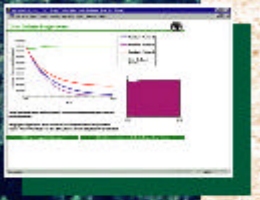
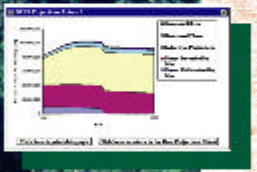
GLOBAL FIBRE SUPPLY MODEL





Food and Agriculture Organization of the United Nations

Acknowledgements

FAO expresses sincere appreciation and gratitude to all who contributed to the Global Fibre Supply Model (GFSM). The contributions have been far wider than the list provided here and appreciation is extended to all these people and agencies.

The support of government forest services, universities, research institutes, industry associations and ECE/FAO are also gratefully acknowledged. The governments who helped organise the regional workshops in Brazil, Ghana and Malaysia were particularly helpful. Lakehead University, University of Toronto and University of Umeå provided valuable information and assistance as did the International Institute for Applied Systems Analysis, the Instituto Florestal em São Paulo, the Forest Research Institute of Malaysia and the European Forest Institute. The various industry associations in Brazil, Malaysia, Ghana and Canada all contributed to the process with important inputs.

The Forest Products Division in the Forestry Department and the members of the FAO Advisory Committee on Paper and Wood Products undertook study management. The overall management team included Karl-Hermann Schmincke, Olman Serrano from FAO; David Barron, Celso Foelkel, Claes Hall; and Lise Lachapelle (chair), Mario Leonel, J.K. Lyden (vice-chair), Irene Meister, M'Hammed Mezzour, Jan Remröd, Kiyoshi Sakai, Maureen Smith, from the Steering Committee of the FAO Advisory Committee on Paper and Wood Products. Gary Bull served as Project Manager.

Various supporting reports and working papers were submitted by Warren Mabee, Musyoka Ngusya, Devendra Pandey, Peter Duinker, Reino Pulkki, Robert Scharpenberg, Roberto Scoz, Klara Vichnevetskaia and Jeremy Williams.

The FAO academic programme was used to gain the insights and experiences of colleagues in the academic community. Peter Duinker, Warren Mabee, Reino Pulkki, all have made significant contributions to the various projects undertaken in this study.

The following individuals served as focal points or participants in the review process: Mike Apsey, Darcie Booth, David Barron, Magnus Berg, David Boulter, David Brooks, Joseph Buongiorno, Mafa Chipeta, Ralph Colberg, Marc de Montalembert, Celso Foelkel, Claes Hall, Catrinus J. Jepma, Sulaeman Kusumanegara, Michael Martin, Benny Nasendi, Sten Nilsson, Heiner Ollmann, Harshad Pande, Tim Peck, Kit Prins, Les Reed, Antti Rytkönen.

The support of colleagues in FAO who provided guidance, data and critical review is also gratefully acknowledged. Without their cooperation the development of the statistics and models would have not been possible. Michael Martin and Chris Brown provided very useful advice and Patrick Durst, Torsten Frisk and Pape Kone facilitated the regional workshops.

Ms Franca Monti, deserves special mention for her superior library skills and her continual assistance in helping all the project team find the data.

The core draft system development included Gary Bull, Warren Mabee and Robert Scharpenberg. Robert was involved with the project from the beginning helping to shape the initial project, build prototypes, provide data quality control and data management. Warren served as the principal computer programmer and designer of the information system. Gary Bull served as Project Manager and main author of this document. The core team for data collection included Josef Engelbertz, Andreas Kress, Patrick So, Bjorn Vikinger. Both Elisa Rubini and Liana Micotti provided outstanding help in editing, layout and formatting. Final design of the report was done by Ronald Nixon.

Foreword

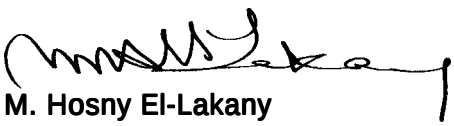
At the 1995 meeting of the FAO Advisory Committee on Paper and Wood Products, a need was expressed for more reliable data, information, forecasts and preliminary analysis of industrial fibre sources. As a consequence the Global Fibre Supply Model was designed and constructed to collect and compile the latest available forest inventory data, including recovered and non-wood fibre, focusing primarily on the sources of industrial fibre as raw material for the sawmilling, wood-based panels, and pulp and paper industries.

The FAO Forestry Department designated Mr Karl-Hermann Schmincke, former Director of the Forest Products Division, and Mr O. Serrano, Chief, Wood and Non-wood Products Utilization Branch, to lead and guide the study. They undertook to provide strategic management advice in carrying this project to completion. The project has provided useful information for both the ongoing outlook studies and the upcoming forest resources assessment. It also serves as a prototype system to guide departmental discussions on the development of a more comprehensive information system.

The success of the study is attributed to the excellent work of a strong statistical team drawn from many countries. It is also due to the willing participation of governments, industry and universities in the regional workshops. The enthusiasm of governments and industry for our work was demonstrated at the workshops held in Asia, Latin America and Africa in 1997 as well as in discussions with the United States and Canadian forest services. The sincerity shown by the participants revitalized interest and enthusiasm in statisitics. The regional workshop process did indeed help in creating, as one colleague put it, “a genuine thirst for statistics”.

Conducting a study of this nature and magnitude has many challenges since it addresses several audience classes with different points of view. The focus of any review of this work should therefore be on the efforts to collect and organize statistics for use in discussions of sustainable forest management. The development of simple models and the examination of possible policy factors should be considered secondary efforts which were built to show policy makers the value of having organized forestry statistics for planning and policy purposes.

This work has generated a great deal of interest both internally in the FAO forestry community and certainly outside the Organization. The FAO Forestry Department hopes that with constructive comments from you, as critical readers of this document, FAO can further contribute to the ongoing international dialogue on sustainable forest management.



M. Hosny El-Lakany
Assistant Director-General
Forestry Department

Executive Summary

FAO Forestry Department initiated the Global Fibre Supply Model (GFSM) in late 1995 upon the recommendation of the FAO Advisory Committee on Paper and Wood Products. The study was intended to respond to several important policy questions: What sources of wood fibre exist today and where could we go in the future to find wood fibre to meet the growing demand for forest products? How much productive forest is needed to supply sustainably expected future fibre demand?

This study does not make claims to address all the dimensions to these questions; rather, the work undertaken should be viewed as a ''first step'' in the FAO's more extensive and ongoing efforts to address these issues particularly through regional and global outlook studies. This first step is certainly an important one and can be viewed as a significant contribution to progress in the development of supply and demand forecasting models.

In general terms the study contributes to forest policy development by highlighting and underscoring the pressing need for reliable data, information and analysis on industrial fibre sources and their utilization. The study includes a compilation of the recent forest inventory statistics along with recovered and non-wood fibre data. The focus is primarily on the sources of industrial fibre as raw material for the sawmilling, wood-based panels, and pulp and paper industries.

A simple model was constructed and linked to the statistics to begin to reveal some of the issues affecting future developments in fibre supply. This modelling provides a first look at some of the major factors affecting supply for important producer countries in Asia/Oceania, Latin America and Africa. It is worth emphasizing that the model does not provide sufficient information to analyse supply and demand balances and users must be very cautious in interpreting the outcome in order to avoid drawing inappropriate conclusions.

The resource statistics were reviewed and received close scrutiny in a series of workshops in Africa, Asia and Latin America regions to verify the statistics and estimates developed by FAO. "Ground-truthing" will ensure that important data sources have not been missed for any country and that all points of view have been considered. This is particularly critical for estimating future industrial fibre supply. It is important to note that these regions have traditionally been the greatest challenge from a statistical point of view and so they were a major focus of the work completed in the study.

The lessons learned from the GFSM work include:

- ❏ The statistical structure developed in the GFSM can be improved over time and can also be modified for use by the countries themselves for forest statistical reporting.
- ❏ Emphasis could be placed on the development of national inventory systems within most countries and on a more cooperative process for statistical reporting.

- ❏ FAO should consider allocating more resources to the further development of an information system for reporting on various aspects of forest resources and forest related products.
- ❏ More information could be collected on log prices and harvesting and manufacturing costs in cooperation with the multistakeholder processes in countries. This information will improve our analysis of global and regional trends.
- ❏ Further attention could be paid to develop methodologies for additional forest resources, such as trees outside of forests, for the purpose of collecting statistical information.
- ❏ Since plantation resources are playing an increasing role in fibre supply, more attention could be paid to forest plantations statistics and models.
- ❏ Additional emphasis could be placed on cost-effective capacity building which will provide a better foundation for country participation in the data collection and standardization process.

Contents

LIST OF FIGURES

LIST OF TABLES

Introduction

OVERVIEW

In late 1995, on the recommendation of the FAO Advisory Committee on Paper and Wood Products, the FAO Forestry Department initiated the Global Fibre[1] Supply[2] Model (GFSM). The study was intended to respond to several important policy questions: What sources of wood fibre exist today and where could we go in the future to find wood fibre to meet the growing demand for forest products? How much productive forest is needed to supply sustainably expected future fibre demand?

These challenging questions have important biological, economic, social, cultural and political aspects. This study does not make claims to address all these dimensions; rather, the work undertaken should be viewed as a ''first step'' in the FAO's more extensive and ongoing efforts to address these issues particularly through regional and global outlook studies. This first step is certainly an important one and is intended to make a significant contribution to progress in the development of supply and demand forecasting models[3] .

In general terms the study contributes to forest policy development by highlighting and underscoring the pressing need for reliable data, information and analysis on industrial fibre sources and their utilization. The study includes a compilation of the recent forest inventory statistics along with recovered and non-wood fibre data. The focus is primarily on the sources of industrial fibre as raw material for the sawmilling, wood-based panels, and pulp and paper industries.

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[1] Fibre is defined broadly as fibrous wood and non-wood raw material for primary industries producing sawn timber, wood-based panels, and pulp and paper products. While the majority of this fibre is harvested from forests and plantations, other kinds of fibre considered in this report include recovered paper, and non-wood fibres.

[2] Economists define supply in terms of a price-quantity relationship. Foresters also use the word supply to describe the physical capability of the forest to produce wood coupled with recognition of some constraints on availability imposed due to physical barriers, transport distance and legislation. Supply in this report means the wood production capacity of the forest adjusted for current and reasonable future limitations on availability.

[3] Binkley (1987) said: ''The quality of extant data severely constrains further empirical work on timber supply models. A unit of effort spent on improving the data series available for timber supply analysis will have a greater return than the same unit of effort spent on estimation techniques or the inclusion of additional explanatory variables.''
Brooks (1987) said ''The most serious difficulty encountered in assembling a model of forest resource dynamics is not, however, the choice of an appropriate methodology, but the lack of consistent, comparable data for many regions."

A simple model was constructed and linked to the statistics to begin to reveal some of the issues affecting future developments in fibre supply. This modelling provides a first look at some of the major factors affecting supply for important producer countries in Asia/Oceania, Latin America and Africa.

REPORT OBJECTIVES

The objectives of this report are to:

- Present current statistics useful in analysing fibre supply by region and a sample of what is available by country from the statistical database.
- Describe a simple model that could identify some of the potential sources of fibre supply and illustrates many of the major factors which have an impact on supply as we look to the future.
- Display some preliminary forecasts for Africa, Asia-Oceania and Latin America. These forecasts are offered to both invite further discussions on methodology and promote a discussion of the key factors influencing fibre availability.
- Summarize some lessons learned in the GFSM exercise and give direction for future development of the work.

This report summarizes a larger body of work completed in the GFSM efforts. Complementing this work is a series of working papers, a special edition of *Unasylva,* and a user-friendly database and computer model.

UNIQUENESS

The GFSM builds a bridge between two existing priority programmes in the FAO Forestry Department – the Outlook Studies and the Forest Resources Assessment 2000 (see Figure 1). It does this by focussing on statistics currently weak or missing such as the collection and compilation of commercial forest volume inventory, forest growth and potential removal data for the developing regions – Africa, Asia-Pacific, and Latin America and the Caribbean. It will strengthen FAO's Outlook Studies in these rapidly developing regions by improving our statistics on wood fibre potential and complement existing econometric modelling of demand for forest products.

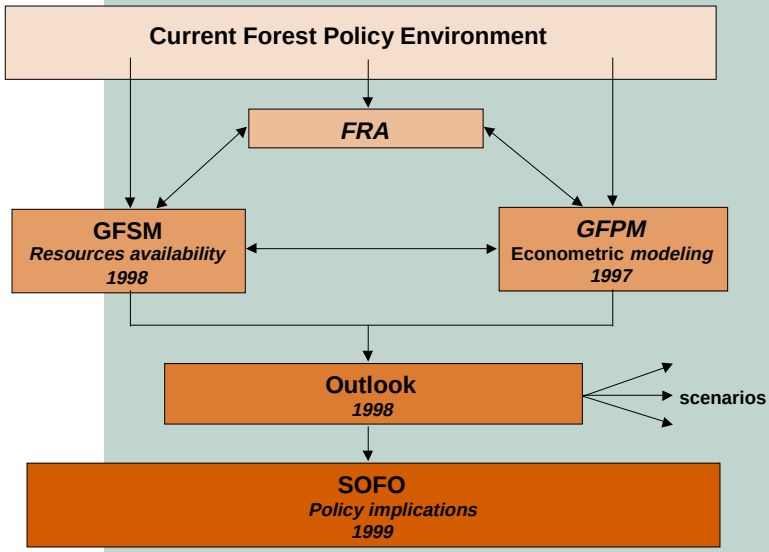
The GFSM is being monitored by representatives from the forest products industry, governments and research institutes. A special Steering Committee is providing guidance on the scope of the project and feedback on the information generated. Participation is encouraged through regional workshops, four of which have already been held.

The study was deliberately designed to avoid duplication of effort with other agencies working in the area of fibre supply. Therefore, to meet the terms of reference and for the sake of completeness, it incorporates statistics and forecasts from the International Institute of Applied Systems Analysis (Russia), the Economic Commission for Europe and FAO Geneva (Europe), and the Canadian and United States Forest Services (North America).

FAO APPROACH

FAO has adopted a multiple-pronged approach in preparing outlook studies. The *Forest Resources Assessment* (FRA) provides foundation data on forest area and key characteristics of the forest resource. A *Global Fibre Supply Model* (GFSM) is providing a simulation model to forecast fibre supply potentials under different scenarios. Likely developments in the consumption, production and trade of forest products are provided through a Global Forest Products Model (GFPM). These three components provide the analytical foundation necessary to support a set of scenarios to be presented as the FAO global *Outlook for Forests and Forest Products*. The scenarios developed will describe the adjustments required in forest management, wood products production, consumption and trade in order to achieve certain desired future conditions for the forestry sector. The global *Outlook for Forests and Forest Products* will be developed after consultation with governments, industry and non-governmental organizations. The implications for policy will be summarized in the *State of the World's Forests 1999* (FAO's biennial review).

Figure 1
Forestry statistics and outlook studies processes



The approach described above is an iterative process, which will be carried out on a periodic basis, with FRA2000 being the beginning of the cycle once again. Through it, the FAO Forestry Department hopes to contribute more effectively to the global forest policy debate on issues such as sustainable forest management, biological diversity and climatic change. In addition, it will assist in addressing questions such as: How will we meet the growing demand for wood products? Will technological advances offset changes in wood availability? What role can recycling and non-wood fibres play?

REPORT STRUCTURE

The report is organized as follows:

Section 2	Description of methodology
Section 3	Background for the study
Section 4	Current fibre supply situation
Section 5	Impact of major supply factors
Section 6	Alternative futures
Section 7	Discussion and conclusions
Annex 1	Statistical summary of forest area, growth, volume, harvesting intensity (potential removals) and alternative fibres and plantations plus summary of possible futures for some regions
Annex 2	Major definitions and classification

Methodology

STUDY DESIGN

The initial task was to construct an appropriate database for data compilation and information management. A pre-test was conducted, definitions were developed, and input tables for data compilation were completed. A team of experts worked on a country-by-country basis through the latest available inventory reports to extract the data necessary to complete the country profiles in terms of forest area, growing stock volume, growth and removals, for the major industrial roundwood producers in Africa, Asia-Pacific, and Latin America and the Caribbean.

The analysts used Microsoft Access as the relational database management programme and Visual Basic as the programming language for supply forecasting. (Another forecast model was developed in FORTRAN, later converted to VBASIC, and it is described in more detail in GFSM Working Paper No. 5.)

In order to forecast to the year 2050, it is necessary to place the fibre supply projections into an appropriate policy context. Based on a thorough review of the policy issues addressed in previous supply studies, the major policy factors identified for consideration at this time are:

- sustainable forest management;
- land-use change – deforestation;
- land-use change – protected area;
- plantation afforestation rate;
- plantation development gains;
- non-wood and recovered fibre; and
- material efficiency and technological change.

The implications of these factors are described in more detail in Section 5. The study team recognizes that prices and costs are also important determinants in defining the economic supply but, due to the limited financial resources available for the project, these factors were not explicitly included. In particular, the definitions and classification were chosen to match those of the Forest Resources Assessment 2000. This will help the reader to follow upcoming FAO reports, assist the FRA and Outlook Studies teams with some of their information requirements and also improve the linkage of the GFSM study to some important current forest policy issues.

Table 1
List of countries included in the GFSM assessment

Africa (26)	North America (3)	Asia (22)	Europe (28)
Angola	Canada	Afghanistan	Albania
Botswana	Mexico	Bangladesh	Austria
Cameroon	United States of America	Bhutan	Belgium
Central African Republic		Brunei Darussalam	Bulgaria
Congo, Democratic Rep.	**Central America (9)**	Cambodia	Croatia
Congo, Republic of	Belize	China	Czech Republic
Côte d'Ivoire	Costa Rica	India	Denmark
Equatorial Guinea	Cuba	Indonesia	Estonia
Gabon	Dominican Republic	Iran	Finland
Ghana	El Salvador	Japan	France
Guinea	Guatemala	Korea,DPR	Germany
Guinea-Bissau	Honduras	Korea, Rep. of	Greece
Kenya	Nicaragua	Laos	Hungary
Liberia	Panama	Malaysia	Ireland
Madagascar		Myanmar	Italy
Malawi	**South America (13)**	Nepal	Latvia
Morocco	Argentina	Pakistan	Lithuania
Mozambique	Bolivia	Sri Lanka	Norway
Nigeria	Brazil	Thailand	Poland
Sierra Leone	Chile	Turkey	Portugal
Somalia	Colombia	Viet Nam	Romania
South Africa	Ecuador	Guyana	Slovakia
Tanzania, United Rep.	French Guiana		Slovenia
Uganda	Guyana	**Oceania (6)**	Spain
Zambia	Paraguay	Australia	Sweden
Zimbabwe	Peru	Fiji	Switzerland
	Suriname	New Zealand	United Kingdom
	Uruguay	Papua New Guinea	
	Venezuela	Solomon Islands	**USSR, former area (1)**
		Vanuatu	Russian Federation

Definitions

In conducting a study of this nature it is critical to have a clear set of terms for forest resources. The definitions must have at least the following characteristics to be useful for both consistency of the various statistical reports and for outlook work:

The definitions must be in general agreement with new terminology negotiated in international forums. For example, the definitions used must be compatible with the FAO Forest Resources Assessment 2000. Where definitions did not exist the terms used draw heavily on the forestry literature for description. The terms must be flexible enough to utilize old data sets. For example, the FAO Forest Resources Assessment 1980 contains very important data on forest volume utilized in building a country profile.

The major terms must be able to accommodate the country level data collected. For example, each country has its own unique way of classifying forest area and volumes and the standard definitions must be able to accommodate these differences.

The terms must be readily understandable to a wide audience of users. This ensures greater transparency in the presentation of data.

It is imperative for any long-term planning to establish standards that can be applied to a wide variety of circumstances. Annex 2 contains a complete list of definitions used in the study.

Classification of fibre resources

Figure 2 summarizes the classification of forest area for the natural forest (forest undisturbed and disturbed by man). In addition, there is fibre also available from industrial plantations, recovered fibre and non-wood fibre. Figure 3 summarizes the forest volume and growth classification. In addition to classifying from a fibre supply point of view, this classification scheme allows the study to maintain a high degree of consistency with other activities within the Forestry Department. In particular, the classification was chosen to be consistent with that of the Forest Resources Assessment 2000. This will help the reader to follow upcoming FAO reports, assist the FRA and Outlook Studies teams with some of their information requirements and improve the linkage of the GFSM work to some important current forest policy issues.

