Nations General Assembly. 2007. Non-Legally Binding Instrument on All Types of Forests. A/C.2/62/L.5. 22 October 2007.

Watts, K., Handley, P., Scholefield, P. and Norton, L. (2008). Habitat Connectivity – Developing an indicator for UK and country level reporting. Phase 1 Pilot Study - Contract report to Defra (Defra Contract CR0388). Forest Research, Farnham, Centre for Ecology and Hydrology, Lancaster. http://randd.defra.gov.uk/Document.aspx?Document=WC0704_7707_FRP.pdf

White, P.S. & Pickett, S.T.A. 1985. The Ecology of Natural Disturbance and Patch Dynamics. Orlando, FL, Academic Press.

Yushi, M., Datong, N., Guang, X, Hongchang, W. & Smil, V. 1997. An Assessment of the Economic Losses Resulting from Various Forms of Environmental Degradation in China Occasional Paper of the Project on Environmental Scarcities, State Capacity, and Civil Violence (Cambridge: American Academy of Arts and Sciences and the University of Toronto. http://www.library.utoronto.ca/pcs/state/china.htm

Annex 1 National Definitions of Forest Degradation

Africa	**National definition**
Congo	Passage de forêt à forêt, est un processus qui conduit à la diminution de la biomasse sans disparition du couvert forestier (Source : COMIFAC: soumission de 2007, 2008 et 2009).
Ghana	Decline in the productivity of the forest including the provision of environmental services and supplies (NTFPs, timber etc).
Liberia	In addition to the reduction of the capacity of the forest to produce goods and services, inability of the forest to produce timber and other wood products.
Mali	Une forêt est dégradée lorsque d'un temps t1 donné à un autre temps t2 on note que le nombre d'espèces, le potentiel de biomasse est en régression
Asia	
Brunei	The definition agreed by 3rd Meeting of the ASEAN Experts Group on International Forest Policy Processes (IFPP). Jakarta, Indonesia, 14-15 May 2007.
Iran	Loss of forest in quantitative (area, canopy) and qualitative (productivity) specification due to abiotic or biotic measures.
Mongolia	Forest degradation means loss of wood stock, fragmentation, biodiversity loss and changing of timber species, to less value. In general forest degradation is the reduction of the capacity of a forest to provide goods and services.
Nepal	Degraded forest has been designated when forest area converts to scrublands.
Turkey	Crown closure is used as a criterion to characterize the quality of forest resources. Crown closure less than or equal 10% reflects the severely degraded forests.
Europe	
Croatia	No operational definition for forest degradation but in the forestry practice different forest categories are identified in terms of degradation.
Czech Republic	Air pollution threat zones of forests are determined by degree of damage and rapidity of damage changes according to defoliation.
Romania	Degraded stand is stand strongly damaged as a result of an unfavourable action of natural or human factors.
Russian Federation	Degradation of the forest is gradual loss of viability and dying off of tree stands as a result of deterioration of an ecological condition of the forest environment under influence of anthropogenic or natural factors.
Slovakia	Regressive development of ecosystem or forest stand is development leading to simplification of ecosystem, decrease in biomass or loss of biodiversity.
Slovenia	Degraded forest means forest in which the growth rate or the fertility of forest land is reduced, or other possibilities for it to perform its function as a forest are reduced by negative outside influences.
Latin America	
Costa Rica	Degradación de los bosques se entiende como los cambios significativos en la estructura, composición y funcionalidad de los bosques, los cuales disminuyen o destruyen la capacidad de ofrecer bienes y servicios. (Nasi, R. et al.2002. (CATIE).
Mexico	Definición de la degradación se refiere a la alteración de la vegetación: toda aquella vegetación primaria que pasa a una etapa de sucesión secundaria (arbórea, arbustiva ó herbácea) así como toda aquella vegetación secundaria que pasa a un estado de sucesión inferior ya sea de arbórea a arbustiva o de arbustiva a herbácea.
Paraguay	Se maneja el concepto de degradación forestal como la disminución de la calidad del bosque.

Source: Country survey replies

Annex 2 Degraded Forest Area in Reporting Countries

Country	Total forest area 1000 ha	Degraded forest area 1000 ha	Degraded forest of the total forest area %
Ghana[1)]	1 634.1	1 127.5	69.0
Kenya	3 467.0	346.7	10.0
Lesotho	134.0	13.4	10.0
Mali	12 572.0	12 320.6	98.0
Niger	1 266.0	1 046.0	82.6
Mexico	65 540.0	4 856.4	7.4
Chile	16 000.0	20.0	0.1
Iran[2)]	1 847.0	129.3	7.0
Mongolia	13 397.5	3 910.0	29.1
Turkey	21 188.0	10 568.0	49.8
Croatia	403.0	513.0	21.4
Czech Republic	2 697.0	42.0	1.5
Iceland	126.9	33.0	26.0
Latvia	3 034.7	242.8	8.0
Romania	6 400.0	130.6	2.0
Russian Federation	808 790.0	4 151.7[3)]	0.5
Russian Federation		75 911.6[4)]	9.4
Slovenia	1 247.0	6.7	0.5
Tonga	8.3	3.3 – 4.2	40 – 50

Sources : Country survey replies

1) Hawthorne & Abu-Juam (1995)

2) Caspian forest only

3) Roslesinforg (2008). The Basic Parameters of Forest Activity for 1988, 1992-2007.