Figure 2
Land classification for the Global Fibre Supply Model

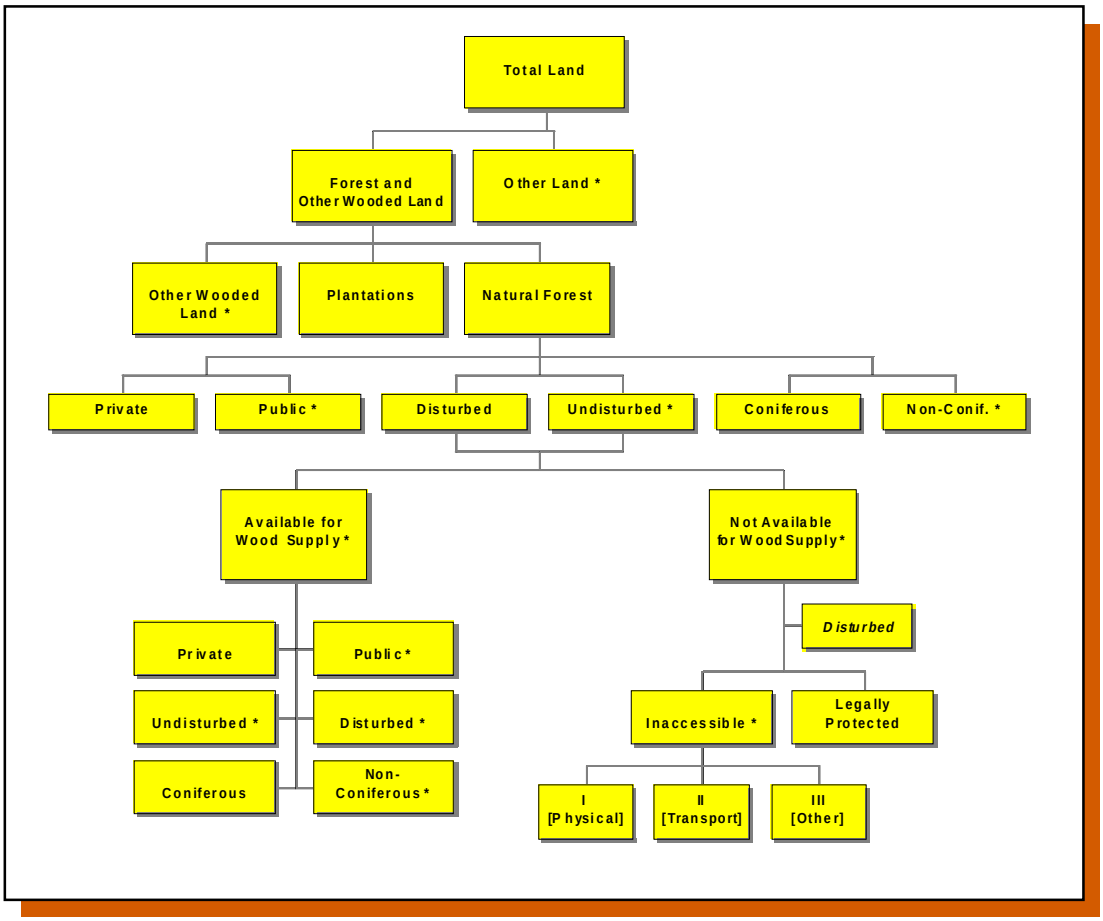
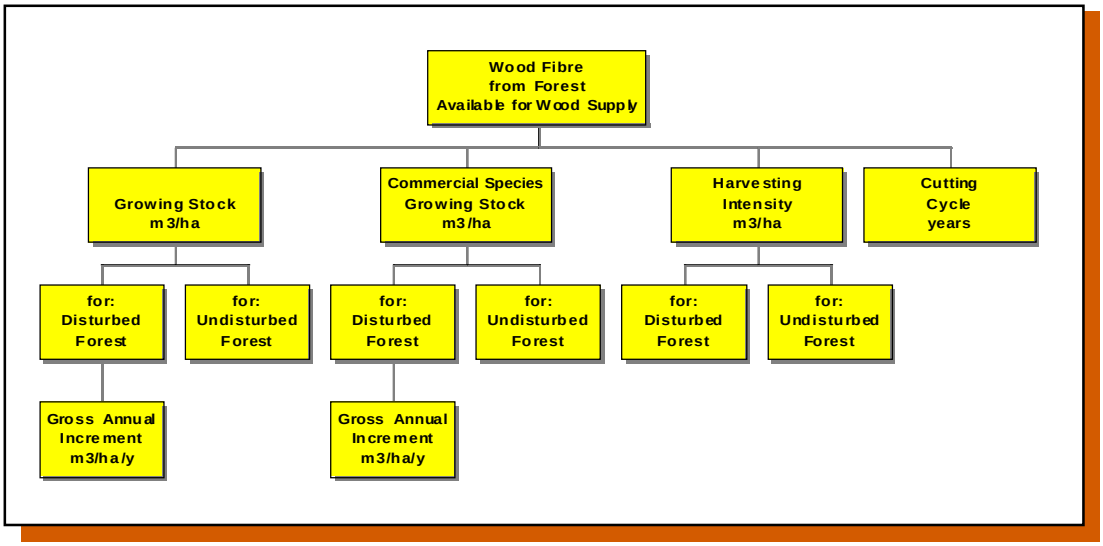


Figure 3
Forest volume and growth classification



Describing the current situation

The statistics chosen for collection are important because they serve as a basis for examining both the current and future conditions of the forests. The creation of possible futures requires the manipulation of critical variables in a set of equations that forecast changes in fibre sources over time. The critical statistics in the case of the GFSM are:

- area – i.e. current forest area available for wood supply;
- area – area change for natural and plantation forest;
- volume – both growing stock and commercial species growing stock;
- growth – gross annual increment and mortality;
- fellings/removals – harvesting intensity and cutting cycle;
- recovered and non-wood fibre – production capacity.

Constructing alternative futures

Modelling the future in today's forest policy context also requires the use of equations to manipulate the statistics or variables just described and which have at least some ability to express the sustainability of supply. Figure 4 is a summary of the formulae considered for use in the analysis of natural forests. Currently equations III and IV are being used in the modelling efforts and once better conversion factors are developed equations I, II and V will also be included to improve our analytical abilities.

Figure 4
Formulae for calculating fibre supply futures

I: $\frac{G_{ud}}{c} + (i \cdot A_d)$

II: $\frac{G_{ud}}{c} + (0.5 \cdot i \cdot A_d)$

III: $\frac{H_i \cdot A_{ud}}{c} + (i \cdot A_d)$

IV: $\frac{H_i \cdot A_{ud}}{c} + (0.5 \cdot i \cdot A_d)$

V: $2\frac{(G_{ud} + G_d)}{r}$

Symbol	Explanation
G_{ud}	Commercial Species Growing Stock – Forest undisturbed by man
G_d	Commercial Species Growing Stock – Forest disturbed by man
A_{ud}	Area available for wood supply – Forest undisturbed by man
A_d	Area available for wood supply – Forest disturbed by man
H_i	Harvest intensity
i	Increment
c	Cutting cycle
r	Rotation period

There are a wide range of equations used to calculate area of forest undisturbed by man and forest disturbed by man. Based on an extensive review of the literature on yield regulations, particularly as applied to tropical forest conditions[4], the GFSM identified five equations as useful.

Equations I and II rely on the growing stock statistics of

[4] Since the yield regulation formulae were originally developed in temperate and boreal forest conditions, a modification of the formulae presented can make them applicable to these forests as well. For example, in some forests the cutting cycle would be replaced with a rotation age and the harvest intensity replaced with merchantable volume.

commercial species in the forest undisturbed by man and allow for the gradual transition over time from an undisturbed forest to a disturbed forest. Equation II allows for the application of a reduction factor to the increment statistics. Since in many countries the increment statistics are very difficult to obtain, the ability to reduce increment because of uncertainty, mortality, bark and other factors is very important. The primary disadvantage of the use of these formulae relates directly to the inadequacy of forest inventory data which only report volumes for large-diameter trees, usually above 50 cm diameter at breast height (dbh). In calculating future potential supply this is simply not appropriate since all trees, and certainly all those above 10 cm dbh, are of significance and should be reported. Unfortunately, the needed conversion factors have not yet been developed, particularly to convert the inventories from, for example, a 50 cm class to a 20 cm class.

Equations III and IV focus on harvesting intensity statistics for the gradual conversion of the undisturbed forest to disturbed forest. Once the conversion has occurred, the formulae use the growth in the forest as the driving variable in calculating supply. A reduction factor to the growth of 0.5 is applied in the case of equation IV and this reflects the uncertainty over the growth statistics. For example, it is often unclear in the source of information if the growth includes a mortality factor or not.

Equation V is a barometer against which one can compare the results of the other four equations. It is useful to have a reasonable range of formulae for analysts to compare results and select the most appropriate equation for projecting futures.

Normally it is most appropriate to calculate the amount of fibre to be removed on the basis of the standing commercial forest and the growth of the forest, i.e. using equations I and II. However, since volumes are so difficult to determine from a supply point of view, the harvesting intensity applied to the area available for wood supply is a suitable surrogate for supply forecasting calculations.

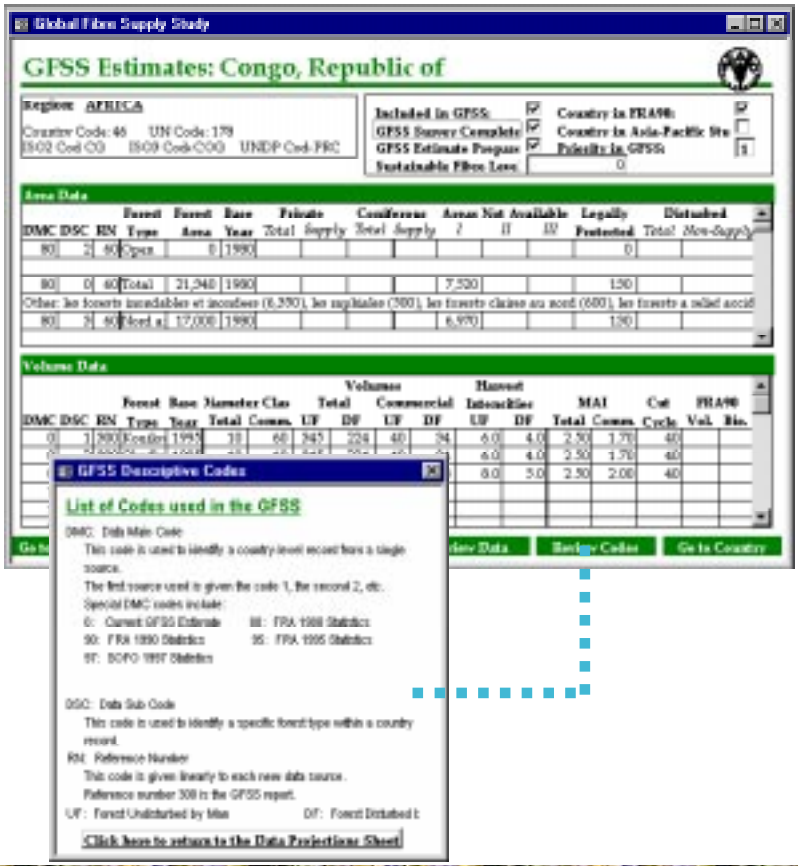
In determining the supply levels for industrial plantations, non-wood fibres and recovered fibres, the array of options are narrower than with forest undisturbed by man and forest disturbed by man. This is either because the data or information currently available are limited or the data can be handled in a more straightforward manner. The GFSM model identifies a single formula for the calculation of each of these components (see Working Paper No. 1 for details).

Tool for accessing and displaying the current situation and forecasts

In order to access readily available statistical information and to assist in quickly displaying possible scenarios a database and model that is directly linked were constructed. Figure 5 shows the front page of the database and

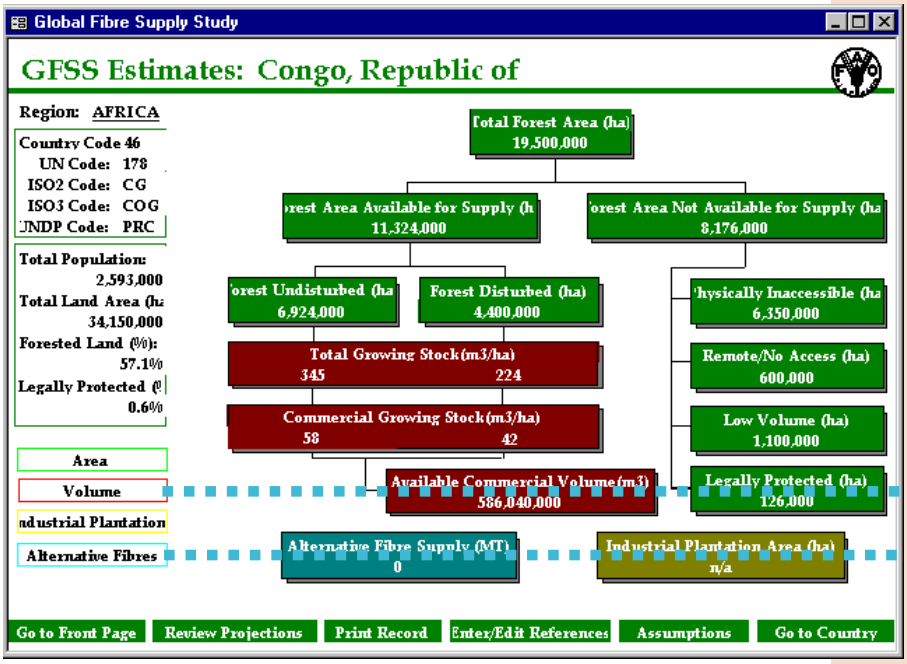
Figure 5
Front page of global fibre supply database and model

model. For each of the items mentioned in the right-hand column there are a number of activities that can be explored by the user.

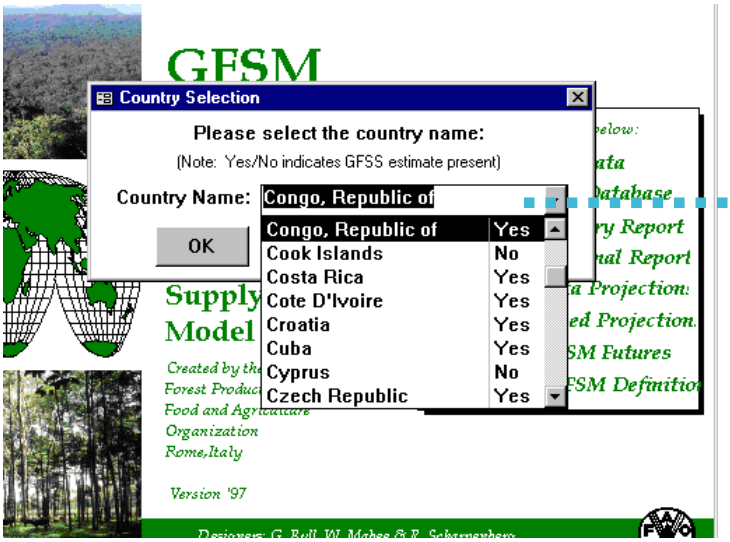


The first button ***Enter New Data*** allows the analyst to enter new data and reference material. It will only be accessible to designated analysts in charge of data entry and standardization.

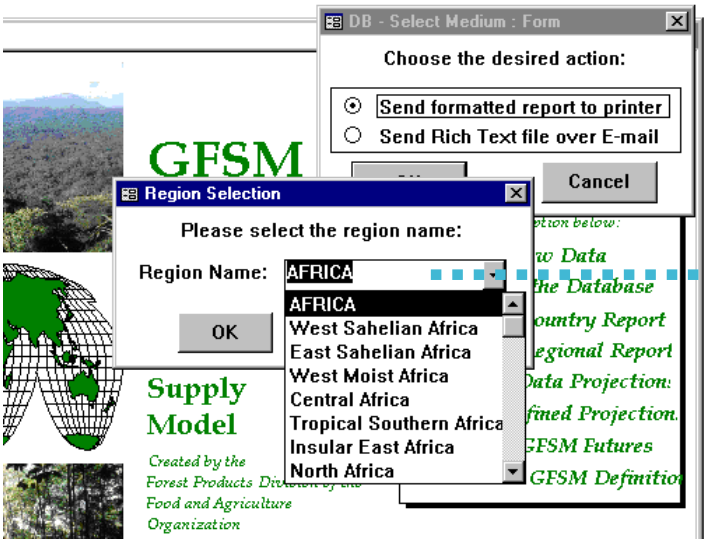
The second button ***Review the Data*** provides a quick snapshot view of the most important country statistics on forest area, volume, alternative fibres and plantation data. Other relevant statistics are provided along with a list of major assumptions made in creating the basic data (Section 2 – *Base data*)

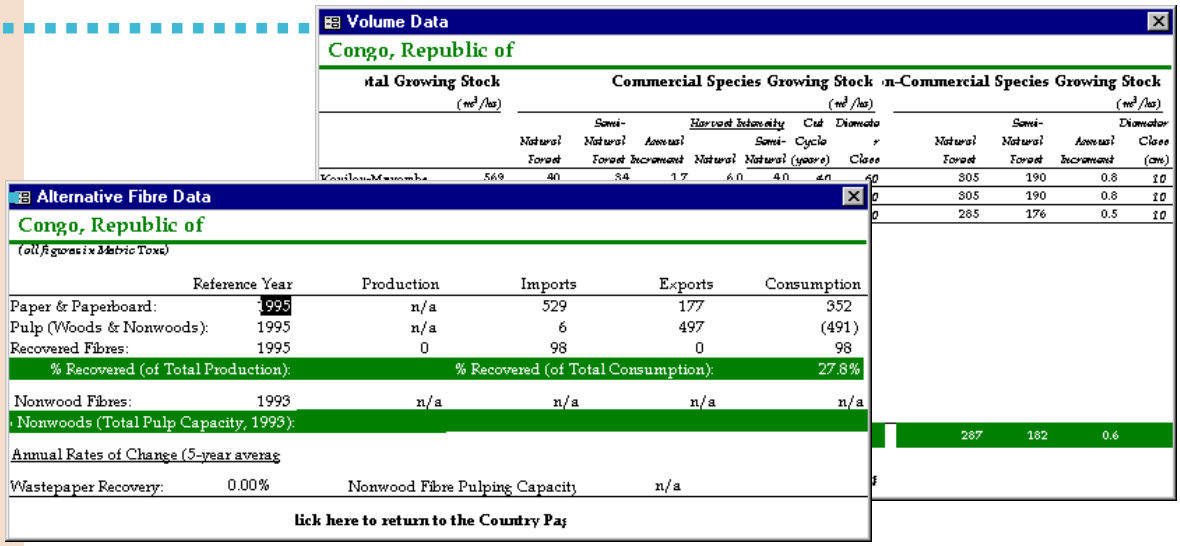


The third button ***Create Country Reports*** allows database users to generate reports which are automatically formatted and updated with the latest statistical information.

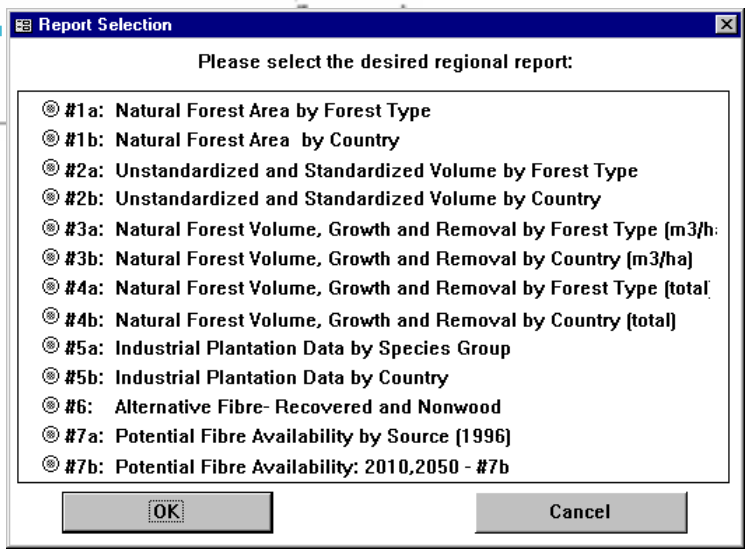


The fourth button ***Create Regional Reports*** allows users to generate a variety of regional reports to meet specific needs. For example, there are reports on forest area, volume, growth and removals by country at the forest type level or aggregated at the country level. There are also reports describing possible futures using the GFSM forecast model. Currently, the user has the ability to choose one of some 14 reports.

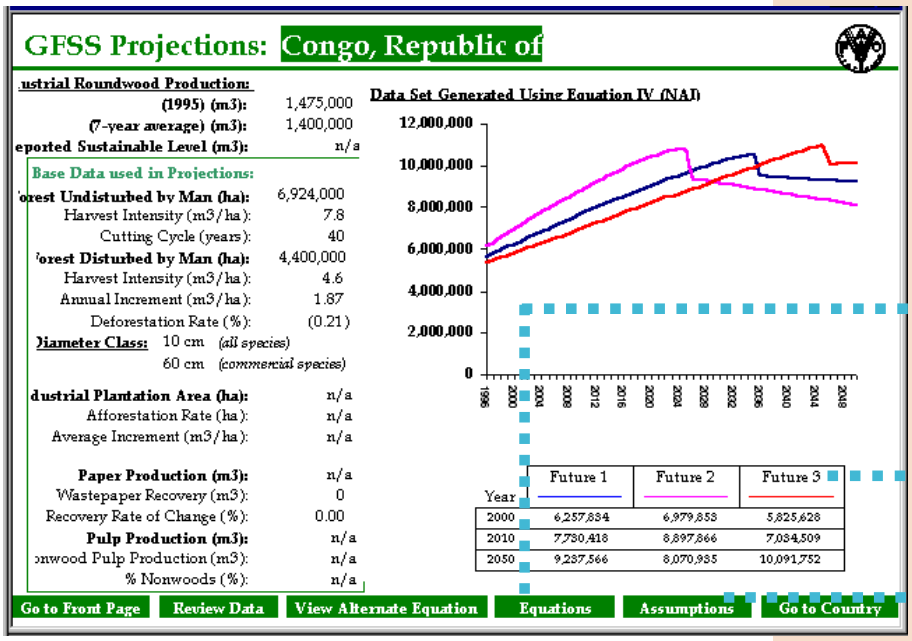



Volume Data
Congo, Republic of
Commercial Species Growing Stock
Natural Forest
Semi-Natural Forest
Annual Increment
Harvest Intensity
Natural
Semi-Natural
Cut Cycle (years)
Diameter Class
Non-Commercial Species Growing Stock
Natural Forest
Semi-Natural Forest
Annual Increment
Diameter Class (cm)
Alternative Fibre Data
Congo, Republic of
(all figures in Metric Tons)
Reference Year
Production
Imports
Exports
Consumption
Paper & Paperboard: 1995 n/a 529 177 352
Pulp (Woods & Nonwoods): 1995 n/a 6 497 (491)
Recovered Fibres: 1995 0 98 0 98
% Recovered (of Total Production): % Recovered (of Total Consumption): 27.8%
Nonwood Fibres: 1993 n/a n/a n/a n/a
Nonwoods (Total Pulp Capacity, 1993):
Annual Rates of Change (5-year averag
Wastepaper Recovery: 0.00% Nonwood Fibre Pulping Capacity n/a
lick here to return to the Country Pa

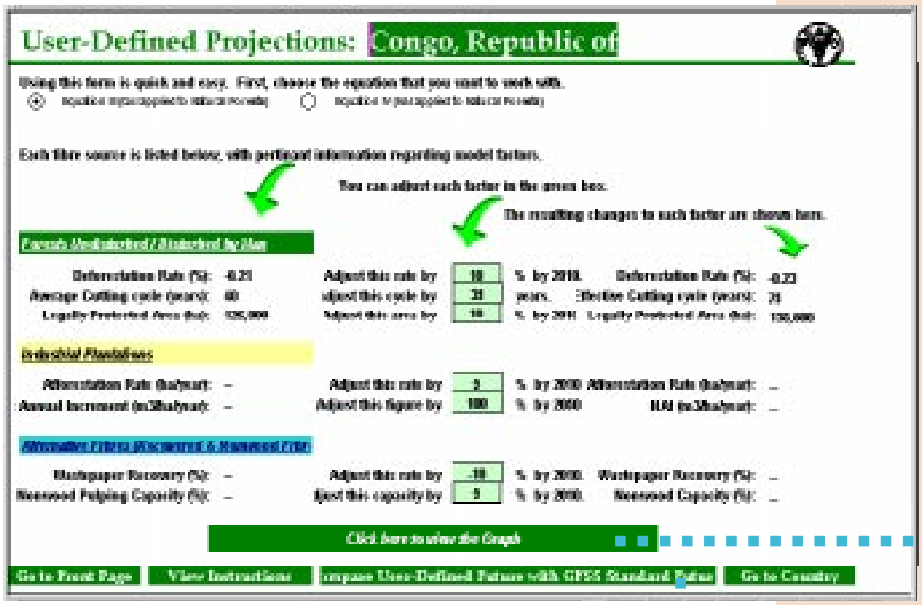

Country Summary : Congo, Republic of


Report Selection
Please select the desired regional report:
#1a: Natural Forest Area by Forest Type
#1b: Natural Forest Area by Country
#2a: Unstandardized and Standardized Volume by Forest Type
#2b: Unstandardized and Standardized Volume by Country
#3a: Natural Forest Volume, Growth and Removal by Forest Type (m3/h
#3b: Natural Forest Volume, Growth and Removal by Country (m3/ha)
#4a: Natural Forest Volume, Growth and Removal by Forest Type (total
#4b: Natural Forest Volume, Growth and Removal by Country (total)
#5a: Industrial Plantation Data by Species Group
#5b: Industrial Plantation Data by Country
#6: Alternative Fibre- Recovered and Nonwood
#7a: Potential Fibre Availability by Source (1996)
#7b: Potential Fibre Availability: 2010,2050 - #7b
OK
Cancel

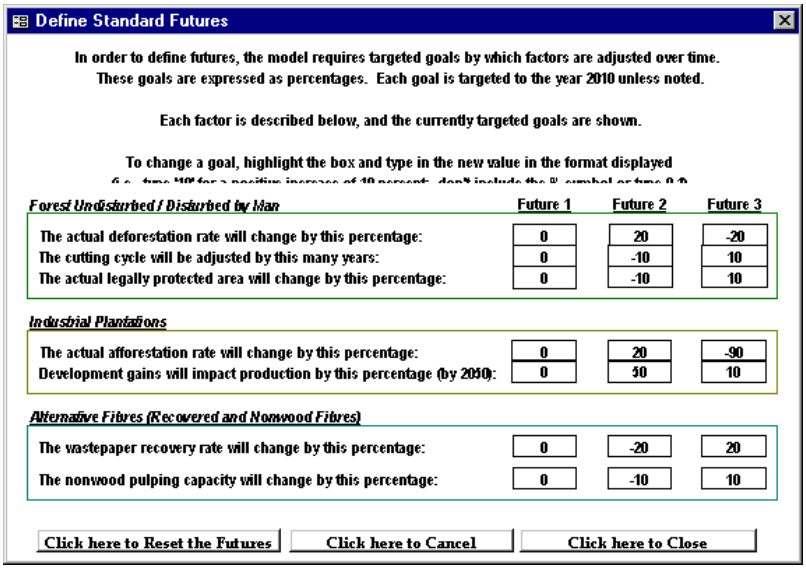
The fifth button ***GFSM Data Projections*** facilitates the exploration of three possible futures for each country and, most importantly, it describes the role each source of fibre could play in those futures. A list of major assumptions made in creating the futures is included (Section 2 – *Forecasting*).



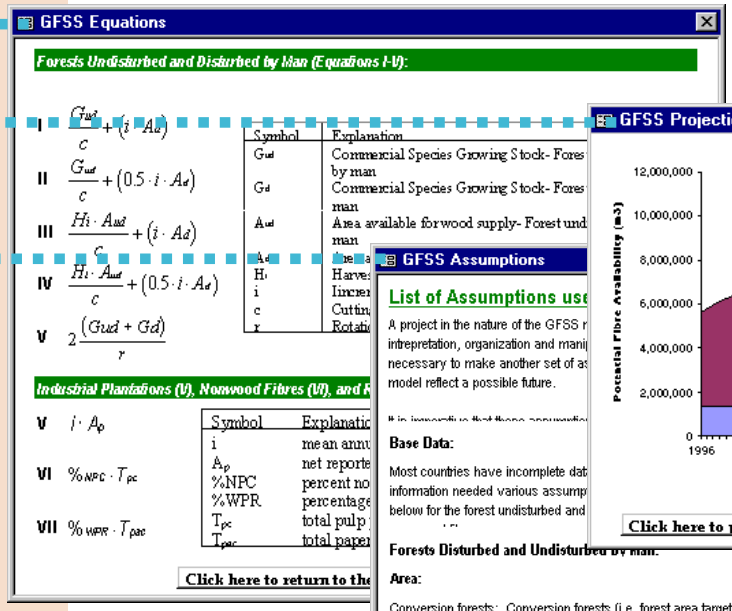
The sixth button ***User Defined Projections*** allows the user to explore a different future by manipulating variables as described in Section 5 and compare with the standard futures as set by the ***GFSM*** analyst. This is particularly useful for exploring country-specific policy issues affecting industrial wood supply. Instructions on how to use this feature are provided.

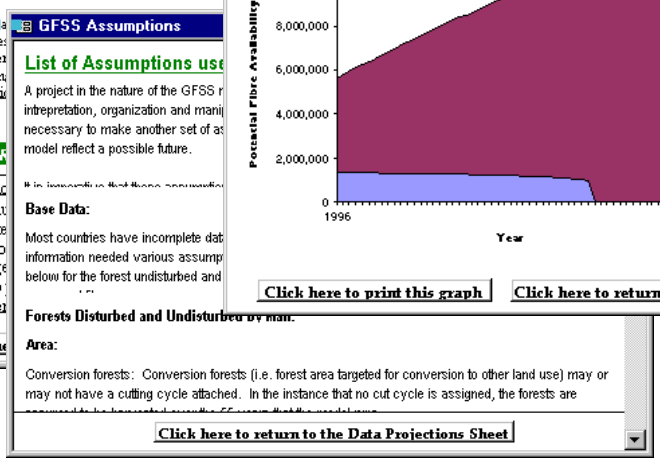


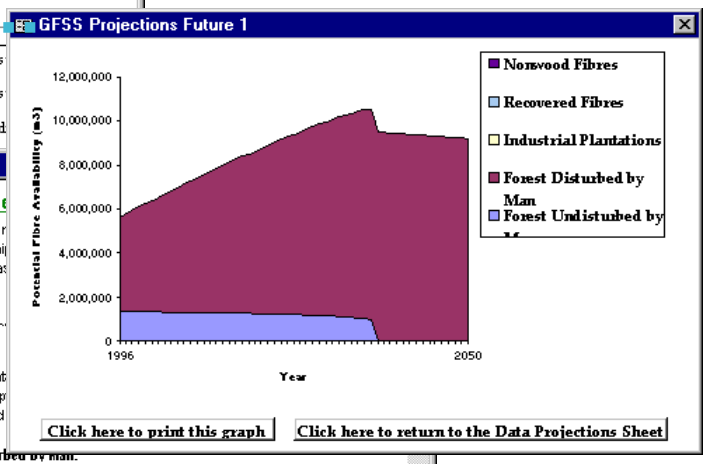
The seventh button ***Define GFSM Futures*** allows the analyst to set the standard variables as described in Section 5 for all countries. These variables can be reset at any time to help public policy makers, industry analysts and NGOs explore alternative futures.

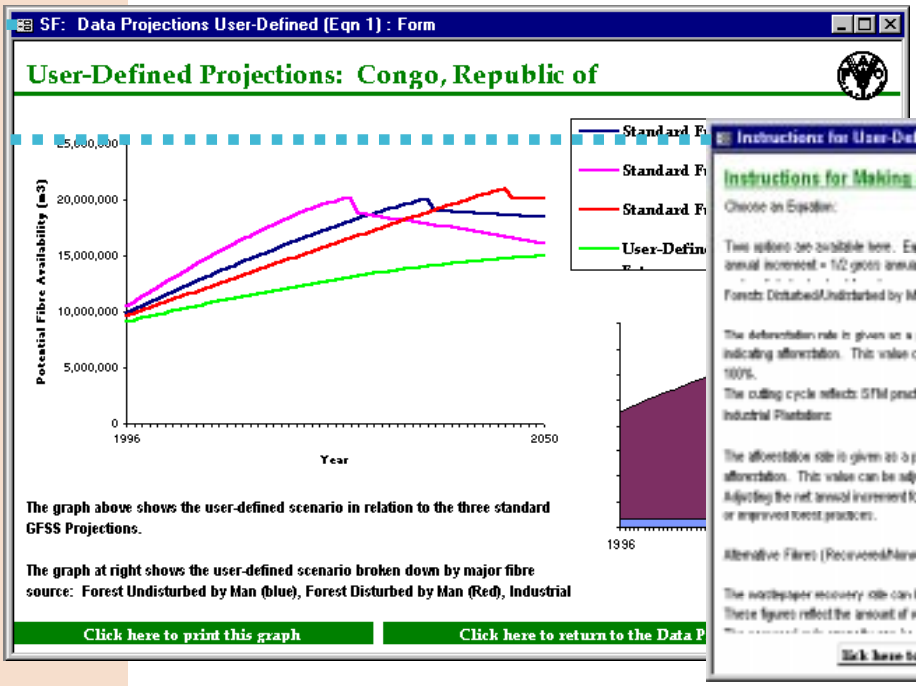


The eighth button ***Review GFSM Definitions*** contains a complete summary of the terms used in the database and model.

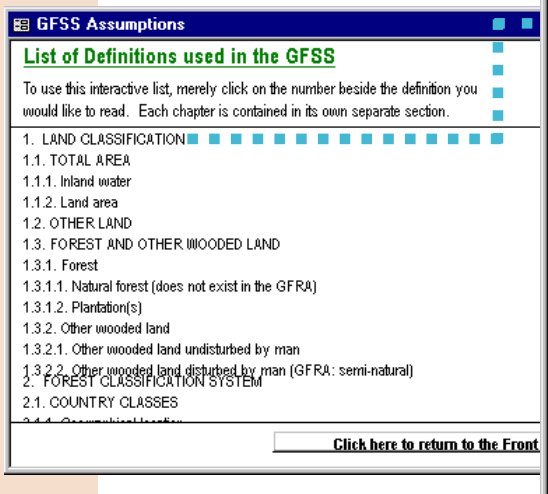

GFSS Equations
Forests Undisturbed and Disturbed by Man (Equations I-V):
Industrial Plantations (V), Nonwood Fibres (VI), and
Symbol
Explanation
Click here to return to the

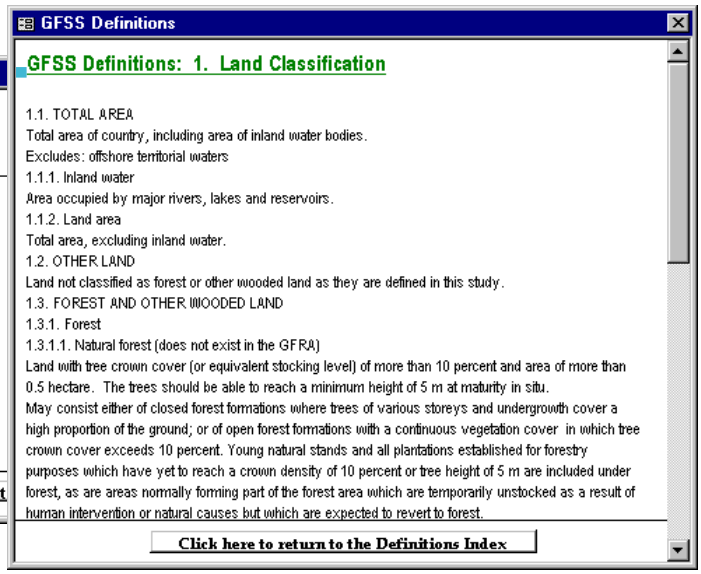

GFSS Assumptions
List of Assumptions use
A project in the nature of the GFSS
Base Data:
Most countries have incomplete dat
Forests Disturbed and Undisturbed by Man:
Area:
Conversion forests: Conversion forests (i.e. forest area targeted for conversion to other land use) may or may not have a cutting cycle attached. In the instance that no cut cycle is assigned, the forests are
Click here to return to the Data Projections Sheet


GFSS Projections Future 1
Nonwood Fibres
Recovered Fibres
Industrial Plantations
Forest Disturbed by Man
Forest Undisturbed by
Potential Fibre Availability (m3)
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1996
2050
Year
Click here to print this graph
Click here to return to the Data Projections Sheet


SF: Data Projections User-Defined (Eqn 1) : Form
User-Defined Projections: Congo, Republic of
Potential Fibre Availability (m3)
20,000,000
15,000,000
10,000,000
5,000,000
0
1996
2050
Year
The graph above shows the user-defined scenario in relation to the three standard GFSS Projections.
The graph at right shows the user-defined scenario broken down by major fibre source: Forest Undisturbed by Man (blue), Forest Disturbed by Man (Red), Industrial
Click here to print this graph
Click here to return to the Data P


Instructions for User-Defined Projections
Instructions for Making a User-Defined Projection
Click here to return to the User-Defined Projections She


GFSS Assumptions
List of Definitions used in the GFSS
To use this interactive list, merely click on the number beside the definition you would like to read. Each chapter is contained in its own separate section.
1. LAND CLASSIFICATION
1.1. TOTAL AREA
1.1.1. Inland water
1.1.2. Land area
1.2. OTHER LAND
1.3. FOREST AND OTHER WOODED LAND
1.3.1. Forest
1.3.1.1. Natural forest (does not exist in the GFRA)
1.3.1.2. Plantation(s)
1.3.2. Other wooded land
1.3.2.1. Other wooded land undisturbed by man
1.3.2.2. Other wooded land disturbed by man (GFRA: semi-natural)
2. FOREST CLASSIFICATION SYSTEM
2.1. COUNTRY CLASSES
Click here to return to the Front


GFSS Definitions
GFSS Definitions: 1. Land Classification
1.1. TOTAL AREA
Total area of country, including area of inland water bodies.
Excludes: offshore territorial waters
1.1.1. Inland water
Area occupied by major rivers, lakes and reservoirs.
1.1.2. Land area
Total area, excluding inland water.
1.2. OTHER LAND
Land not classified as forest or other wooded land as they are defined in this study.
1.3. FOREST AND OTHER WOODED LAND
1.3.1. Forest
1.3.1.1. Natural forest (does not exist in the GFRA)
Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 hectare. The trees should be able to reach a minimum height of 5 m at maturity in situ.
May consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground; or of open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent. Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 10 percent or tree height of 5 m are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest.
Click here to return to the Definitions Index

The emphasis of the database and model is transparency, flexibility and simplicity. In practical terms this means ease of access to forest standardized and unstandardized data, and ease of use of a simulation model which is relevant to some current forest policy issues.

SCOPE AND VALIDATION

Due to limited resources, and in order to keep the project to a more manageable size, it was decided that this project could not include at this time:

- fuelwood;
- trees outside of forests;
- non-industrial forest plantations;
- price and cost data;
- the geographic area of the Middle East;
- the geographic area of the republics of the former USSR;
- countries where industrial roundwood production is less than 100 000 m^3, unless the information was readily available.

In the future it will be necessary to collect the additional statistics to cover the fibre source of the regions/countries mentioned in order to present a more complete global picture of fibre supply for industrial and non-industrial uses (see Table 1). The price and cost information needs will also have to be addressed in order to bring market forces to bear on the supply analysis.

It is important in an exercise of this manner to validate the data used on basic area and volume of fibre available. Due to time and budgetary limitations and at the instruction of the Steering Committee, the data compiled was screened in two ways: First, it was examined by forestry experts and consultants who have knowledge of the particular country. Second, it was taken to regional workshops in Malaysia, Ghana and Brazil for an examination by government, private sector and non-governmental representatives.

MAJOR ASSUMPTIONS

A project of this nature requires the analysts to make key assumptions in data collection, interpretation, organization and manipulation. In addition, for any fibre supply modelling exercise, it is necessary to make a set of assumptions in model construction and development in order to describe possible futures. To gain more widespread acceptance of the information and the forecasts it is imperative that assumptions are made transparent and therefore considerable effort is made below to describe them fully. It should be noted that the assumptions described below are generic in nature and therefore used in the countries to which they apply. Naturally, the data collected from each country requires that additional unique assumptions are applied in order to standardize the data fully. In a report of this nature it is not appropriate to present an exhaustive description but the intention is to establish a continual dialogue with country analysts whereby all assumptions will be developed through a workshop participation process, a process which has already been initiated with over 25 countries for this report and now is still ongoing in the outlook study and FRA processes.

Base data

Most countries have incomplete data sets for natural and plantation forests. In order to fill in the essential information needed various assumptions were made in developing the base data. These are described below for the forest undisturbed and disturbed by man, the industrial plantation forest and the non-wood and recovered fibre.

Forest Undisturbed and Disturbed by Man

Forest Area

Area estimates contain three major assumptions.

1. The collection of total forest area statistics has a long history. It is now possible to calculate forest area with remote sensing information along with ground checks and it is assumed that this is the best possible method for area statistics for many countries in the absence of detailed inventory reports. The FAO Forest Resources Assessment 1990 forms an important part of the ***GFSM*** area assessment in developing countries.
2. It is also assumed that other wooded land will not yield a significant amount of industrial roundwood. Thus it is excluded from the current ***GFSM*** assessment.
3. There are distinctly different points of view on the issue of what area is available for fibre supply at a point in time and these are legitimate differences since our knowledge is imperfect[5]. While the precise boundary of the area available for wood supply cannot be defined, it is necessary for an industrial fibre outlook study to assess the area which is available under current market conditions, with current technology and infrastructure. Therefore assumptions were made using country experts and other data sources to deduct the forest area not available for wood supply. Forest area not available for wood supply was placed into the following classes and subclasses:
    a) legally protected according to IUCN classes 1 and 2;
    b) economically inaccessible;
        i) physically inaccessible due to factors such as steepness of terrain.
        ii) far from industrial sites due to transportation distance or lack of infrastructure.
        iii) too low in commercial volume, degraded forest or some other legitimate reason specific to each country.

It is worth noting that a similar evaluation procedure was used in the 1980 Forest Resources Assessment for the tropical forest.

[5] For example, there is sometimes a different view between governments and industry over area available for wood supply. From a government's point of view an area could be available for wood supply if there is no official policy, regulation or legislation which precludes its inclusion in a concession agreement. Industry may take a different view since it will assess the likelihood of an area of the concession being included in, say, protected area, or an area being physically inaccessible due to restrictions on permissible harvesting systems. This naturally leads to a divergence of opinion but neither policy actor can be considered unreasonable.

Forest Volume and Growth

Growing stock volume in cubic metres per hectare (m^3/ha)is reported at the diameter class which is standardized to 10 cm. It is also possible to indicate the unstandardized volumes if the information is requested. It is important to note that these statistics are not necessarily a reflection of the forest volume available for future wood supply.

Commercial species volumes are based on the tree species considered commercial under current market conditions for a particular country. The commercial or potentially commercial volume in the natural forest of tropical countries is normally far lower than the total growing stock. It is very important to pay special attention to the reported diameter class of the growing stock. In many cases the statistics are not a reflection of the commercial growing stock available today for industrial uses but of all age classes of commercial species greater than 10 cm.

Forest undisturbed by man in the tropical forest areas will not, in general, have any net growth since mortality is an offsetting factor to any annual growth. This is not the case in the forest disturbed by man and estimates of increment by forest type are included. There is a paucity of good data in this area.

For the temperate and boreal forests the study relies on the estimation procedures already made in statistical reports from the countries, research institutes or the ECE/FAO reports, all of which are mentioned in Section 6. Naturally the assumptions are different and the reader should refer to the relevant documentation.

Forest Removals

Harvesting intensity estimates for the tropics will change with the transition from forest undisturbed by man to forest disturbed by man under the historical and future forms of management. Working Paper No. 6, which is an annotated bibliography on this subject, strongly supports this assumption.

Under sustainable forest management practices harvesting intensity should remain fairly constant in a forest disturbed by man with each cutting cycle. The cutting cycles' statistics attempt to reflect the common silvicultural and harvesting prescriptions used most commonly in a country by each forest type.

In boreal and temperate regions the removal is expressed on an annual basis since the harvesting systems are generally different from the tropical regions and it is the total volume divided by the rotation age for each forest type.

Industrial Plantations

The plantation area includes all plantations whose primary objective is to produce industrial roundwood – that is sawlogs, veneer logs, pulpwood and other industrial wood. They include areas of "non-forest" species, such as rubber and coconut and, to a lesser extent, oil palm. Presently relatively few countries are using these species for forest products but more use is anticipated in the future. They exclude all plantation areas where it was

possible to identify, or in some cases infer, that the objective was non-industrial – that is mainly fuelwood but also poles, tan-bark and areas managed exclusively for other non-timber products. If, however, an area is managed for a non-timber product such as naval stores (e.g. some of the pines in Sri Lanka) they are included since they will eventually produce industrial roundwood.

The gross annual increment is an estimate by species and by country of the increment in m^3/ha/a continued over the commercial rotation of the crop. Once more is known about mortality, reduction factors can be applied to yield a net annual increment.

Recovered Fibres

The percentage of wastepaper recovered is a fraction of total paper and paperboard production. For a few countries, particularly those with political turmoil, figures were either unreliable or unavailable. In such cases estimated values were used to fill data gaps. Working Paper No. 4 describes the background of wastepaper statistics in detail.

All available recovered fibre is provided by wastepaper recovery. While this is not always the case, as there are viable operations concerned with recovering solid timber and engineered wood products, the use of recovered fibre is still predominantly in the pulp and paper industry with the recovery and recycling of wastepaper.

Non-wood Fibres

Most non-wood fibre produced is used towards the production of pulp for paper. Non-wood fibre usage is significant in a limited number of countries. In some cases estimates were made to fill data gaps and these are also described more fully in Working Paper No. 4.

Forecasting

Forests Undisturbed and Disturbed by Man

Forest Area

Conversion forests. These forests (i.e. forest area targeted for conversion to other land use) may or may not have a cutting cycle attached. In the instance that no cutting cycle is assigned, the forests are assumed to be harvested over the 55 years that the model runs.

Adjusting the legally protected forest areas. Targets for legally protected forest areas are expressed as a percentage of the current legally protected area (i.e. 1995 base year). Therefore, the total legally protected area can be said to increase or decrease by the target percentage. The target date is fixed at 2010. It is also assumed that increases or decreases in the legally protected forest area will be applied evenly over forests both undisturbed and disturbed by man.

Transformation from undisturbed forest. All undisturbed forests are assumed to transform to disturbed forests after a single harvest.

Transformed areas are assumed to still contribute to the overall productive capability although in many forest types the sustainable productivity will be at a lower level under existing management.

Deforestation. The annual deforestation is applied to a percentage of the area available for wood supply. The original rate is provided by the *State of the World's Forests* (FAO 1997). One year of deforestation reduces the overall area available for wood supply, which is reflected in the next year's calculation. Thus, the actual area being deforested and, as a result, the area available changes from year to year. The deforestation rate itself is applied evenly over every year of the cutting cycle. The deforestation rate is applied evenly over the entire undisturbed and disturbed forest area available for supply.

Adjusting the deforestation rate. Changes to the overall deforestation rate are expressed as a percentage of the current deforestation rate. Thus, the deforestation rate can be said to increase or decrease by the target percentage. This target percentage is applied as an even reduction or gain in the overall deforestation rate over each year of the cutting cycle. Changes in the deforestation rate are applied evenly to both the disturbed and undisturbed forest areas.

Forest Volume

Potential commercial growing stock. It is the portion of the actual commercial growing stock that will be potentially utilized and includes all age classes of commercial value.

Inventory diameter class. One of the most critical factors in compiling forest inventory data is establishing the diameter class of the inventory. Each country compiles data at different classes and the challenge is to find the forest volume at the 10 cm class. Crude conversions, described in Working Paper No. 1, have been used for reporting purposes.

Forest Growth and Removals

Growth. It is assumed that the forest undisturbed by man has little or no growth in terms of a net increase in the potential commercial growing stock.

Removals. For the undisturbed forest the removals are assumed to be the forest volume distributed over the cutting cycle for a particular forest type. Removals should not exceed the net growth of forest once the forest is disturbed.