4) Sanitary and Pathological Condition of Forest Lands for 2007. www.rosleshoz.gov.rn./activity/pathology/reports

Annex 3 Causes of Forest Degradation

Country	Poverty	Shifting cultivation	Grazing	Fuelwood collection / charcoal	Excessive logging	Illegal logging	Mining	Illegal settlement	Roads	Insecurity in forest	Land occup ation	Lack of tenure	Fire	Drought	Pests, insects, diseases	Erosion	Wind and snow	Other
Congo Republic	3.	1.		2.														
Ghana		40%	2%	2-3%	10%		5%						40%					
Kenya				3.		1.		2.					4.					
Lesotho				30%		10%							25%	25%				10%
Liberia		6.		5.		4.	7.	8.	9.				2.		3.	1.		
Mali			4.	2.		1.							3.	5.				
Niger		2.		3.										1.				
Somalia	3.					1.				2.								
Tanzania		25%		25%		20%	5%						25%					
Costa Rica		3.				1.							2.					
Mexico		82%	14%					1%										
Argentina			1.		4.	2.							3.					
Chile			2.		1.								3.					
Ecuador						70%												
Paraguay				1.		2.							3.					
Peru		1.		2.		3.	4.											
Brunei													1.					
China.					1.								2.		3.			
Cyprus														1.	3.	2.		
Iran			2.	4.	1.		3.						6.		5.			
Mongolia			18%		12%	20%							28%		22%			
Turkey						1.	4.				2.	6.			5.	3.		
Bulgaria													60-70%				2.	
Croatia													95%					
Iceland			1.								2.				3.			
Latvia			7%										10%		16%		57%	10%
Lithuania															1.		2.	
Romania						1.							2.					
Russia													1.		2.			
Slovakia															1.			2.
Slovenia													1.					2.
Ukraine													3%	32%	38%		11%	17%
Cook Islands				2.							3.				4.		1.	
Kiribati																1.		

Note: Percentage numbers refer to contribution of each factor to forest degradation. Ordinal numbers indicate the order of priority as listed by respondents.
Source: Country survey replies

Annex 4 Indicators Suggested by Survey Respondents for Assessing Forest Degradation by SFM Element

Extent of forest resources	Biological diversity	Forest health and vitality	Productive functions of the forest	Protective functions of the forest	Socio-economic functions	Contribution to carbon cycle
Stocking density (13)	Number of species of flora and fauna (13)	Area affected by pests diseases and insects (15)	Growing stock (15)	Area affected by erosion (15)	Recreation (10)	Carbon sequestration (13)
Species composition (13)	Species composition (11)	Area affected by fire (8)	Species composition (4)	Water regulation capacity/catch-ment areas (6)	Employment (9)	Biomass (8)
Forest area/cover (10)	Ecosystem diversity (6)	Area affected by flooding (2)	NTFPs (4)	Water quality and quantity (4)	Commercial value of forest products (8)	Growing stock (4)
Age structure (9)	Genetic diversity and quality (6)		Size distribution of growing stock (3)	Windbreaks (2)	Tourism (6)	
Tree size structure (5)	Introduced species (3)		Timber production (3)		Cultural and spiritual values (5)	
Forest type (2)			Fodder production (2)		Accessibility by local communities (4)	
Area under FMPs (2)			Area under FMPs (2)		Non-commercial values (3)	
					Forest products (2)	

Note: Only indicators mentioned more than once are listed. The numbers refer to the number of respondents (N=45).
Source: Country survey replies

Annex 5 Unofficial Translations of Forest Degradation

Language	Translation
Albanian	Degradimin e pyjeve
Arabic	تاباغلا روەدت
Bulgarian	Горски деградация
Czech	Degradace lesní
Chinese	森林退化
Croatian	Degradacije šuma
Danish	Nedbrydning af skove, forarmelse
Estonian	Metsade degradeerumine
Finnish	Metsän rappeutuminen
Flemish	Bos degradatie
French	Dégradation forestière
German	Walddegradierung, Walddegradation
Greek	Αποψίλωση των δασών
Hindi	वन गिरावट
Hungarian	Erdő degradáció
Indonesian	Degradasi hutan
Italian	Degrado delle foreste
Japan	森林劣化
Korean	포리 스트의 저하
Latvian	Mežu degradācija
Lithuanian	Miškų degradacija
Maltese	Degradazzjoni tal-foresti
Norwegian	Skogdegradering
Polish	Las degradacji
Portuguese	Degradação florestal
Romanian	Padure de degradare
Russian	Деградация лесов
Serbian	Деградације шума

Slovakian	Degradácia lesné
Slovenian	(Forest) razgradnje
Spanish	Degradación forestal; alteración del bosque (Mex.)
Swedish	Skogsförsämring
Thailand	ป่าไม้การปลด
Turkish	Orman bozulması
Ukranian	Деградація лісів
Vietnamese	Rừng suy thoái

Sources: Based on http://translate.google.com/?hl=en#, expert consultations and some author's adjustments