Yield Calculations

Sustainable supply. Sustainable supply as a concept has now been broadened in many regions expanding from the traditional tenets of sustained yield[6] to include the concepts of biological diversity and ecosystem management (see Working Paper No. 3). This means broadening the analysis to include spatial as well as aspatial possibilities in forest yield regulation and, despite the increased complexity, quantify the long-term supply. Several formulae are used in an attempt to reflect supply levels which might be deemed ‘’sustainable”, at least from a productive capacity point of view (one criterion in the Montreal and other processes).

Yield regulation diameter class. Supply calculations require the specification of the diameter class. Since different countries choose different diameter classes for yield regulation calculations, it is important to compare the diameter classes used before comparing modelling results.

Adjusting the cutting cycle. Increased reliance on practices regarded as contributing to forest sustainability is reflected in an increase in the cutting cycle. Conversely, abandoning the principles of SFM is reflected by a decrease in the cutting cycle. Target changes in the cutting cycle are applied at the beginning of the cycle. Therefore, implementing a management plan which entails improved SFM would have an immediate effect upon the model output.

Industrial Plantations

Afforestation rate. The afforestation rate is derived from various government sources and other published information. Where no information is available the estimates are made by plantation experts with knowledge of the region. It is assumed to be an annual planting rate. However, to offset the effects of replanting a currently existing plantation or changes in government initiatives, the afforestation rate is reduced by 7 percent annually and thus is brought to 0 percent by the year 2010.

Adjusting the afforestation rate. Changes to the afforestation rate are expressed as a percentage of the overall afforestation rate. Thus, the rate may be increased or decreased by a target percentage. This rate only refers to additional area planted.

Industrial plantation area available for supply. The plantation area that is available for supply is variable. It is assumed that 5 percent of a country's industrial plantation area was available in 1995. (Notable exceptions are countries with long-standing plantation programmes where the area available for current wood supply is assumed to be 50 percent.) This percentage rises linearly until the year 2015, when it is assumed that 80 percent of a country's plantation area is available for supply. However, where reliable information on the area currently available exists, it will be used in the simulations.

Development gains. There is provision in the model for gains from improved plantation development, such as better silvicultural practices or improved genetic stock. The development gains factor is expressed as a target percentage. Essentially, it represents a percent increase in the production capacity of industrial plantations. The target percentage is evenly applied over 55 years until the year 2050. The default is set at 30 percent but Working Paper No. 2 gives a more detailed review of other percentages that could be used for simulation modelling purposes.

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[6] This report does not review the merits and shortcomings of sustained yield or any modification of the concept. However, as a well respected forest economist once said:

> *The concept of sustained yield should not have followed the crosscut saw into oblivion, nor is it likely to. Divergence between industrial and social rate of time preferences, different attitudes towards risk, and the implications of forest ownership patterns all seem likely to inhibit experimentation with other objectives. Also sustained yield management does create benefits which are not always noted (Nautiyal 1988).*

Actual increment. The industrial plantation increment values are commonly very high. The model reduces the increment value by 25 percent in order to take into account bark, age class distribution, inadequate management practices, environmental restrictions, losses incurred in harvesting and transport or possible over-estimations of plantation growth.

Recovered Fibres

Conversion of metric tons to cubic metres. The conversion factor to convert metric tons to cubic metres is assumed to be 2.5 m^3/t. This factor is an estimate taken from an amalgamation of various sources.

Existing recovered paper usage rate of change. The rate of change in recovered fibre use as estimated (see Working Paper No. 4) is applied on a linear basis over the 55 years of the model run. The existing rate of change is derived from historic wastepaper recovery statistics and paper and paperboard production figures, as published by FAO (FAOStat 1997).

Maximum recovered paper. The wastepaper recovered will not exceed twice the 1995 level (i.e. if they recovered 100 tons in 1995, nowhere in the forecast will they recover more than 200 tons).

Maximum recovered paper usage rate. The wastepaper recovered will not exceed 70 percent of the overall paper production, based on current trends of paper production. This prevents any unreasonable amounts of wastepaper recovery.

Adjusting the recovered fibre usage rate of change. The rate of change in wastepaper recovery can be adjusted by setting a target percentage and then adjusting the rate of change up or down by this percentage. The target date is 2010. This allows the pattern of wastepaper recovery usage to be adjusted over the course of the model run.

Non-wood Fibres

Conversion of metric tons to cubic metres. The conversion factor to convert metric tons to cubic metres is assumed to be 2.5 m^3/t. This factor is a rough figure taken from an amalgamation of various figures compiled by different sources.

Existing non-wood fibre usage rate of change. The rate of change in non-wood fibre use is estimated (see Working Paper No. 4) and applied on a linear basis over the 55 years of the model run. The existing rate of change is derived from historic non-wood fibre usage statistics and pulp production figures as published by FAO (FAOStat 1997).

Adjusting the non-wood fibre usage rate of change. This adjustment is made by establishing a target percentage (i.e. non-wood fibre use might increase or decrease by a percentage over the next 15 years) and then applying this change to the existing non-wood fibre usage rate of change. Thus, the pattern of non-wood fibre usage could change over the course of the model. The target date for this factor is 2010 (15 years into the model).

DATA AND STATISTICAL ISSUES

Data quality and resolution

Data quality is very mixed, inconsistent or missing altogether. For example, in a few countries there is recent forest inventory data of outstanding quality while in most countries inventory information is poor or is very old.

Data resolution means the spatial scale at which the forest inventory data was collected and the intensity of the survey conducted. It is difficult to aggregate data from the field level to the country level. Often forest inventory projects are small scale with a much narrower purpose and it is difficult to take the information and apply it to the country level. For example, the field project may estimate that the average growth of the forest in a particular forest type is 1.8 m^3/ha/a. Given that there is no other information on other forest types in the country, does it mean we should apply it? Experts had to make judgement calls and then the data was reviewed by people in the most important countries.

Statistical inconsistencies

Many countries do not declare their statistical assumptions in defining their forest inventories. The critical factors include definition of commercial species, appropriate volume expansion factors to standardize forest volumes, definition of accessible forest area, and tree growth increments in both open and closed forest formations.

It is also difficult to get a standard definition of land area, forest area, and protected areas. In many cases there are different numbers for the same area or volume from different reports for the same country. Deciphering the best estimate required extensive effort by our country assessment team.

3 Background

INTRODUCTION

This section provides a brief review of recent global fibre studies and the themes they highlighted, and an overview and analysis of industrial roundwood production by region since 1970. Taken together this material provides the necessary contextual backdrop for the material presented in the subsequent sections of this report.

RECENT GLOBAL FIBRE STUDIES

The interest in fibre supply studies which examine the resources needed for the production of wood products is significant and it is increasing. There is less forest undisturbed by man, the dynamics of the forest disturbed by man are frequently unknown and the area of plantations is increasing significantly. In addition, there are significant new fibre sources emerging in the form of non-wood and recovered fibre. Finally, there are emerging new fibre sources, such as trees outside of forest, non-forest land and other lands, which play a very significant role in some regions. Given this complex matrix of fibre sources and the many variables which play upon them, it is necessary to persevere with the challenging task of developing and maintaining the basic forest and fibre statistics since they provide a key foundation for forest and forest product planning.

In addition to the statistics, it is necessary to identify some of the critical factors that will have an impact on future fibre supply. Table 2 summarizes a review of recent literature which identifies some of the major supply themes. The selected reference list included in this table is not meant to be exhaustive but to serve as a quick overview of some major issues that are being raised by researchers and analysts. The GFSM attempted to include some of these issues in the factors which influence supply and these are described more fully in Section 5. It is worth bearing in mind that the outlook studies process, as described in Figure 1, will address a much broader and complex range of factors than those discussed here.

INDUSTRIAL FIBRE PRODUCTION TRENDS

In analysing fibre supply it is useful to have an overview of the historic and current developments in the use of different types of forest products in various regions since it helps to place in context the current reported utilization of forest resources. There are at least three possible benefits to such a comparison:

Table 2
Summary of recent fibre supply analyses by thematic area

Major Industrial Roundwood Supply Issues	# of Citations	GFSM Factor or other Element *(n/a = not addressed)*	Reference													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
Level of investment in silviculture & countries investment stimulation policies	10	SFM	US	AF AS GL		GL	GL		RU	EU		GL	GL	GL	GL	
Land use change (deforestation, afforestation, protected area)	9	Forest area & accessibility	CA	GL	GL		GL				GL	GL			TE BO TR	
Better ecosystem management	8	SFM	US CA	GL	GL		GL			EU	GL	GL			GL	
Material efficiency & technology change	8	Material efficiency	US	GL	GL	GL			RU			GL	GL	GL		
Higher prices expanding supply	8	Accessibility	US	GL		GL	GL	GL				GL	GL			GL
Land ownership (non-industrial landowner, fragmented ownership, privatization trends)	5	Forest ownership	US	GL						EU		GL			GL	
Higher management or harvesting costs	5	Accessibility		GL				GL		EU		GL			GL	
Poor wood quality or poor forest condition	4	Accessibility & harvest intensity	CA		GL			GL		EU						
Poor industrial and institutional infrastructure	4	Accessibility	CA	RU					RU			GL				
Natural forest depleted	4	SFM		AS								GL		GL	TE BO	
Emergence of recovered and non-wood fibres	4	Non-wood & recovered fibre		GL						EU	GL	GL				
Plantations	3	Afforestation & development gains									GL		GL	GL		
Re-classification of the growing stock	2	Forest area & volume	US	GL												
Sustainable forestry with broader social objectives	2	SFM	CA		GL											
Financial abilities of the wood industry	2	n/a		GL								GL				
Product substitution	2	n/a				GL	GL				GL					
Air pollution & global warming	2	SFM							RU						GL	
Difficult operating terrain	1	Accessibility	CA													
Competition for roundwood supply	1	n/a			GL						GL					
Age class imbalances & lower yields on subsequent rotations	1	Harvest intensity			GL										GL	
Data uncertainty and error	1	Simulation modelling							RU							

Key to authors

1	Boulter & Darr 1996	**6**	Reed 1995	**11**	Sedjo & Lyons 1990
2	Margules, Groome & Poyry 1996	**7**	Nilsson 1995	**12**	Sedjo & Lyons 1995
3	Waggener & Lane 1996	**8**	Wall 1995	**13**	Arnold 1993
4	Reid Collins 1995	**9**	Nilsson 1996	**14**	Zhang & Buongiorno 1996
5	Apsey & Reed 1995	**10**	McNutt 1996		

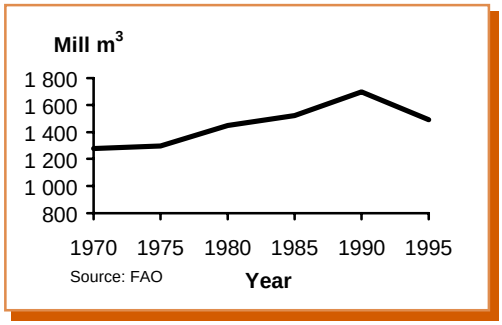
Key to region

GL	Global	**EU**	Europe
US	United States	**RU**	Former USSR
CA	Canada	**TR**	Tropical
AF	Africa	**TE**	Temperate
AS	Asia	**BO**	Boreal

1. The difference between the total fibre forecast and the historic trends in production may provide some guidance to assessing the economics of the future timber supply under a given set of conditions.
2. In the longer term, the relationship between industrial roundwood production and potential fibre availability, which is linked to the growth/drain ratio or a growth/removal ratio, is a very useful one to monitor since it is one of the indicators of the available country's forest resources to meet production targets (see Section 4, Tables 6-8 for discussion on potential removals for industrial production).
3. The difference also helps to highlight errors in the statistics, particularly at the country level. For example, the reported production statistics in Cambodia and Angola are very much lower than potential fibre availability calculations. This indicates that the reported statistics from the countries are not including the illegal fellings that are sometimes 300 percent higher than the reported production in some countries.

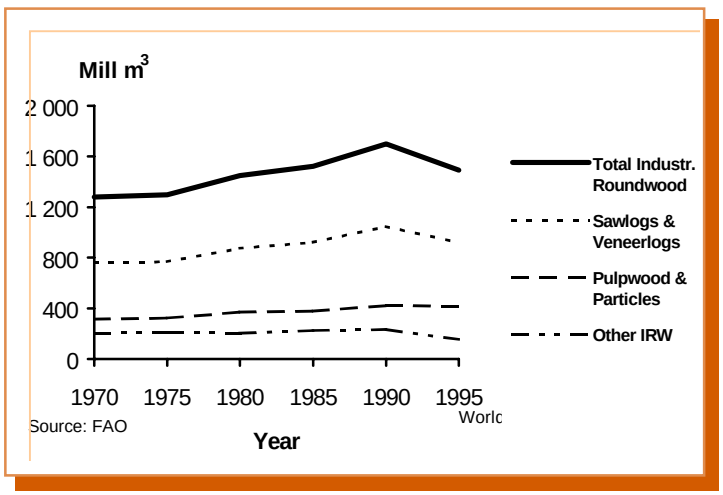
Industrial roundwood is still the major source of fibre for the wood-processing industries. Industrial roundwood comprises "sawlogs and veneer logs", "pulpwood and particles" and "other industrial roundwood". Other industrial roundwood consists of roundwood used for such applications as tanning, distillation, match blocks, poles, posts, and pitprops.

Figure 6
Global industrial roundwood production 1970-1995



Demand for forest products is driven by many factors and one of the most important ones is population growth. Between 1970 and 1994, world population increased by more than 50 percent. In the South American and African regions, it increased by more than 60 percent and 90 percent, respectively (FAO 1997). Global production of industrial roundwood has, until recently, shown sustained increases that parallel population growth. Total reported industrial roundwood production in 1990 was about 1.7 billion m^3 (Figure 6). Since 1990, however, reported world production has declined to about 1.5 billion m^3 in 1995.

Figure 7
Global industrial roundwood production by product group 1970-1995



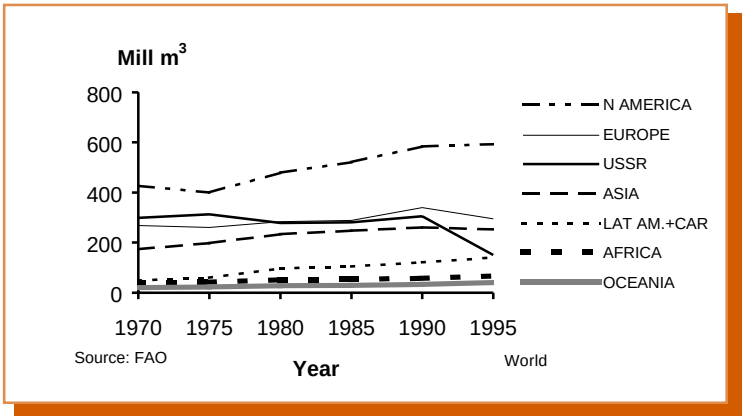
An analysis of industrial roundwood production by product group (see Figure 7) demonstrates that the decline of world production between 1990 and 1995 results mainly from a decline in the production of sawlogs and veneer logs

and other industrial roundwood. Pulpwood production has continued to grow between 1990 and 1995, but at a reduced rate.

There are several possible reasons behind the decline in sawlog production. An obvious one is increased substitution by wood-based panels in traditional sawn timber applications, for example the use of veneered fibreboard or particle board in traditional sawn timber applications such as furniture and joinery. It can also be postulated that the leading consumer countries in North America, Scandinavia and Europe are approaching saturation levels for per caput requirements. Similarly the current group of rapidly developing countries may not have the same timber construction traditions that drove the high demand in developed countries when they were at the same income levels. In the main producing countries there might also be a preference for higher value-added products being made directly from sawnwood so that an increasing share of sawnwood output is not produced as a commodity for sale but for input into secondary products (FAO 1997). On the supply side, increasing scarcity of large-diameter logs suitable for cost-competitive sawing may be promoting the use of engineered wood products and other non-wood alternatives.

Figure 8 shows the regional distribution of industrial roundwood production. Major producers are North America, Europe, the former USSR and Asia. The world's five largest producer countries are United States, Canada, the Russian Federation, China and Brazil. A steadily increasing portion of the world production comes from Latin America. Figure 8 also suggests that the decline in world roundwood production between 1990 and 1995 was primarily triggered by a sharp production decline in the former USSR and by moderate reductions in Europe and Asia. All other regions maintained or increased their production level.

Figure 8
Global industrial roundwood production by region 1970-1995



The decline in production from the 1990 level reflects both supply and demand conditions. While a major factor was the dislocation of output in the Russian Federation, where reported industrial roundwood removals were down substantially (around 50% from the 1990 level), the decline also reflects weak demand in industrialized countries. Further, the supply of logs was increasingly affected by environmental restrictions on harvesting in North America and the main tropical Asian countries. Some African countries also increased their restrictions on logging and export, both for forest management reasons and to encourage greater domestic processing (FAO 1997).

Asia-Pacific

The Asia-Pacific region currently produces about 20 percent of the world's industrial roundwood (Figures 9 and 10). Industrial roundwood production increased steadily in the two decades preceding 1990 but has declined slightly between 1990 and 1995. The Pacific subregion, however, has continued to increase production. Leading producers of industrial roundwood in Asia are China, India, Malaysia, Indonesia and Japan. In Oceania the major producers are Australia, New Zealand and Papua New Guinea. The Asia-Pacific forestry sector provides a good example of a demand-driven expansion of industrial roundwood production. Concerns continue to exist, however, over the long-term sustainability of wood supplies.

Figure 9
Industrial roundwood production in Asia 1970-1995

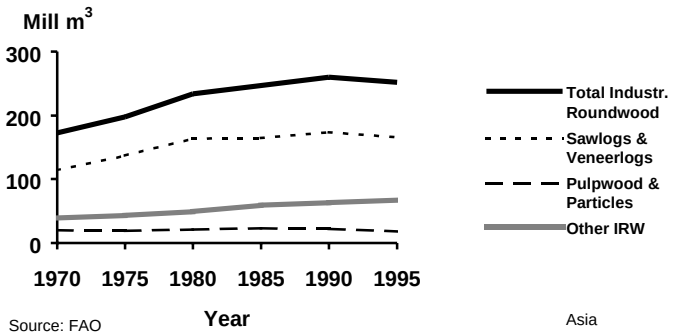
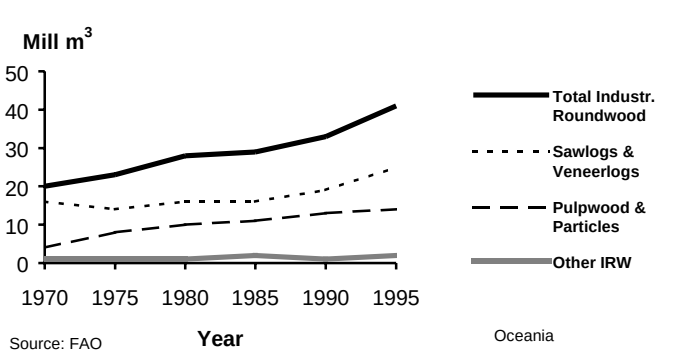


Figure 10
Industrial roundwood production in Oceania 1970-1995



The production decline in Asia is mainly due to declines in sawlog and veneer log production. These represent the higher quality logs coming mainly from natural forests. Decreases in log production in Malaysia and Indonesia are responsible for most of this decline. Potentially the most significant response to shortfalls in industrial wood supplies has been the establishment of plantation forests. In the future, plantation-grown wood is likely to supplement significantly natural forest production in the Asia-Pacific region, particularly as a source of pulpwood; as a raw material for reconstituted wood-based panels; and for "other industrial roundwood" applications. Furthermore, roundwood production might be influenced by higher processing efficiency through the use of more residues, the adoption of better technologies, increased recycling and reduction in wastes (FAO Asia-Pacific Forestry Sector Outlook Study 1998).

The proportion of logs processed domestically in Asia is continuing to increase and is expected to exceed soon 90 percent from the current 88 percent. This reflects increasing populations, growing economies and the emphasis on exporting value-added products in this region (ITTO 1996). The major exporters of unprocessed logs are currently Malaysia, New

Zealand and Papua New Guinea. Australia also exports a large amount of industrial roundwood as wood chips.

Africa

Africa's industrial roundwood production increased by 65 percent from 40 million m^3 in 1970 to 66 million m^3 in 1995. Its global share of production increased from 3.2 percent to approximately 4.5 percent in the same period. Several countries have, however, reduced production during this period, mainly for forest management reasons. The largest producers of industrial roundwood in Africa are South Africa, Nigeria, Democratic Republic of Congo, Côte d'Ivoire and Cameroon.

The proportion of log production processed domestically in Africa is declining and is currently estimated at about 60 percent (ITTO 1996). This is mainly due to increasing volumes of logs being exported to Asian markets. Asian companies are reported to be harvesting in Cameroon, Gabon, the Republic of Congo and the Central African Republic. A recently reported establishment of new forest industries in connection with concession rights in the Democratic Republic of Congo may contribute to an overall production increase in the future, although production from this initiative could be limited by the economic accessibility of the forests.

Figure 11
Industrial roundwood production in Africa 1970-1995 by region

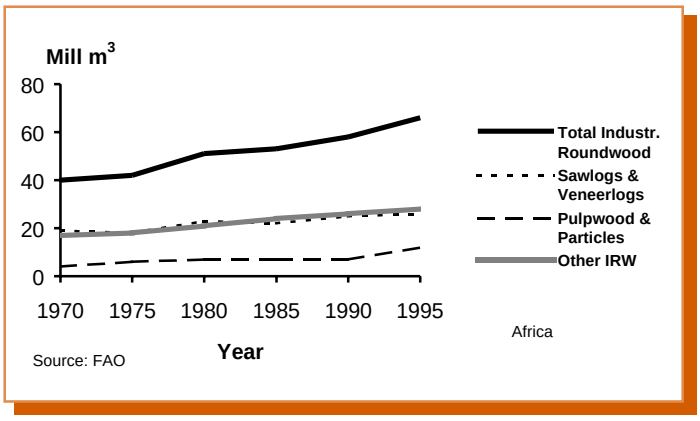
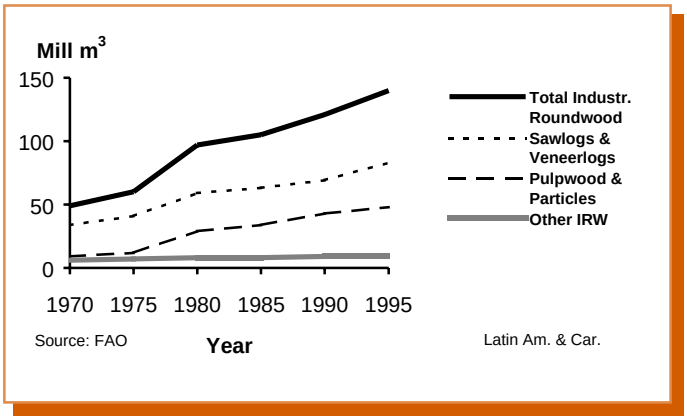


Figure 11 shows that in Africa production volumes of sawlogs and veneer logs are approximately equal to production volumes of other industrial roundwood. Very recently the production of pulpwood and particles has increased. This is mainly influenced by increasing plantation production in South Africa.

Latin America & Caribbean

Industrial roundwood production in Latin America and the Caribbean increased rapidly between 1970 and 1995. Production grew by 186 percent, from 49 million m^3 to 140 million m^3 annually. This increase was largely a result of increasing production of sawlogs and veneer logs and pulpwood. The region's production accounts for about one-tenth of the world total. Currently Brazil is the world's fifth largest producer of industrial roundwood and by far the largest single producer in the region. Brazil accounts for about 55 percent of the region's industrial roundwood production. Other major producers are Chile, Argentina and Colombia. Almost all logs produced in the region are processed domestically (ITTO 1996).

Figure 12
Industrial roundwood production in Latin America and Caribbean 1970-1995



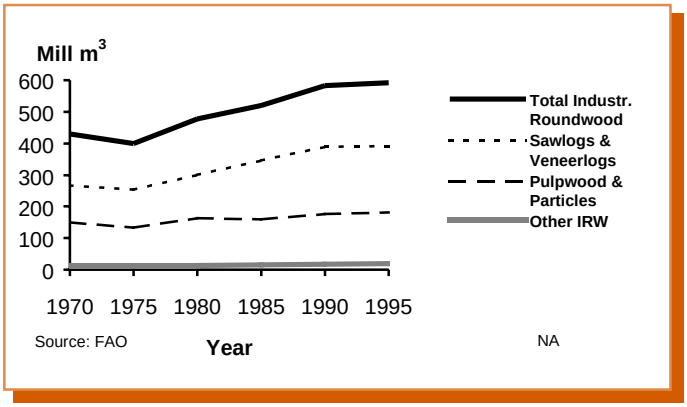
Industrial roundwood production in this region is expected to continue to increase. It is possible, however, that large areas of natural forest in South America may be withdrawn from industrial production for policy reasons. The economic accessibility of wood in the Amazon region may also prove to be a constraint. A considerable portion of future production growth, however, is expected to originate from fast-growing plantations.

North America

Aside from a brief downturn in the early 1970s, production in North America increased steadily until 1990 when the rate of growth again began to slow down (Figure 13). This is the world's largest industrial roundwood producing region with the United States and Canada together accounting for almost 40 percent of total global production.

In the United States industrial roundwood production may be constrained in the short term by an unprecedented age class situation for softwood inventories during the decade beyond 2000. By 2000 or thereabouts, large-diameter softwood timber will have been harvested on private lands and the harvest on public lands will be constrained by non-market forces. After the year 2010, plantations initiated in the last two decades will reach merchantable size in the South and Pacific Northwest (ECE/FAO 1996b).

Figure 13
Industrial roundwood production in North America 1970-1995



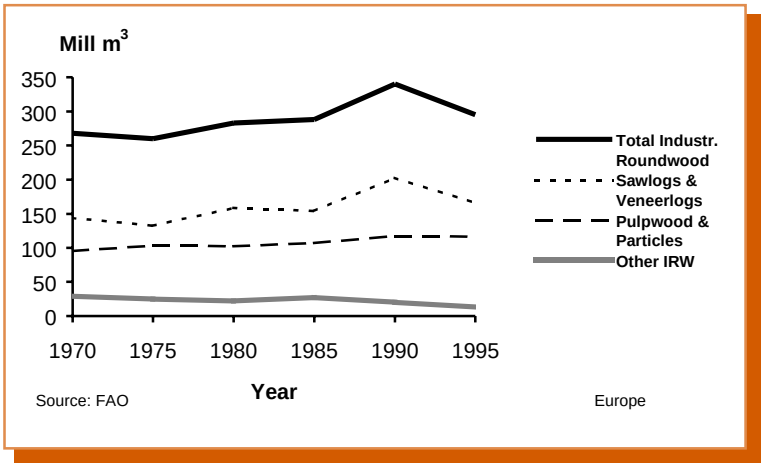
In Canada there are still physical stocks of mature and overmature timber available for harvest. However, there is considerable variation in the quality and condition of this timber, and the rate of harvest is constrained, to a greater or lesser extent, by public sustainable forest management policies and a growing demand for other values on the forest land base. Prospects for timber supply vary considerably on a regional basis. Most of the available timber is hardwood, while most demand is for softwood. Even with these constraints there appear to be some further surpluses available to facilitate further expansion of the Canadian harvest which means industrial roundwood production increases are possible (ECE/FAO 1996b).

Europe

Since peaking in 1990, industrial roundwood production in Europe has declined to about 295 million m^3 in 1995. As Figure 14 shows, this decline is mainly due to a reduced production of sawlogs and veneer logs.

For the Nordic countries (Sweden, Finland, Norway) it is estimated that harvest levels are currently well below the estimated net annual increment. Theoretically these countries have considerable potential for expansion of production. In Western Europe the main producers are Germany, France, Austria, Spain and Portugal. Industrial roundwood production in these countries has increased only modestly since 1970. In 1990 a number of European countries markedly increased production as a result of windthrow salvage harvests. For example, Germany doubled its annual production in that year. This explains partly the production peak in 1990 and also the reduced production in subsequent years. Production levels in most Eastern European countries have also declined since 1990. Changes in political structures and related efforts in transition to market economies have resulted in some dislocation in the forest and forest industry sector.

Figure 14
Industrial roundwood production in Europe 1970-1995



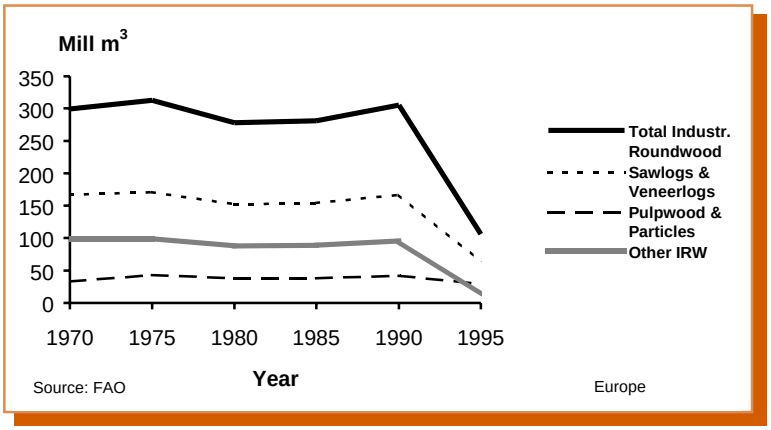
Russia

Since 1990 the reported industrial roundwood production in the former USSR has declined by about 50 percent (Figure 15). Significant uncertainty exists, however, as to the proportion of the observed decline that is real, and the proportion that originates from severe disruption to statistical systems. This is especially the case with respect to “other industrial roundwood”, which accounted for about one-third of the 1990 production volume and contributes heavily to the production decline since 1990.

Despite the decline, the Russian Federation is still the world’s third largest producer of industrial roundwood behind the United States and Canada. A significant proportion of the former USSR’s production came from Siberian forests that were made accessible by the development of infrastructure in the region, principally the trans-Siberian railway. This enabled export to Western Europe from Baltic ports. In 1990, Siberian sawlogs travelled, on average, more than 1 000 km from forest to mill. Sawnwood was also transported over very long distances.

A major factor in the production decline since 1990 was the imposition of market driven freight charges on the trans-Siberian railways. This new charging mechanism made huge areas of central Siberia economically inaccessible overnight.

Figure 15
Industrial roundwood production in former USSR 1970- 1990



The former USSR is therefore a “wild card” in all future developments in the forest sector. Russia, in particular, contains some of the world’s largest potentially usable forests. It also spans the East and the West, being able, therefore, to influence events in both the Pacific Rim basin and in Western Europe (FAO 1997).

PRODUCTION TREND ANALYSIS

It can be reasonably postulated from examining these production trends that:

- ❏ the level of industrial roundwood production varies widely from region to region;
- ❏ there are conflicting trends between regions (although they may be temporary in nature);
- ❏ the product types are changing significantly over time in most regions;
- ❏ the historic trends provide no strong evidence of a decline in the future production of industrial wood products. Indeed the latest econometric forecasts indicate an average annual increase in production of 1.3 percent per annum.

In some past studies it has been frequently assumed that, if demand for forest products is to be met, market forces will make the necessary raw material available to meet demand. However, this approach to forecasting industrial production does not identify the source of raw material for industrial production. Earlier it has been argued that this is a critical analytical issue, and so, the remainder of this report attempts to describe the most recent efforts to improve our basis for analysis.

4 Current Fibre Supply Situation

CLASSIFYING FIBRE SOURCES

The major sources of fibre for industrial production can be divided into the following categories:

- Forest undisturbed
- Forest disturbed by man
- Plantations
- Non-wood
- Recovered

These terms are fully described in our definitions, which are found in Annex 2. Essentially the forest undisturbed and disturbed by man is natural forest and represents the traditional major sources of fibre supply for industrial purposes. Industrial plantations, recovered fibre and non-wood fibre represent newer sources of industrial fibre and their capacity to meet future industrial needs will be important to address in the future. As mentioned in Section 2 there are also additional sources of fibre such as trees outside of forest, non-forest land and ''other'' land which will have to be examined in the future as these will also play a more prominent role in some regions.

SELECTED SUMMARY OF REGIONAL STATISTICS

This section summarizes the types of statistics collected by region in the GFSM process. Annex 1 contains a more detailed analysis by country and the upcoming CD-ROM will feature information on each country by forest type.

These statistics are the core of the project. They represent FAO's latest attempts to assemble industry-relevant fibre supply information which provides an essential basis for the implementation of sustainable forest management.

Table 3 presents a global summary of natural forest area available and not available for wood supply. The area available for wood supply under current market conditions is approximately 48 percent of the total natural forest area. Of the area available for wood supply at least 44 percent is estimated to be undisturbed. The North American region did not provide statistics on the area of forest undisturbed so it is not possible to offer a better assessment. The total natural forest area varies slightly from the number reported in the FAO State of the World's Forests 1997 report (3.454 million ha) because the GFSM did not attempt to assess countries with very minor forest cover.

Table 3
Natural forest area ('000 ha) by region – Global summary

Region	Total	NOT Available for Supply	Available for Wood Supply	Undisturbed	Disturbed
Africa (26)	399 618	233 157	166 461	59 469	106 992
Asia (22)	408 605	177 338	231 267	48 729	182 538
Oceania (6)	87 867	61 593	26 274	8 415	17 859
Europe (28)	140 713	20 960	119 753	0	119 753
Russia (1)	694 139	166 597	527 542	514 090	13 452
North America (2)	542 700	238 940	303 760	0	303 760
Central America (10)	78 168	49 760	28 408	0	28 408
South America (13)	869 097	709 105	159 992	34 850	125 142
TOTAL	**3 220 907**	**1 657 450**	**1 563 457**	**665 553**	**897 904**

***** Number of countries currently included in database

Table 4 presents the total growing stock and the commercial species growing stock expressed in m^3/ha. In general the disturbed forest has a lower average volume because research reports have indicated a lower standing volume after logging. The differences are more dramatic in regions such as Africa and South America where harvesting may not have been appropriate from a silvicultural point of view thus leading to lower volumes, but this may be changing.

Table 4
Average standardized forest volume by region (m^3/ha)–summary

	Growing Stock**		Commercial Species Growing Stock	
Region	**Undisturbed**	**Disturbed**	**Undisturbed**	**Disturbed**
Africa (26)*	227	124	105	53
Asia (22)	151	84	62	65
Oceania (6)	139	103	87	84
Europe (28)	0	142	0	142
Russia (1)	111	133	165	195
North America (2)	n.a.	205	0	199
Central America (10)	n.a.***	100	0	96
South America (13)	158	116	70	48

***** Number of countries currently included in database.
** Volumes pertain to the forest available for supply; the reference diameter is 10 cm.
*** n.a. indicates not currently available.

In the Forest Resources Assessment 1990 the total reported growing stock volume was reported to be 383 727 million m^3 for forest and other wooded lands. Table 5, which represents a summary of a much more detailed assessment of volume, indicates a total growing stock volume on forest area of 182 005 million m^3. For all regions, with the exception of Russia, the commercial species growing stock is lower than the total growing stock. South America and Africa show the greatest difference and this is likely due to the fact that many tropical tree species in these regions are not commercialized. The total difference between the growing stock and commercial growing stock is not important because of the significant increase in volumes calculated for Russia.

Table 5
Total standardized volume by region ('000 000 m^3) – Summary

Region	Growing Stock**			Commercial Species Growing Stock**		
	TOTAL	Undisturbed Forest	Disturbed Forest	TOTAL	Undisturbed Forest	Disturbed Forest
Africa (26)*	26 796	13 519	13 277	11 927	6 274	5 653
Asia (22)	22 670	7 160	15 510	15 089	2 942	12 147
Oceania (6)	3 013	1 166	1 847	2 226	729	1 496
Europe (28)	17 029	0	17 029	17 029	0	17 029
Russia (1)	59 112	57 319	1 794	87 371	84 744	2 627
North America (2)	30 926	0	30 926	30 018	0	30 018
Central America (10)	2 339	0	2 339	1 845	0	1 845
South America (13)	20 120	5 602	14 518	7 995	2 241	5 753
TOTAL	**182 005**		**97 240**	**173 499**	**96 931**	**76 567**

* Number of countries currently included in database
** Volumes pertain to the forest available for supply; the reference diameter is 10 cm

Table 6 indicates that the total growth is 3.2 billion m^3 in the forest available for wood supply of which 2.7 billion m^3 is potentially commercial. This growth has not been adjusted for mortality in the forest. It is useful to draw this kind of comparison since what is referred to as the growth/drain or growth/removal ratio is an indicator of the change in forest volume one can expect in the future. Harvesting intensity is normally expressed on the basis of a cutting cycle, a periodic basis, but it could also be expressed on an annual basis in regions where the harvesting system is based on clear-felling. Based on historic management practices the Asian, South American and African regions indicate a significantly lower harvesting intensity once the forest is disturbed. In the boreal regions, such as Russia, and the northern part of North America the harvesting volumes per unit area could increase with each rotation. The critical factor is the type of silvicultural or harvesting system chosen for management purposes.

Table 6
Total potential growth and harvesting intensity by region ('000 000 m³) – Summary

Region	Gross annual increment**				Harvesting intensity**	
	Total (1 000 000 m³)		Average (m³/ha)		Time periodic (m³/ha)	
	All species	Commercial species	All species	Commercial species	Undisturbed Forest	Disturbed Forest
Africa (26)	146.3	56.9	1.4	0.5	Cutting cycle 11.5	4.4
Asia (22)*	328.3	273.7	1.8	1.5	Cutting cycle 33.9	17.3
Oceania (6)	42.1	34.7	2.4	1.9	Cutting cycle 30.5	36.8
Europe (28)	622.5	562.9	5.2	4.7	Annual n.a.	3.3
Russia (1)	946.0	946.0	5.0	3.5	Rotation 122.3	166.4
North America (2)	659	659	6	6	n.a.	n.a.
Central America (10)	49.0	38.3	1.5	1.1	Cutting cycle n.a.	12.8
South America (13)	473.1	147.7	3.7	1.1	Cutting cycle 18.0	11.2
TOTAL	**3 266**	**2 719**	**n.a.**	**n.a.**	**n.a.**	**n.a.**

***** Number of countries currently included in database
** Volumes pertain to the forest available for supply. See Annex 1, Table 2 for harvesting intensity by country

The total plantation area is approximately 58 million ha in the southern regions and has a potential annual growth of approximately 84 million m³. It is generally agreed that plantations will play an ever-increasing role in meeting the needs of industrial roundwood. The growth represents about 5 percent of the growth estimate for the natural forest but with a reclassification of some of the boreal and temperate forests this would increase significantly.

Table 7
Industrial plantation area and growth by region (1995) – Global summary

Region	Total Plantation Area 1995 (1000 ha)		Total Annual Growth
	Reported Industrial Plantations	Net Industrial Plantations	1 000 000 m³
Africa (20)	3 381	3 173	1.0
Asia (15)	54 665	44 068	16.61
Oceania (4)	2 709	2 709	19.46
Europe	n.a.	n.a.	n..a.
Russia	n.a.	n.a.	n.a.
North America	n.a.	n.a.	n.a.
Central America (5)	490	428	0.01
South America (9)	8 516	8 320	47.02
TOTAL	**69 761**	**58 698**	**84.09**

Table 8 summarizes recent estimates of wastepaper and non-wood fibre by region. Europe, North America and Asia produce over 90 percent of the wastepaper and Asia has the capacity to produce over 90 percent of the non-wood fibre. Alternative fibres complement fibres from industrial plantations and natural forests to complete the picture of total fibre availability for industrial uses.

Table 8
Alternative fibres – recovered and non-wood fibres by region – Global summary

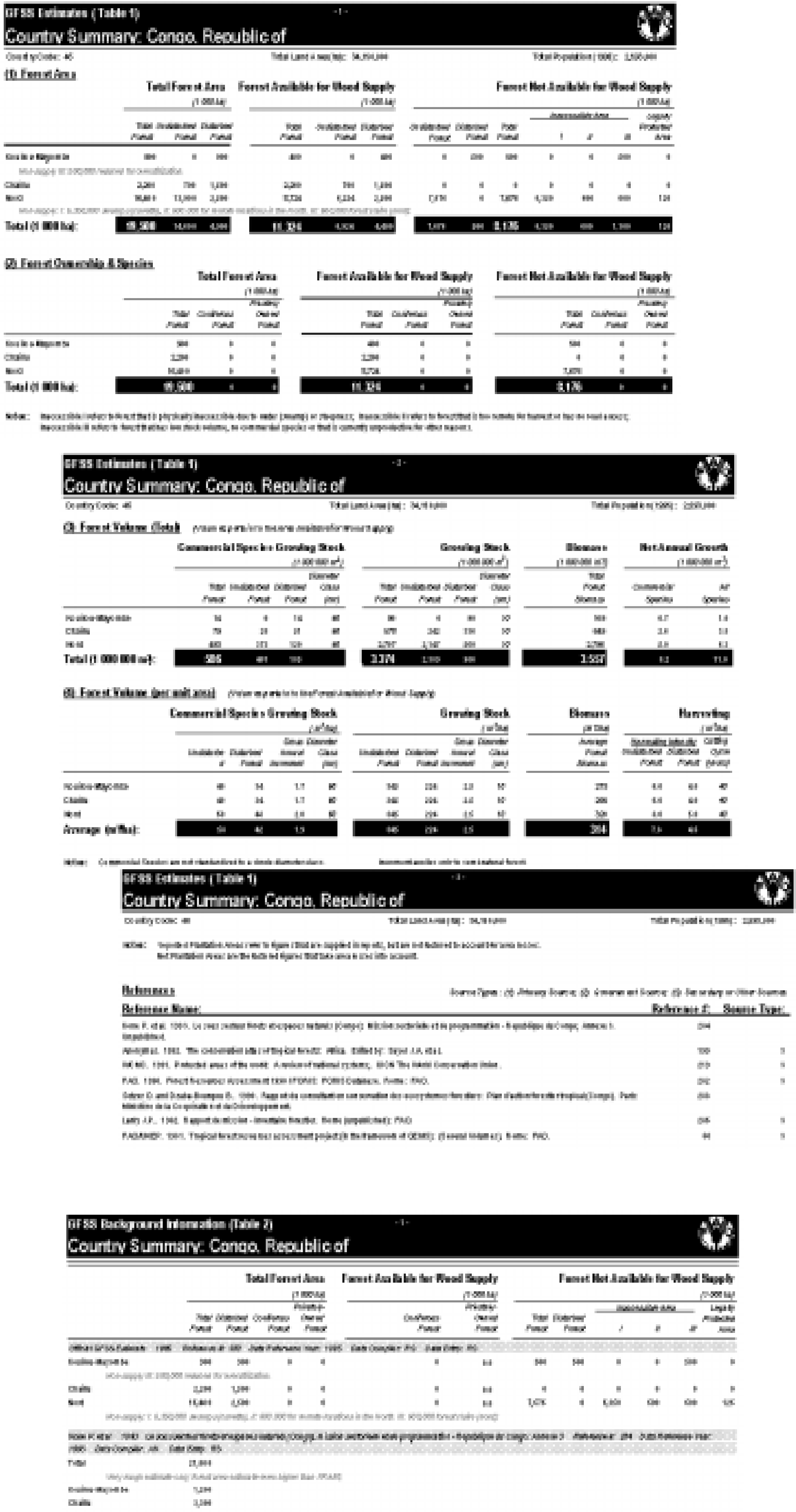
Region	Recovered fibres			Non-wood fibres		
	Paper and Paperboard Production	Wastepaper Recovery	Fibre Availability (equivalent volume)	Pulp Production	% Nonwood Used in Total Capacity	Fibre Availability (equivalent volume)
	1 000 000 MT		1 000 000 m^3	1 000 000 MT	%	1 000 000 m^3
Africa (26)*	2.27	0.70	1.76	1.84	0.10	0.25
Asia (22)	72.95	27.52	68.79	36.49	18.76	46.90
Oceania (6)	3.13	1.20	2.99	2.42	0.00	0.00
Europe (28)	77.99	31.58	78.96	36.75	0.52	1.29
Russia (1)	4.07	1.09	2.73	4.89	0.00	0.00
North America (2)	107.98	34.89	87.22	91.39	0.19	0.47
Central America (10)	3.21	1.07	2.69	0.48	0.43	1.08
South America (13)	9.18	2.64	6.61	9.42	1.05	2.64
TOTAL	**280.78**	**100.69**	**251.74**	**183.67**	**21.05**	**52.62**

* Number of countries included in database.

SELECTED SUMMARY OF A COUNTRY STATISTICS

Table 9 provides an example of a series of country statistical reports that are currently available in the GFSM database. The country chosen for demonstration purposes is the Republic of Congo. The report contains a summary of information on forest area, volume, plantations and reference material examined in assessing the state of the forest resources (the sample report is titled: GFSM estimate – Table 1). There is also an optional feature in the reporting features which allows the user to examine detailed statistics by reference (sample report is titled: GFSM background information – Table 2). The primary advantage of this additional report is exposing all the data to interested analysts to cross-check and validate conflicting data. Finally, there is the possibility to produce alternative futures for each country using the modelling tool fully explained in GFSM Working Paper No. 1 (see sample report titled: Data projection).

Table 9
Summary of major country statistics for Republic of Congo, an example



GFSS Estimates (Table 1)

Country Summary: Congo, Republic of

(1) Forest Area

Total Forest Area — Forest Available for Wood Supply — Forest Not Available for Wood Supply

(2) Forest Ownership & Species

Total Forest Area — Forest Available for Wood Supply — Forest Not Available for Wood Supply

GFSS Estimates (Table 1)

Country Summary: Congo, Republic of

(3) Forest Volume (Total)

Commercial Species Growing Stock — Growing Stock — Biomass — Net Annual Growth

(4) Forest Volume (per unit area)

Commercial Species Growing Stock — Growing Stock — Biomass — Harvesting

GFSS Estimates (Table 1)

Country Summary: Congo, Republic of

References

Reference Name: — Reference #: — Source Type:

GFSS Background Information (Table 2)

Country Summary: Congo, Republic of

Total Forest Area — Forest Available for Wood Supply — Forest Not Available for Wood Supply

5 Impact of Major Supply Factors

IDENTIFYING SOME OF THE MAJOR FACTORS

The initial phases of the GFSM project developed a quantitative approach to policy analysis (the model as fully described in GFSM Working Paper No. 1) and established a set of base data. The addition of a modelling capability enabled alternative futures to be predicted for each country by varying critical factors that have an impact on wood supply[1]. The variable factors presently incorporated in the model are not an exhaustive collection. Rather they are a subset of a larger set of variables that have been identified as affecting wood supplies, in various studies within the last decade (Table 2). Table 10 lists some of the major factors identified as having the potential to have significant impact on the futures for selected regions. These factors were selected according to their relative importance, their feasibility in modelling and their links with statistics available. In the future a wider range of factors will be incorporated in the modelling framework.

A sustainable forest management (SFM) variable is included in the model because implementation of SFM principles has the potential to affect future

[1] A suite of additional models are already being developed or under way to assist with the Outlook Study process. All of these models will interact in some manner with the data compiled in the GFSM.

Table 10
Selected major factors that influence fibre supply

	Future 1	Future 2	Future 3
Forests disturbed/undisturbed by man			
Sustainable management (as expressed by cutting cycle- periodic or annual)	♦	♦	♦
Land use – deforestation	♦	♦	♦
Land use – legally protected area change	♦	♦	♦
Industrial Plantations			
Afforestation rate	♦	♦	♦
Development gains	♦	♦	♦
Non-wood Fibres			
Non-wood fibre pulping capacity	♦	♦	♦
Recovered Fibres			
Wastepaper recovery rate	♦	♦	♦

wood supplies and because SFM is a central global forest policy issue. (It is also a major theme of the new strategic plan of the FAO Forestry Department). Similarly, land-use change has had probably the most significant impact on forestry production potential in the past 30 years. Land-use change takes place in many forms. In the natural forest, deforestation and the establishment of protected and semi-protected areas have had, and are likely to continue to have, significant impact on the forest available for industrial wood supply. For plantation forests, the rate at which countries establish plantation programmes (afforestation rates), the duration of those programmes and the extent of efforts put into silvicultural and genetic treatments, i.e. development gains, will also have a significant impact on future fibre supply. Non-wood and recovered fibres are also seen as important new sources of fibre. These already play a very significant role in meeting fibre demand and this role will undoubtedly increase in the future.

Finally, there is a very active discussion in the literature on material efficiency and technological change. A variable that explores improvements in material conversion factors and different forest product output per input of standing tree is yet to be incorporated in the modelling capability and is thus not included in Table 10.

SUSTAINABLE FOREST MANAGEMENT IN NATURAL FORESTS

The impact of sustainable forest management on global fibre supply is frequently mentioned in forest policy discussion. In attempting to address this theme, the GFSM model allows the user to adjust the cutting cycle. Adjusting the rate of harvest through this key variable provides a means of simulating SFM from a fibre supply perspective. In the real world, the general expectation is that SFM will necessitate changes in forest rotation ages, particularly in the case of boreal forests, or changes in cutting cycles in the case of tropical and temperate forests. Reviews of the literature in GFSM Working Papers No. 5 and No. 6 support this assertion for the tropical forests.

To demonstrate the impact of SFM on global fibre supply a range of examples and evidence was examined in GFSM Working Paper No. 3. The concept of SFM has been broadened in recent years and, as a result, the objectives of management are shifting emphasis away from predominantly timber production towards a balance with ecological and social sustainability. Conceptualization of SFM has outpaced the development of specific on-the-ground practices that will achieve sustainability, and there are many knowledge gaps to be filled. Yet there are many active efforts, throughout the world, to develop and implement SFM approaches.

Table 11 summarizes a number of examples of volume and cost impacts in applying SFM. In many cases, impact magnitude is based on a single study, so great caution should be exercised in accepting the magnitude of the impacts as being representative. The studies reviewed here, however, consistently showed that there will be reductions in harvest volume, particularly in the short term, and costs can be expected to rise by between 5 percent and 25 percent, on average. There is, however, an expectation

that long-term supply will increase through application of SFM (see Working Papers No. 5 and No. 6). In the tropics, the maintenance of site productivity and the retention and prevention of damage to immature stems drive much of this increase. In temperate forests, the longer term increase is expected to be less pronounced and may not be captured without intensified silviculture. Instead, the value of the harvest may rise as more large and high-value products are harvested.

Table 11
Summary of cost and volume impacts of implementing SFM by region

Region	Country	Case study	Short-term volume reductions	Cost impacts
North America	**West Coast**	Clayoquot Sound	30-40%	8-25% cost increase
North America	**Canada**	White River	10-25%	Increase
North America	**Canada**	Seine River	24%	
Europe	**Sweden**	A. Barklund	6-8%	NA
Asia	**Malaysia**	Sarawak	50%	Increase
Asia	**Malaysia**	Innoprise Corporation	6-8%	5% cost increase
Asia	**Malaysia**	Dermakot	up to 100%	
Asia	**Indonesia**	Indonesian Plan	18.4%	
Asia	**Indonesia**	STREK Project	9 - 15%	Increase
Latin America	**Bolivia**	Chimanes	24 - 57%	35-67% loss in profits to logging contractors
Latin America	**Eastern Amazonia, Brazil**	Paragominas Region	up to 100%	$ 72/ha increase
Latin America	**Brazil**	Precious Woods	24-57%	0% cost increase but assumes more trees as commercial species
Latin America	**Suriname**	CELOS	9%	10-20% cost savings
Latin America	**Costa Rica**			Increase

SFM is primarily a systematic approach to sustaining each component of the forest ecosystem and sustaining interactions between the components. In forests available for wood supply, this means combining wood production with other management objectives, above all, and maintaining ecological capacity through the conservation of plant and animal biological diversity and soil and water conservation. Similar intentions were not specified as clearly in the classic management concept of sustained yield. It is now, however, generally agreed that forest management must systematically address a fuller range of environmental, social and economic issues. Table 12 presents a summary of major differences in management approaches between the two concepts.

Table 12
Contrast of sustained yield and sustainable forest management for temperate forests

SFM	Sustained Yield Forestry
Maintain the productivity of the forest, by avoiding erosion, soil degradation, and impoverishment of the soil ecosystem.	Emphasizes productivity but the tendency is to use agricultural techniques to establish plantations or to use the least-cost regeneration technique.
Use practices that mimic natural disturbances to the extent that is feasible.	No emphasis on the mimicking of natural disturbances. Aesthetic impacts are considered, as well as silvicultural characteristics of species and economics. Where feasible, convert stands of species with low commercial value to high-valued species.
Seek harvesting methods that reduce the level of disturbance in the forest. This has primarily meant that the size of clear-cut areas is being reduced and partial harvesting systems are being used more widely.	Increasing utilization and reducing costs are the primary motivators, subject to social constraints on clear-cut size.
Maintain wildlife populations and maintain species.	Maintaining wildlife and non-timber species was generally considered outside the purview of forest managers and applied biologists were primarily concerned about maintaining populations of game species.
Maintain structural and biological diversity in managed forests.	The agro-industrial ideal was to have uniform rows of same sized, single species trees. Aesthetic considerations and economic costs were primary constraints.

Source: Bull, Williams and Duinker 1996

In practical terms, SFM has to be incorporated into timber yield regulations[2]. The many formulae for yield calculation contain three basic elements: the biological rotation period or the felling cycle, the forest volume increment or growth, and existing growing stock of the forest. Changing management techniques to SFM means a change in the yield calculated. The first change is sometimes applied to the rotation age or felling cycle; it is frequently being made longer. This means that the interventions in the forest are less and the total volume removed from the total forest will change in each felling cycle. So, for example, if the felling cycle is extended from 30 to 50 years for the same forest area then the total average removal per year will also change. The sustainable harvesting volumes to be removed depend on the management strategy.

Growth and growing stock variables have also been given some prominence in the model through the provision of an array of equations. In the case of growth, two equations allow the introduction of a mortality factor of 0.5 and for the growing stock considerable effort was expended to identify the commercial growing stock by forest type which, in the case of the tropical region, is significantly lower than the total growing stock. In future developments of the model there will be more flexibility to allow the simulation of different assumptions with respect to mortality and the volume attributable to commercial species.

[2] It is a value judgement of the authors that yield regulation other than by market forces is necessary. This position is strongly supported in the forestry literature since there are many substantive externalities which a market approach does not deal with in an effective manner.

LAND-USE CHANGE – DEFORESTATION

Deforestation remains a serious policy issue for some forest regions. Table 13 summarizes the deforestation/afforestation rate on a regional basis. There is considerable variation between regions with Central America and the Caribbean reporting the greatest deforestation and Europe the highest afforestation. Given that the forest area change is negative in five out of eight regions, deforestation can be expected to remain a prominent issue in the public policy debate over forests.

Table 13
Average annual change of forest area by region as reported in 1995

Region	Forest area	Annual change	
	1 000 ha	*1 000 ha*	*%*
Asia (39)	474 172	-3 328	-0.7
Oceania (16)	90 695	-91	-0.1
Africa (55)	520 237	-3 748	-0.7
South America	870 594	-4 774	-0.5
Central America & Caribbean (31)	79 443	-1 037	-1.3
North America (2)	457 086	763	0.2
Europe (31)	145 988	389	0.3
Area of the Former USSR (15)	816 167	557	0.1
TOTAL (all countries)	**3 454 382**	**-11 269**	**-0.3**

Source: FAO 1997

A meaningful analysis of changes in the world's forests requires a differentiation between increases or decreases of forest area and the changes in forest condition. That is, both deforestation and forest degradation need to be observed and measured. The most frequently reported parameter is forest cover change. Forest condition, although equally important for wood supply, is less intensively observed and monitored. Future work by FAO will address this issue.

LAND-USE CHANGE – PROTECTED AREA

Figure 16 indicates growth in the total area of forests under legal protection and growth in the number of areas designated *Protected Forests* between 1900 and 1990. From 1970 to 1990 the increase in area under protection is nearly 140 percent. Figure 17 indicates that the average area of protected sites is increasing in size. These figures do not indicate how much of the total area under protection is forested. The rapid rise in the area under protection is a clear indication of the importance of conservation and preservation issues in forest policy.

Figure 16
Cumulative growth of the world's protected areas

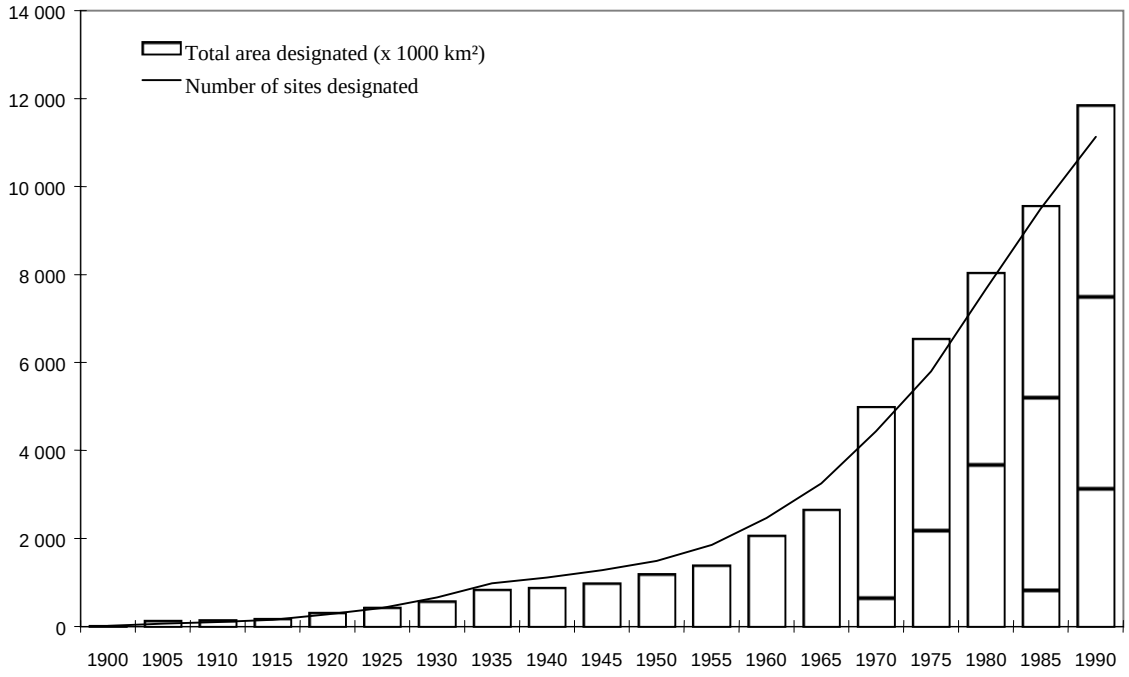


Figure 17
Non-cumulative growth of the world's protected areas

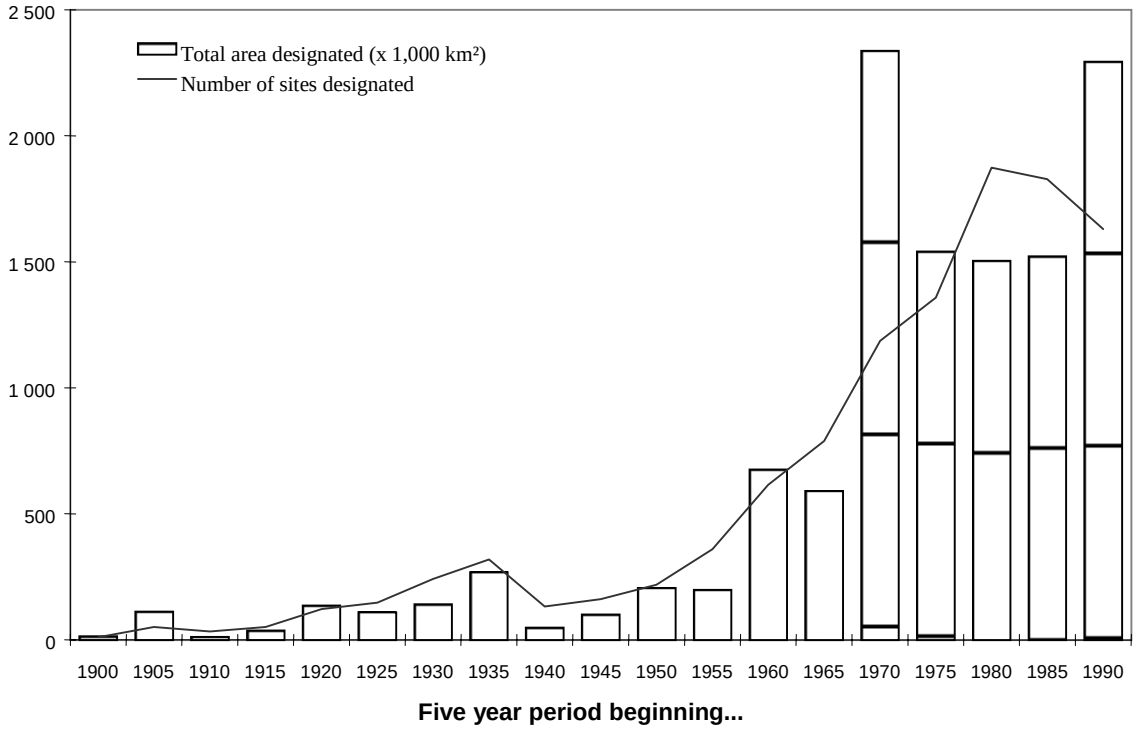


Table 14
Afforestation rate by country (1995)

Country Name	Average Annual Change in Plantation Area	
	(000 ha)	*(% total area)*
Angola	0	0
Argentina	25	3
Australia	20	2
Bangladesh	50	26
Bhutan	0.3	2
Brazil	200	4
Myanmar	3	1
Cameroon	1.6	7
Sri Lanka	10	20
Chile	120	7
People's Republic of China	500	2
Benin	0.8	8
Fiji	1	1
Ghana	1	7
India	500	7
Indonesia	250	5
Japan	0	0
Kenya	1	1
Korea, Republic of	0	0
Malawi	0	0
Malaysia	50	2
Morocco	1	1
New Zealand	50	3
Nicaragua	1	4
Pakistan	50	8
Philippines	44	9
Zimbabwe	5	5
South Africa	24	2
Tanzania, United Republic	1	1
Uganda	0.5	0
Burkina Faso	3	19
Uruguay	20	7
Viet Nam	0	0
Zambia	0	0

Policy makers will continue to debate the appropriate proportion of forest resources to be reserved under legally protected status. Increases in the area under reservation will obviously remove fibre production potential. Consequently, the ability to simulate changes in protected areas for natural forests has been included in the GFSM model.

INDUSTRIAL PLANTATIONS – AFFORESTATION RATE

Table 14 summarizes the planned afforestation rates reported by country in terms of area and percent. There is frequently a significant difference between planned and actual afforestation rates but for the purposes of this study the planned rates are used as a starting point. Recent performance of countries should be reviewed to determine the reliability of these rates for modelling purposes.

Table 14 also indicates the countries where plantation programmes are established but where active afforestation is not yet reported. These appear as having low to no afforestation rates. So, for example, Japan has significant areas in plantations but they are not expanding at the present time.

Since the growth on plantations is so much higher than on natural forests policy developments which promote the use of plantations will have a significant impact on the plantation rate.

INDUSTRIAL PLANTATIONS – DEVELOPMENT GAINS

Development gains, particularly in industrial plantations, are another key factor in analysing potential fibre supply. These development gains include both silvicultural

and genetic gains. Naturally biotechnology will also play an important role in the future but a proper evaluation of biotechnology's role in the future is presently beyond the resources of the GFSM project.

GFSM Working Paper No. 2 provides a partial survey of studies published on factors affecting productivity in tropical forest plantations. The paper provides only a start to what would be a long and complicated process of database construction to identify reference material on the subject. In general, it can be concluded that a good tree improvement programme (starting with species/provenance matching to site) can usually result in considerable gain in wood yields from tropical forest plantations. Optimal nursery and silvicultural practices (including those discussed in GFSM Working Paper No 2: seed pre-treatment, application of nitrogen-fixing soil micro-organisms, optimal spacing for defined end use, selection of adequate site, fertilization, and irrigation) can considerably increase such gains further.

Quantification of possible increases in plantation yield for a particular site, species or provenance is difficult. The data presented in Table 15 should be treated very carefully. The gains reported cannot be expected to be reproduced within the same range at a different geographic location and under different climatic and edaphic conditions. Moreover, it is nearly impossible to predict the interrelations of different factors involved that can affect plantation productivity. Percentage gains as a result of silviculture and tree improvement operations, as reviewed in this study, are widely variable. Incorporating the wide range of such data into a model for prediction of future gains is a challenging task.

Despite these cautions it is, nonetheless, worthwhile considering the results in a forecasting exercise. The statistics presented in Table 15 indicate the range of increases expected in development gains and this range could be used as a rough guide to determine the variable to apply in simulating alternative futures.

Table 15
Potential increases from development (genetic & silvicultural) gains

Genus	Country	Gain (%)					
Treatment		DBH	MAI	BA	V	H	Y
Acacia							
Spp./Prov. Matching	PR. China	8-728			107-129		
	Thailand	229-1107					
	Fiji	157					
	Indonesia		59-242				
	Pakistan	41-257					
	Sri Lanka	56-247					
Spacing	Malaysia		222				
	Thailand		11-52				
Symbiotic Associations	Senegal					8-50	
	Philippines	192				70-210	

Genus / Treatment	Country	Gain (%) DBH	MAI	BA	V	H	Y
Eucalyptus							
Spp./Prov. Matching	P.R. China	212					
	Thailand	41-63					
	Sri Lanka	147					
	Israel		700				
	Nigeria		239				
	Australia/Tasm.	8-517					
	Brazil		82				
Spacing	PNG			41			
	India	89	17-1445				
	Australia	59-82					133
	Thailand				729		
	Ethiopia		34				
Genetic Improvement	Brazil		78		25-178		
	South Africa				8-60		
	India		400		463		
Teak							
Spp./Prov. Matching	India	32				15-33	
Genetic Improvement	India	144				102	
Fertilization/Irrigation	PNG					1 138	
	Puerto Rico						60
	India	93-176	57-121			13-4348	
Site Quality	El Salvador et al.		1 600				
	Liberia					260-350	
	Benin					161	
	Bangladesh	45-54					
	Thailand				502		
	India					150	
Pinus							
Spp./Prov. Matching	Kenya	26			150		
	India	0-175					
	Thailand		283				
	Malawi			174-379			
	Tanzania	92					
	Zimbabwe	28					
	Nigeria	37					
	Zimbabwe	28					
	Nigeria	37					
	Rep. Korea				53-67		
	New Zealand				20-30		
	various tropical	21-64			75-400	26-31	
Genetic Improvement	various				5-46		
	Korea				57-100		
	Australia		17-18	11-22	9-53		
	Zimbabwe				17-37		
	var. East Africa				11		
Fertilization	Indonesia					25-100	
	New Zealand				19		
	Australia	4-10					
	PNG					452-820	
	P.R.China					30	
	New Zealand				46-288		
	Madagascar					83	
	Swaziland					29	

Note: Spp./Prov. matching means matching species/provenances to site. See also note on next page.

Note: The percentage of volume (V) or VUB (volume under bark), or VOB (volume over bark)), MAI (mean annual increment), DBH (diameter at breast height), BA (basal area), H (height) or yield (Y) gain is calculated by comparing the additional volume of wood (or other parameter) resulting from the genetic or silvicultural improvement (e.g. fertilization, provenance selection, site selection, spacing selection) with a base value. For example, an additional 1 m^3/ha of wood under a tree improvement programme, as compared to a volume yield of 10 m^3/ha from an unimproved source, would be a 10% gain. The basis for comparison can be either an unimproved situation (e.g. unfertilized plantation, local seed source), or the poorest performer in the study.

NON-WOOD AND RECOVERED FIBRE

Currently, wood is the major raw material input to the global pulp and paper industry. Significant levels of non-wood fibres are used in a handful of countries, most notably in the People's Republic of China, India, and several other Asian countries, but there are also stronger indications of interest in the fibre, particularly in North America. At present, the most common non-wood fibre is straw (Table 16). This material accounts for 46 percent of total non-wood fibre consumption, followed by bagasse (14%) and bamboo (6%) (Atchison 1995). Other non-wood fibres, such as cotton, hemp, sisal, and kenaf, are also becoming more important in the manufacture of pulp and paper.

Non-wood species currently used only sporadically in the pulp and paper industry are likely to become more important, as collection and targeted production of non-wood fibre expand beyond the present focus in East Asia, to a more global scale.

Table 16
Non-wood pulping capacities by region

	Total papermaking pulp capacities *(thousand metric tons)*			
Raw materials	1985	1988	1990	1993
Straw	6 166	5 260	7 623	9 566
Bagasse	2 339	2 267	2 646	2 984
Bamboo	1 545	1 674	1 468	1 316
Miscellaneous (cotton, reeds, sisal, jute, hemp, abaca, kenaf, flax)	3 302	6 366	6 870	6 870
Total papermaking non-wood capacity	**13 352**	**15 567**	**18 607**	**20 736**
Total paper and paperboard production	**178 558**	**225 887**	**238 939**	**250 359**
Percentage non-wood	7.4%	6.9%	7.8%	8.3%

Source: GFSM Working Paper No. 4.

Table 17 indicates that currently all regions except North America are consuming more wastepaper than they are recovering. The North American region has consistently been the largest supplier of this material, and maintains a dominant player status in world exports of wastepaper. Of the other regions, the Asia-Pacific has the largest demand for wastepaper. Europe, Africa, Latin America and the former USSR each have a lower level of demand that probably could be serviced through reserves of wastepaper from previous years or from slight increases in national recovery levels in the countries of these regions.

Table 17
Wastepaper recovery levels by region

Region	Wastepaper recovery	Recovery of total production	Wastepaper consumption	Ratio of Recovery:consumption
	('000 tons)	*(%)*	*('000 tons)*	*(x:1)*
Europe	31 923	46	32 297	0.99
Asia-Pacific	35 603	40	40 946	0.87
North America	41 999	45	34 427	1.22
Latin America	4354	31	5853	0.74
Africa	901	23	924	0.98
Former USSR	40	2	629	0.06
Total	**114 820**		**115 076**	

Source: GFSM Working Paper No. 4

6 Alternative Futures for Fibre Supply

DEFINING THE FUTURE

One of the main objectives in collecting, compiling and analysing forest resource statistics is to provide a better foundation for predicting or simulating possible future events. A difficult step is establishing a starting point or baseline – a rough indicator of immediate supply levels based on current growing stock, forest increments, harvesting intensity and forest losses. In the GFSM, the baseline was established by making a separate calculation for each major source of fibre (forest disturbed and undisturbed by man, industrial plantations, non-wood and recovered fibres) and then combining them. Details on the methodology and assumptions to carry out this task were reviewed in Section 2 – *Constructing alternative futures*.

There are significant limitations to keep in mind when reviewing the preliminary forecasts reported in this section and these are described at the end of this section. The emphasis of the work in the GFSM thus far is to create a "starting point" from a statistical point of view and to provide some modelling tools to help structure the discussion. The project does not attempt to find the right answer but to provide a vehicle to assist in exploring alternatives, in other words, a planning tool.

A set of preliminary futures for the Asia/Oceania, South America and Africa regions is described in Section 6. These will be adjusted as policy makers and analysts provide greater clarity as to what the future might hold. For South America and Asia/Oceania only one possible future is described; for Africa, three futures are presented to demonstrate the flexibility of the GFSM model to work with different assumptions.

For Europe, United States, Canada and Russia the forecasts were developed using a different methodology by the government agency, the research institute or the agency responsible for "official" forecasting; therefore, it is not possible to aggregate the forecasts for these regions merely by adding them together. Details of the reference materials used in compiling these forecasts are highlighted in the respective sections. Until there is a consensus on an appropriate and consistent methodology to be employed across all countries for global analysis it is not possible to give a definitive global picture.

ASIA/OCEANIA

Figure 18 describes one possible supply future for the Asian region. In this example, the increase in supply is primarily driven by assumptions made with respect to the role of plantations. The example simulates a future in which all undisturbed forest available for wood supply is transformed into disturbed forest by the year 2030. The deforestation rate is set sufficiently high that for many Asian countries the portion of the wood supply to come from natural forests continues to decline. Recovered fibre and non-wood fibre partially offset these declines. Since the role of trees outside of forests is quantitatively unknown in industrial fibre supply, estimates of the impact of this variable have not been made.

Figure 19 provides a brief summary of potential fibre availability for Oceania. The stability of the future described here is due to the continued significant role of plantations and the management of disturbed forests to provide a stable, even increasing, fibre supply. The undisturbed forests available for wood supply are assumed to be unlikely to play a significant production role beyond 2040.

Figure 18
Potential fibre availability 1996 - 2050 for Asia Future 1 ***(million m³)***

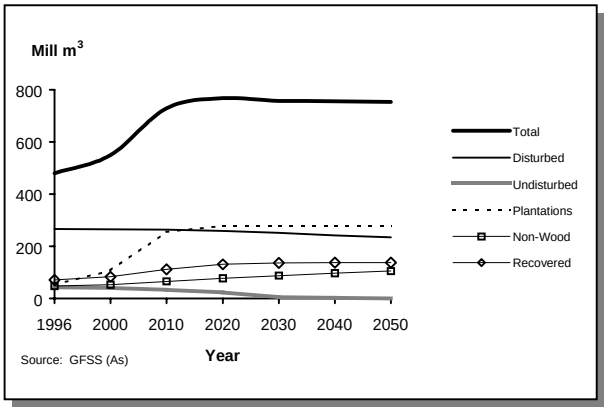
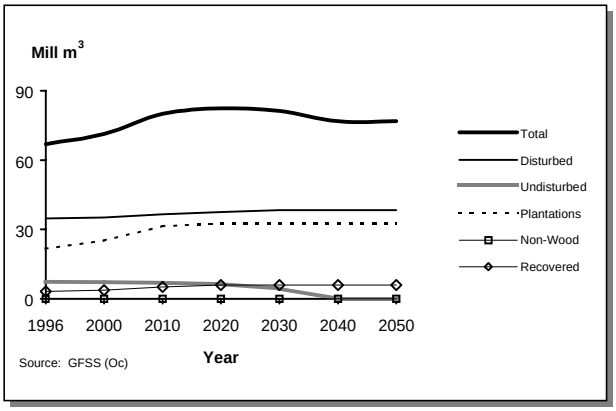


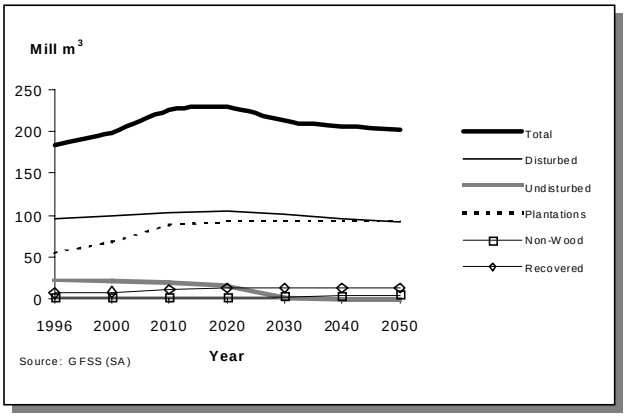
Figure 19
Potential fibre availability 1996 - 2050 for Oceania Future 1 ***(million m³)***



SOUTH AMERICA

Figure 20 describes a possible future for the South American region. In this figure, the future role of plantations and forests disturbed by man is shown to be approximately equal. The supply significance of forests undisturbed by man is expected to decrease significantly under current market conditions. In

Figure 20
Potential fibre availability 1996 - 2050 for South America Future 1 ***(million m³)***



addition, changes in government policy in the important producer countries are also likely to change the future in South America and consequently the shape of the curves presented here. The GFSM model offers a capability to model the fibre supply impacts of some of these potential policy changes.

AFRICA

Table 18 lists the major factors identified in the GFSM futures for Africa. The list of factors is not an exhaustive set but rather a subset of a larger set of variables that have been raised in various studies within the last decade. The factors included in the GFSM modelling capability were selected based on their relative importance and the feasibility of obtaining information for each. In the future a wider range of factors could be added to the modelling framework.

Table 18 also indicates the variations introduced in order to produce three potential futures that are displayed graphically. The modelling in this example uses equation IV, as described in Section 2 – *Constructing alternative futures*.

Table 18
Selected major factors influencing fibre supply in Africa

	Future 1	Future 2	Future 3
Forests disturbed/undisturbed by man			
Sustainable management (as expressed by cutting cycle – periodic or annual)	0	-10	10
Land use – deforestation	0	20	-20
Land use – legally protected area change	0	-10	10
Industrial Plantations			
Afforestation rate	0	20	-90
Development gains	0	50	10
Non-wood Fibres			
Non-wood fibre pulping capacity	0	-20	20
Recovered Fibres			
Wastepaper recovery rate	0	-10	10

Note: percentage increases are applied in the model only to 2010

The graphic representations shown in Figure 21, Figure 22 and Figure 23 are, of course, only summary data. The more detailed forecasts are generated by country forest type.

Figure 21 describes a future where all factors are held constant (set to zero) with the deforestation rate being that which is reported in the Forest Resources Assessment 1990. The figure suggests that if fibre supply is to remain stable it will be necessary to increase the role of plantations in order to supplement the losses with the conversion from undisturbed forest to disturbed forest.

Figure 22 (Future 2) explores the impact of increasing the deforestation by 20 percent from the current level, placing less land in protected area status, and introducing shorter cutting cycles in the natural forests. For industrial plantations it is assumed that development gains increase by 50 percent and the afforestation rate increases by 20 percent which is seen to be an offsetting strategy for a projected downfall in supply from the natural forest. The non-wood fibre capacity is decreased by 20 percent and the recovered fibres potential is decreased by 10 percent.

Finally, Figure 23 (Future 3) explores an alternative future where the emphasis is placed on the natural forest in terms of management strategy. The forest harvesting cutting cycle is lengthened by 20 years and this is combined with a decrease of 20 percent in the deforestation rate, and a 10 percent increase in the areas placed under protected status. Industrial plantation afforestation rates are dramatically reduced – by 90 percent. The non-wood fibre capacity is increased by 20 percent and the recovered fibre by 10 percent.

In summary, and as illustrated using Africa, the model can be used to predict futures based on dramatic departures from the static supply situation for a region, but the most practical use is based on possible or achievable variations, determined on a country-by-country basis. The analysis at the country level allows greater sensitivity to the particular forest policies within a country. It particularly enables a rapid and

Figure 21
Potential fibre availability 1996 - 2050 for Africa,
Future 1 ***(million m³)***

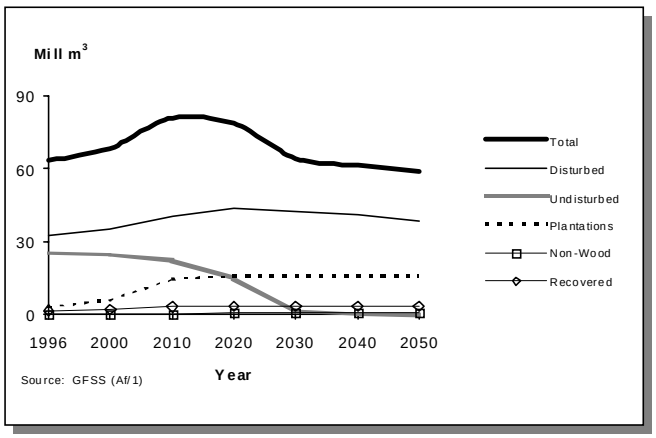


Figure 22
Potential fibre availability 1996 - 2050 for Africa,
Future 2 ***(million m³)***

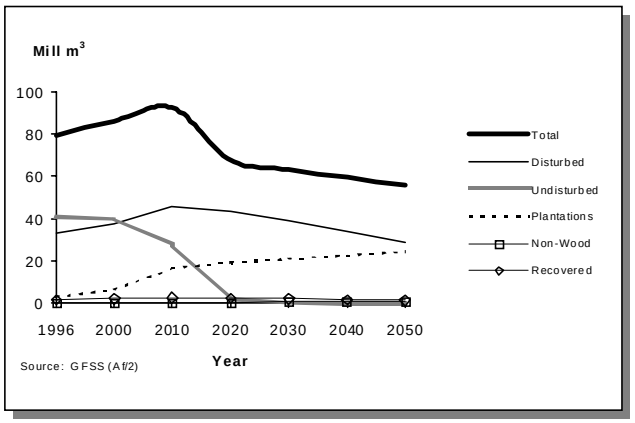
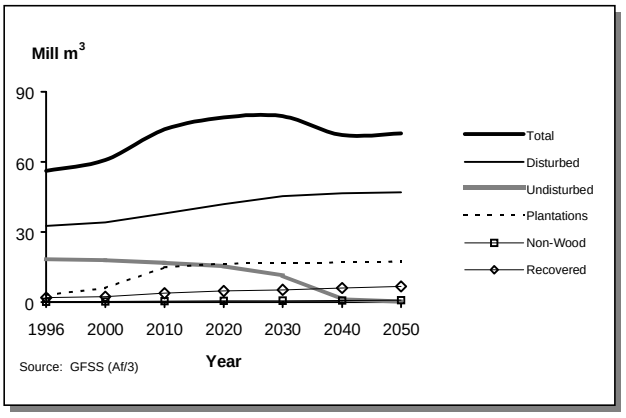


Figure 23
Potential fibre availability 1996 - 2050 for Africa,
Future 3 ***(million m³)***



comprehensible articulation of some fibre supply aspects of sustainable forest management policies suitable for presentation to decision-makers.

RUSSIA

Table 19 shows estimates based on an even and an increasing harvesting level in Russia during the next 200 years. Because large areas of the Russian forests comprise mature and overmature forests, a different (but still sustainable) harvesting profile (to those employed elsewhere) could be undertaken. These overmature forests have a high risk of being affected by large-scale disturbances such as fires, insects and diseases; they have a low productivity, and are subject to significant degeneration in the form of wood rot. Thus, much could be gained by a more rapid liquidation of fibre volume. The model results presented in Table 19 applies an accelerated harvest during the next 40-50 years in the regions with overmature forests. The model calculations indicate that Russian wood supply capacity could be significantly enhanced by applying an uneven harvesting profile in overmature forests. Although not indicated in Table 19, for European Russia, this would result in an additional 40 million m^3 per year of roundwood during the next 40 years (28 million m^3 of industrial roundwood). For Asian Russia, the result would be an additional 100 million m^3 per year of roundwood (65 million m^3 per year of industrial wood) for this period.

It should be noted that this scenario does not require the liquidation of all overmature forests. Up to 80 percent of Russia's overmature forests have uneven-age structures and, as such, a forest management regime that works towards a more balanced profile is one of the crucial components of a sustainable landscape.

Table 19
Estimated long-term sustainable economic industrial wood supply and commercial wood supply (industrial wood + fuelwood), respectively, in million m^3 per year

	European Russia	Asian Russia	Total
Official Russian AAC	133 (187)	219 (325)	352 (512)
Base Scenario Economic Supply (with existing infrastructure and relative prices)	90 (135)	70 (100)	160 (235)
With 10% increase in relative prices in forest products	105 (160)	100 (145)	205 (305)
Investments in infrastructure	110 (165)	105 (160)	225 (325)
With relative price increase of 10% + investment in infrastructure	130 (195)	160 (240)	290 (435)

Source: Nilsson, S. and Shvidenko, A. 1998.

EUROPE

The European Timber Trends Study (ETTS V) developed 14 scenarios of timber supply. Table 20 is a summary of the base low scenario statistics, considered by the Secretariat as the most likely scenario. The removals statistics are based on the official forecasts of individual countries in Europe. The domestic supply, residues and wastepaper forecasts were derived through complex model projections with many assumptions regarding GDP growth, competitiveness of products and suppliers, trade patterns, policies, recovery rates, etc. These assumptions are presented and discussed in the source documents cited below. The recovered fibre data below is converted from the ETTS V scenarios (which are in metric tons for this parameter) with the assumption that each ton of recovered fibre replaces pulp (including fillers, etc.) that would have required the consumption of 2.5 m^3 of industrial roundwood. Fuelwood is subtracted from the ETTS V removal scenarios to reflect the industrial roundwood supply forecasts. This makes the statistics presented more comparable with those for the other regions presented in this report. The net total estimates the potential availability of industrial fibre supply from domestic markets under the assumptions described. A more detailed description of ETTS V is provided in the source document:

Table 20
European forecast of removals, residues & recovered fibre net of fuelwood consumption in million m^3

	2000	2010	2020
Total roundwood removals	422 222	452 288	479 896
Residues	54 582	64 441	74 051
Recovered fibre	33 672	45 628	59 376
Less fuelwood	**-83 514**	**-89 519**	**-94 861**
Net	477 470	541 280	607 526

Source: ECE/FAO 1996c

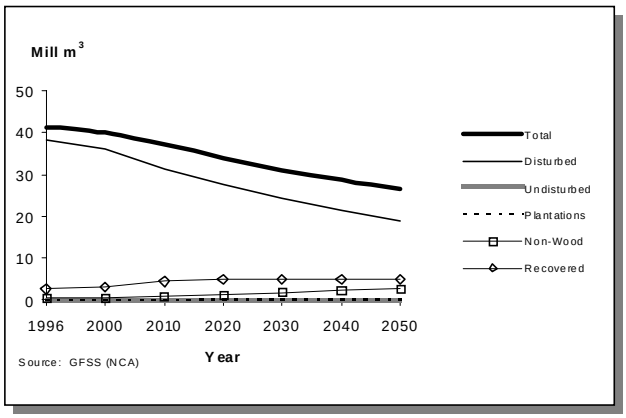
UN Economic Commission for Europe and FAO. 1996. *European forests and timber: into the 21st century*. Geneva Timber and Forest Discussion Papers. ECE/TIM/SP/11. Geneva.

NORTH AND CENTRAL AMERICA

Excluding USA and Canada

GFSM modelling for North and Central America (excluding United States and Canada) is presented in Figure 24 and indicates a continual decline in fibre availability due to continuation of current deforestation trends and no significant role for industrial

Figure 24
Potential fibre availability 1996 - 2050 for North and Central America excluding USA and Canada, Future 1 ***(million m^3)***



plantations in this future. The disturbed forest decline is partly offset by the fibre supply from non-wood and recovered fibre.

United States of America and Canada

USA

Table 21 presents the most recent published information available on projected roundwood harvests from USA timberlands. From the base year 1995 to 2040 roundwood harvests are projected to increase by some 41 percent. The USA South is expected to supply 56 percent of the total required supply by the year 2000 and will be the major source of supply for the next 50 years. The roundwood harvest includes industrial roundwood and fuelwood.

Table 21
USA Projections of roundwood harvest on forestland in the United States 2000-2040, by species group in million m³

Species Group	2000	2010	2020	2030	2040
Softwoods	314.13	322.62	353.75	384.88	413.18
Hardwoods	237.72	263.19	280.17	288.66	302.81
All species	**551.85**	**585.81**	**633.92**	**673.54**	**715.99**

Conversion factor used: 1 cubic foot = 0.0283 cubic meters
Roundwood harvest equals production
Source: Haynes *et al* 1995

Canada

Industrial roundwood projection for Canada

Canadian wood supply data and descriptive text for the GFSM were provided by the Canadian Forest Service:

The forecast shown in Table 22 is a projection of industrial roundwood production. It embeds assumptions about future demand, prices and changes in technology over time. In particular, it assumes that increased demands will result in increased product prices, which will result in some expansion of the economically accessible forest land base in Canada. It also assumes that there will be improved wood utilization as a result of adoption of new and existing technologies. This means that forest products production will increase proportionately more than industrial roundwood production, as more product is produced from the same volume of roundwood.

Table 22
Canadian industrial roundwood production, actual and projected, and estimates of allowable annual cut (AACs) in million m³

Year	1970	1980	1990	1995	2000	2005	2010	2015
Industrial Roundwood Production	**117**	**151**	**156**	**183**	**194**	**202**	**213**	**227**
Allowable annual cut	228	228	253	233	na	na	na	na

na = not available
Sources: ECE/FAO 1996b and CCFM 1997.

The forecast is for coniferous and deciduous species combined. The increased use of deciduous species is already apparent. Deciduous roundwood production (i.e. both industrial roundwood and fuelwood) has more than doubled in the last ten years, increasing from 14 million m^3 in 1985 to over 30 million m^3 in 1990. This trend is expected to continue, reflecting both the relative availability and cost of hardwoods compared to softwoods, as well as the development of new products using hardwood such as oriented strand board that provide good structural performance.

Table 22 also shows the historical allowable annual cuts in Canada; but a forecast is not available at this time. The provinces own the majority of forest lands, and control the rate of timber harvesting on them; the harvest rate on provincial Crown land is regulated through an Allowable Annual Cut (AAC). AACs are a measure of how much timber volume forest companies are permitted to harvest annually, for a specified area over a certain time period (Pers. Comm. Dr. Darcie Booth, Canadian Forest Service, March 1998).

COMPARATIVE ANALYSIS (SELECTED REGIONS)

Table 23 provides the most optimistic assumptions of future commercial fibre availability for five regions. The remaining regions have not been assessed using the model developed for the Global Fibre Supply Model. There is a need to view these upper limits with a great deal of caution. The estimates should be viewed as starting points for a discussion of how to bring the fibre availability to more realistic levels.

Table 23
Total potential fibre availability (all sources) by selected region 1996, 2010, 2050 in 000 000 m^3

	1996	2010			2050		
		Future 1	Future 2	Future 3	Future 1	Future 2	Future 3
Africa	62.95	79.38	94.38	92.87	58.22	55.62	71.83
Asia	482.65	675.65	702.42	716.36	690.87	714.89	844.92
Oceania	66.81	78.18	86.26	82.03	76.18	88.98	82.78
Central America	41.92	36.02	34.44	37.65	25.01	14.13	38.00
South America	182.76	220.01	247.18	234.78	201.35	217.67	242.99
Total	**837.09**	**1 089.24**	**1 164.68**	**1 163.69**	**1 051.62**	**1 091.29**	**1 280.52**

Changes to the factors need to be applied to these calculations based on an assessment and quantification of at least the following:

- ❏ Harvesting residues losses are significant, often between 20 to 30 percent in tropical countries.
- ❏ Afforestation rate can be significantly lower than the officially reported statistics in some countries.

- ❏ Unreported forest harvesting is often significant in many developing countries and this could mean much more of the forest is already disturbed than the GFSM model records. This would lead to significantly lower yields in the future.
- ❏ Recovered fibre will almost certainly increase as a supply source in the future.
- ❏ Industrial plantation investment in genetics and silvicultural programmes leads to significant (but difficult to quantify) gains in fibre supply.
- ❏ Trees outside of forests are important fibre sources in some regions and they are frequently not taken into account in wood supply forecasts.
- ❏ Non-wood usage could significantly increase in developed and developing countries.
- ❏ Improvement in technology has allowed engineered wood products to be produced using much lower quality wood fibre.
- ❏ Sustainable forest management could lead to increasing fibre availability in all regions over the longer term.

It should be restated that it was only possible in this project to quantify some of these factors. Others are not yet integrated into the simulation tool developed for the GFSM. Future upgrades of the model can incorporate these capabilities.

It should also be reiterated that, given the incompatibility of methodology used in the different regional analyses of Europe, North America and Russia, it is not possible to present a forecast or global picture at this time. Hopefully this problem can be rectified in the future.

Discussion and Conclusions

STATISTICS – LAND AND FOREST

The most significant contribution this study has made is the systematic collection, electronic storage, standardization and reporting of forest resources statistics which are directly relevant to the discussion of sustainable forest management, particularly for three regions: Africa, Asia and Oceania, and South and Central America. This process started with, and built on, the extensive efforts of the 1980 and 1990 Forest Resources Assessments.

- ❏ The GFSM has produced a statistical structure, which can be greatly improved over time to be a permanent forest reporting system at the global level. The statistical framework can also be modified to meet forest statistical reporting needs at the country level, thereby helping individual countries to meet their specific reporting requirements.

Obtaining good quality data requires extensive cooperation. Many countries have scattered subnational (frequently outdated) inventories as well as various field and research studies related to essential data needs. The data collected thus far conforms to the internationally agreed-upon definitions developed for the Forest Resources Assessment 2000 and for the sake of completeness includes comparable statistical data provided for Russia, Europe, Canada and the United States. Any inconsistency is due to the formidable challenges faced in translating data developed with a country's set of definitions and standards to internationally agreed-upon definitions and standards.

- ❏ More emphasis should be placed on the development of national forest inventories and appropriate linkages with many subnational forest inventories.
- ❏ Governments, NGOs, industry, research institutes, universities, and international agencies could benefit from a renewed commitment to a vastly improved process for sharing data and information on forests and their related resources.

Once a forest related statistical structure has been developed it needs improvement to include additional relevant statistics, input of new data as it is provided by countries and other sources and a constant analysis of data to ensure that the information is reflecting the situation in the country. The database also needs more input from other institutions that collect part of the data set used to conduct global studies.

- ❏ FAO could allocate more resources to the maintenance and continual improvement of the statistical database and models produced in the GFSM and related exercises.

Even the best forest statistics require extensive interpretation by analysts at virtually any spatial scale from the field level to the country level. The interpretation process could be greatly improved by more effective dialogue between analysts and major policy stakeholders.

- ❏ For FAO the credibility of the forest statistics would be improved by countries placing more emphasis on improving the interpretation process using a multistakeholder/expert review.

Forest available for fibre supply will eventually be converted, in most countries, from undisturbed to disturbed forest. The big proviso, of course, is whether the forest in question is likely to be economically accessible. Maintaining the same fibre supply from these forests, with the same fibre quality, will depend to a large extent on the prevailing types of the harvesting/silvicultural systems employed.

- ❏ To promote more concrete discussions over sustainable forest management it is necessary to start an expansion of the statistical system for the monitoring of prevailing harvesting/silvicultural systems and related price and cost information in order to better assess the amount of fibre available from natural forests and plantations.

Research conducted in the course of this project indicates that a serious issue in forest management globally is not deforestation but degradation which in the long run means the lack of higher quality fibres for use particularly in the sawmilling and veneer industry. Forest degradation is also related to issues such as biodiversity and the argument could be made that managing forest for higher quality fibres is likely very compatible with managing forest for biodiversity and a host of other ecological and social benefits.

- ❏ Special studies on low impact harvesting, improvement cutting and prevailing harvesting/silvicultural practices could be conducted in order to help with the assessment of forest degradation and to help propose solutions which will ameliorate negative forest conditions. These studies would provide valuable material for a multi-objective analysis of forest.

Industrial plantation fibre will play an increasingly significant role in the future in most regions as indicated by the current global afforestation rate and the significant increases in development gains being produced in plantations.

- ❏ The available plantation statistics and related models need to be developed further to allow for a description of forest plantations by more species groups and by age class.

For trees outside of forests, other wooded land and “other land” the statistics are far less clear. The data is simply not available to assess the role of these fibre sources in the future. These fibre sources are, and will continue to be, very significant in some regions.

- ❏ More attention could be paid to developing standardized definitions, methodologies for sampling, and data collection systems for trees outside of forests, other wooded land and other lands on which forests grow.

Overall, the statistics to assess potential fibre availability from natural and semi-natural forests, plantation forests and trees outside of forests and other land are inadequate in most countries. Many, including developed countries, still do not have adequate inventories at the national scale to reflect the dynamics of forest management.

- ❏ Continuous forest inventory systems would substantially improve the possibility to plan the management of forests, particularly the sustainable management of forests. FAO could work with its member countries to develop and maintain such systems.

Developing sustainable data collection and analysis systems requires that appropriate training capability be incorporated. With emerging communication tools there is an opportunity for far more effective interaction with country representatives at a comparatively low cost. The insights gained from having access to local expert knowledge are invaluable to the forest statistician.

- ❏ There is an urgent need for more capacity building in the area of forest statistics and to maintain a stronger network of contacts in all countries for the collection and review of data.

STATISTICS – NON-WOOD AND RECOVERED FIBRES

Non-wood fibre is likely to play an increasing role in the future as a product in itself and as a complementary fibre source for pulping. Utilization of non wood-fibre is not just a phenomenon of developing countries. Recent activities in developed countries suggest they are examining its potential as a major source of supply. The GFSM analysis of non-wood fibre is still very preliminary. A major concern relates to the environmental consequences of processing non-wood fibres.

Utilization of recovered fibre has technical limitations but there exists great opportunity to further utilize it as a major source of supply in some developing regions. Changes in public policies linked to the collection of recovered fibre could ameliorate shortfalls from other fibre sources. On the other hand, technological progress means these fibres are now also beginning to find uses in engineered wood products such as medium density fibreboard.

- ❏ Given the dynamics of change in fibre sources it is useful and necessary to monitor, on a more frequent and continual basis, recovered and non-wood material as a source of fibre.

FORECAST MODEL

A decision made in the GFSM project was to keep the modelling component relatively simple, readily transparent, flexible and user friendly. The study team also tried to build links between the model and some of the

critical factors that are directly related to supply. The primary reason for this strategy is that the team did not want the modelling portion of the exercise to detract from the main focus of the work – the systematic collection and storage of forest inventory data. When the forest statistics are of sufficient quality, then more complex models can be developed and utilized.

Forecasting for different regions and countries with different methodologies, assumptions, definitions and forecasting tools leads to different results. Unfortunately, there was not time to build a complex forecasting model that could be applied to all regions. More effective communication mechanisms with governments and their industry counterparts will be essential if global presentations are to be made in the future; otherwise it is legitimate to say we are comparing apples and oranges as far as forecasting is concerned since we do not have a common basis from which to start the modelling exercise.

It is also important that the forecasting or simulation tools be made even more flexible so that all critical variables can be easily manipulated to explore the impact of their change. For example, it is useful to have the ability to manipulate variables related to forest growth and mortality and the commercialization of species since these types of factors can have a huge impact on sustainable forest management.

- ❏ The modelling component of the GFSM could include more variables to help with the manipulation of the factors that influence fibre supply.

The plantation model used in this exercise was inadequate given the critical role plantations will play as a source of fibre since it should include more detailed age class and species group information to improve our forecasts. The assumptions used were developed by a group of plantation experts and translated by modellers into a framework that was compatible with our work.

- ❏ FAO could undertake a more extensive modelling exercise with plantation forests since the statistics warrant a more complex approach than for the natural forest.

PRICES, COSTS AND TECHNOLOGY

Throughout the text it has been noted that this is not an economic supply study and the focus of the efforts thus far has not been on price and cost information. This is a shortfall of the study but it became quickly obvious that the inclusion of such data was simply beyond the timeline and budget for the project.

The challenges in collecting this type of information in a credible way at a global scale are formidable for a number of reasons including: forest operations and governments are often very reluctant to release cost information since for competitive reasons it is a secret; log market prices are seriously distorted by policy-driven decisions such as export bans; transfer pricing in private operations is often driven by efforts to save on taxes; and, finally, there are no competitive markets for the forest fibre so prices are artificially established.

- Collecting price and cost information will require a substantial effort in order to develop a credible statistical system with this type of information. Despite the challenges it remains one of the logical next steps in the development of a comprehensive forest and forest products information system.

The role of technology has been highlighted in the study as a serious issue. Assumptions with respect to the role material efficiency will play are frequently unsubstantiated, from a statistical point of view.

- Material efficiency studies by major forest products group could be conducted in order to assess better the historic developments and future trends. These studies could include extensive research on conversion factors used to build links between forest products, raw material and forest resources.

POLICY DIRECTION FOR SUSTAINING OR INCREASING FUTURE FIBRE SUPPLY

Most analysts agree that demand for forest products will continue to increase. The potential availability of fibre to meet demand is the central question the GFSM starts to address.

Countries can and do make policy choices that will either maintain, or increase their fibre supplies. These include:

- Increase in the use of recovered and non-wood fibre;
- Expansion of the industrial forest plantation area;
- Intensification of investment in development (genetic and silvicultural) gain;
- Improved utilization of the natural forest fibre resource through better forest management planning and manufacturing processes;
- Changing or modification of harvesting/silvicultural practices to improve the long-term sustainable yield of the forest and at the same time protect the multitude of other forest values;
- Technological improvement to better utilize species and volumes.

There are, of course, many more policy levers that can be manipulated but they are beyond the terms of reference for this particular study. The movement of the levers is dependent on the decisions made by governments, industry, NGOs and the investment community and these agencies all depend on reliable statistical information as a starting point in the development of appropriate forest policies. Despite the shortcomings, it is hoped that the process developed and the statistics presented here can encourage a vigorous debate over the next steps the international community will take to encourage sustainable forest management.

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Statistical Summary

INDEX

Table1: Summary of natural forest area by region and country

AFRICA

Country and Region	Total Natural Forest Area (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest	Natural Forest Available for Wood Supply (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest
Angola	**22 080**	0	22 080	**11 780**	0	11 780
Botswana	**13 916**	5 000	8 916	**1 000**	0	1 000
Cameroon	**19 582**	8 000	11 582	**12 770**	6 894	5 876
Central African Republic	**29 924**	21 000	8 924	**11 355**	9 000	2 355
Congo, Democratic Republic of	**109 203**	77 811	31 392	**61 659**	32 200	29 459
Congo, Republic of	**19 500**	14 600	4 900	**11 324**	6 924	4 400
Côte d'Ivoire	**5 403**	0	5 403	**1 286**	0	1 286
Equatorial Guinea	**1 778**	778	1 000	**1 148**	148	1 000
Gabon	**17 838**	5 768	12 070	**10 818**	2 318	8 500
Ghana	**8 969**	0	8 969	**3 367**	0	3 367
Guinea	**6 250**	100	6 150	**959**	0	959
Guinea-Bissau	**2 308**	67	2 241	**376**	30	346
Kenya	**1 175**	0	1 175	**450**	0	450
Liberia	**4 500**	1 001	3 499	**2 599**	200	2 399
Madagascar	**12 055**	4 697	7 358	**1 170**	0	1 170
Malawi	**3 213**	0	3 213	**1 000**	0	1 000
Morocco	**3 514**	0	3 514	**150**	0	150
Mozambique	**16 834**	0	16 834	**4 984**	0	4 984
Nigeria	**13 629**	530	13 099	**7 899**	0	7 899
Sierra Leone	**1 303**	0	1 303	**333**	0	333
Somalia	**750**	0	750	**0**	0	0
South Africa	**7 204**	0	7 204	**0**	0	0
Tanzania, United Republic	**32 355**	11 355	21 000	**10 790**	1 755	9 035
Uganda	**6 084**	40	6 044	**1 444**	0	1 444
Zambia	**31 355**	0	31 355	**7 300**	0	7 300
Zimbabwe	**8 896**	0	8 896	**500**	0	500
Africa	**399 618**	**150 747**	**248 871**	**166 461**	**59 469**	**106 992**

ASIA

Country and Region	Total Natural Forest Area (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest	Natural Forest Available for Wood Supply (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest
Afghanistan	**954**	24	930	**300**	0	300
Bangladesh	**700**	150	550	**0**	0	0
Bhutan	**2 748**	1 298	1 450	**1 242**	442	800
Brunei Darussalam	**434**	200	234	**427**	193	234
Cambodia	**10 532**	5 167	5 365	**4 984**	1 044	3 940
China (Mainland)	**99 452**	17 000	82 452	**65 160**	0	65 160
India	**50 385**	5 635	44 750	**21 935**	173	21 762
Indonesia	**120 600**	76 071	44 529	**74 166**	38 187	35 979
Iran, Islamic Republic of	**1 465**	1 465	0	**1 465**	1 465	0
Japan	**13 380**	2 380	11 000	**6 468**	0	6 468
Korea, DPR	**5 300**	800	4 500	**2 800**	0	2 800
Korea, Republic of	**4 200**	50	4 150	**2 200**	0	2 200
Laos	**12 431**	7 431	5 000	**2 495**	495	2 000
Malaysia	**16 325**	6 639	9 686	**11 255**	2 760	8 495
Myanmar	**26 875**	7 635	19 240	**20 442**	3 302	17 140
Nepal	**4 766**	2 240	2 526	**2 806**	570	2 236
Pakistan	**2 033**	215	1 818	**1 273**	98	1 175
Philippines	**5 798**	2 107	3 691	**2 202**	0	2 202
Sri Lanka	**1 657**	157	1 500	**0**	0	0
Thailand	**11 101**	1 101	10 000	**0**	0	0
Turkey	**8 856**	0	8 856	**6 595**	0	6 595
Viet Nam	**8 613**	0	8 613	**3 052**	0	3 052
Asia	**408 605**	**137 765**	**270 840**	**231 267**	**48 729**	**182 538**

AFRICA

Natural Forest Not Available for Wood Supply

(1000 ha)

Undisturbed Forest	Disturbed Forest	Total Forest	Inaccessible Area I	Inaccessible Area II	Inaccessible Area III	Legally protected areas	Country and Region
0	10 300	**10 300**	300	0	10 000	0	Angola
5 000	7 916	**12 916**	0	0	2 616	10 300	Botswana
1 106	5 706	**6 812**	980	0	4 800	1 032	Cameroon
12 000	6 569	**18 569**	345	0	14 224	4 000	Central African Republic
45 611	1 933	**47 544**	34 000	5 000	0	8 544	Congo, Democratic Republic of
7 676	500	**8 176**	6 350	600	1 100	126	Congo, Republic of
0	4 117	**4 117**	0	0	2 553	1 564	Côte d'Ivoire
630	0	**630**	280	0	0	350	Equatorial Guinea
3 450	3 570	**7 020**	450	3 000	3 570	0	Gabon
0	5 602	**5 602**	0	0	4 342	1 260	Ghana
100	5 191	**5 291**	0	0	5 162	129	Guinea
37	1 895	**1 932**	0	0	1 932	0	Guinea-Bissau
0	725	**725**	0	0	175	550	Kenya
801	1 100	**1 901**	670	0	1 100	131	Liberia
4 697	6 188	**10 885**	2 345	2 345	5 630	565	Madagascar
0	2 213	**2 213**	0	0	2 081	132	Malawi
0	3 364	**3 364**	0	0	3 364	0	Morocco
0	11 850	**11 850**	475	0	11 000	375	Mozambique
530	5 200	**5 730**	0	0	5 000	730	Nigeria
0	970	**970**	85	0	885	0	Sierra Leone
0	750	**750**	0	0	750	0	Somalia
0	7 204	**7 204**	0	0	7 204	0	South Africa
9 600	11 965	**21 565**	400	6 000	11 255	3 910	Tanzania, United Republic
40	4 600	**4 640**	0	0	4 320	320	Uganda
0	24 055	**24 055**	0	0	24 055	0	Zambia
0	8 396	**8 396**	40	0	8 316	40	Zimbabwe
91 278	**141 879**	**233 157**	**46 720**	**16 945**	**135 434**	**34 058**	**Africa**

ASIA

Natural Forest Not Available for Wood Supply

(1000 ha)

Undisturbed Forest	Disturbed Forest	Total Forest	Inaccessible Area I	Inaccessible Area II	Inaccessible Area III	Legally protected areas	Country and Region
24	630	**654**	404	0	250	0	Afghanistan
150	550	**700**	0	0	613	87	Bangladesh
856	650	**1 506**	500	0	650	356	Bhutan
7	0	**7**	3	0	0	4	Brunei Darussalam
4 123	1 425	**5 548**	0	0	2 000	3 548	Cambodia
17 000	17 292	**34 292**	4 991	0	16 297	13 004	China (Mainland)
5 462	22 988	**28 450**	4 750	0	15 000	8 700	India
37 884	8 550	**46 434**	990	3 288	2 298	39 858	Indonesia
0	0	**0**	0	0	0	0	Iran, Islamic Republic of
2 380	4 532	**6 912**	1 500	0	4 500	912	Japan
800	1 700	**2 500**	800	0	800	900	Korea, DPR
50	1 950	**2 000**	700	0	700	600	Korea, Republic of
6 936	3 000	**9 936**	4 500	1 000	4 436	0	Laos
3 879	1 191	**5 070**	790	0	1 496	2 784	Malaysia
4 333	2 100	**6 433**	5 740	0	400	293	Myanmar
1 670	290	**1 960**	380	900	330	350	Nepal
117	643	**760**	220	260	235	45	Pakistan
2 107	1 489	**3 596**	0	10	2 896	690	Philippines
157	1 500	**1 657**	0	0	1 092	565	Sri Lanka
1 101	10 000	**11 101**	2 000	0	6 801	2 300	Thailand
0	2 261	**2 261**	0	0	2 261	0	Turkey
0	5 561	**5 561**	1 020	0	3 878	663	Viet Nam
89 036	**88 302**	**177 338**	**29 288**	**5 458**	**66 933**	**75 659**	**Asia**

Table1: Summary of natural forest area by region and country (continued)

OCEANIA

Country and Region	Total Natural Forest Area (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest	Natural Forest Available for Wood Supply (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest
Australia	**40 719**	3 814	36 905	**15 905**	0	15 905
Fiji	**757**	557	200	**307**	207	100
New Zealand	**6 228**	2 028	4 200	**268**	68	200
Papua New Guinea	**36 909**	33 409	3 500	**9 000**	7 500	1 500
Solomon Islands	**2 361**	2 111	250	**601**	497	104
Vanuatu	**893**	653	240	**193**	143	50
Oceania	**87 867**	**42 572**	**45 295**	**26 274**	**8 415**	**17 859**

EUROPE

Country and Region	Total Natural Forest Area (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest	Natural Forest Available for Wood Supply (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest
Albania	**1 041**	0	1 041	**909**	0	909
Austria	**3 877**	0	3 877	**3 128**	0	3 128
Belgium	**621**	0	621	**567**	0	567
Bulgaria	**3 386**	0	3 386	**3 162**	0	3 162
Croatia	**1 974**	0	1 974	**1 837**	0	1 837
Czech Republic	**2 630**	0	2 630	**1 947**	0	1 947
Denmark	**420**	0	420	**400**	0	400
Estonia	**1 915**	0	1 915	**1 812**	0	1 812
Finland	**20 122**	0	20 122	**18 652**	0	18 652
France	**14 185**	0	14 185	**12 703**	0	12 703
Germany	**10 407**	0	10 407	**7 826**	0	7 826
Greece	**2 512**	0	2 512	**2 289**	0	2 289
Hungary	**1 977**	0	1 977	**1 626**	0	1 626
Ireland	**322**	0	322	**312**	0	312
Italy	**6 753**	0	6 753	**4 390**	0	4 390
Latvia	**2 757**	0	2 757	**2 248**	0	2 248
Lithuania	**1 823**	0	1 823	**1 610**	0	1 610
Netherlands	**290**	0	290	**273**	0	273
Norway	**8 697**	0	8 697	**6 638**	0	6 638
Poland	**8 606**	0	8 606	**7 450**	0	7 450
Portugal	**2 711**	0	2 711	**2 309**	0	2 309
Romania	**6 190**	0	6 190	**5 413**	0	5 413
Slovakia	**1 977**	0	1 977	**1 284**	0	1 284
Slovenia	**1 077**	0	1 077	**1 077**	0	1 077
Spain	**6 447**	0	6 447	**4 927**	0	4 927
Sweden	**24 437**	0	24 437	**22 048**	0	22 048
Switzerland	**1 233**	0	1 233	**1 068**	0	1 068
United Kingdom	**2 326**	0	2 326	**1 848**	0	1 848
Europe	**140 713**	**0**	**140 713**	**119 753**	**0**	**119 753**

FORMER USSR

Country and Region	Total Natural Forest Area (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest	Natural Forest Available for Wood Supply (1 000 ha) Undisturbed Forest	Disturbed Forest	Total Forest
Russian Federation	**694 139**	680 687	13 452	**527 542**	514 090	13 452
USSR, former area of	**694 139**	**680 687**	**13 452**	**527 542**	**514 090**	**13 452**

OCEANIA

Natural Forest Not Available for Wood Supply

(1000 ha)

Undisturbed Forest	Disturbed Forest	Total Forest	Inaccessible Area I	Inaccessible Area II	Inaccessible Area III	Legally protected areas	Country and Region
3 814	21 000	**24 814**	9 700	0	8 500	6 614	Australia
350	100	**450**	90	0	330	30	Fiji
1 960	4 000	**5 960**	0	0	545	5 415	New Zealand
25 909	2 000	**27 909**	17 625	4 000	4 500	1 784	Papua New Guinea
1 614	146	**1 760**	1 500	0	260	0	Solomon Islands
510	190	**700**	200	0	493	7	Vanuatu
34 157	**27 436**	**61 593**	**29 115**	**4 000**	**14 628**	**13 850**	**Oceania**

EUROPE

Natural Forest Not Available for Wood Supply

(1000 ha)

Undisturbed Forest	Disturbed Forest	Total Forest	Inaccessible Area I	Inaccessible Area II	Inaccessible Area III	Legally protected areas	Country and Region
0	132	**132**	0	0	119	13	Albania
0	749	**749**	0	0	0	749	Austria
0	54	**54**	0	0	0	54	Belgium
0	224	**224**	0	0	0	224	Bulgaria
0	137	**137**	0	0	0	137	Croatia
0	683	**683**	0	0	0	683	Czech Republic
0	20	**20**	0	0	0	20	Denmark
0	103	**103**	0	0	0	103	Estonia
0	1 470	**1 470**	0	0	0	1 470	Finland
0	1 482	**1 482**	0	0	0	1 482	France
0	2 581	**2 581**	0	0	0	2 581	Germany
0	223	**223**	0	0	148	75	Greece
0	351	**351**	0	0	148	203	Hungary
0	10	**10**	0	0	0	10	Ireland
0	2 363	**2 363**	0	0	1 950	413	Italy
0	509	**509**	0	0	345	164	Latvia
0	213	**213**	0	0	57	156	Lithuania
0	17	**17**	0	0	0	17	Netherlands
0	2 059	**2 059**	0	0	1 900	159	Norway
0	1 156	**1 156**	0	0	0	1 156	Poland
0	402	**402**	0	0	252	150	Portugal
0	777	**777**	0	0	575	202	Romania
0	693	**693**	0	0	0	693	Slovakia
0	0	**0**	0	0	0	0	Slovenia
0	1 520	**1 520**	0	0	0	1 520	Spain
0	2 389	**2 389**	0	0	1 917	472	Sweden
0	165	**165**	0	0	0	165	Switzerland
0	478	**478**	0	0	0	478	United Kingdom
0	**20 828**	**20 828**	**0**	**0**	**7 292**	**13 536**	**Europe**

FORMER USSR

Natural Forest Not Available for Wood Supply

(1000 ha)

Undisturbed Forest	Disturbed Forest	Total Forest	Inaccessible Area I	Inaccessible Area II	Inaccessible Area III	Legally protected areas	Country and Region
166 597	0	**166 597**	0	0	101 286	65 311	Russian Federation
166 597	**0**	**166 597**	**0**	**0**	**101 286**	**65 311**	**USSR, former area of**

Table1: Summary of natural forest area by region and country (continued)

NORTH AND CENTRAL AMERICA

	Total Natural Forest Area (1 000 ha)			Natural Forest Available for Wood Supply (1 000 ha)		
Country and Region	Undisturbed Forest	Disturbed Forest	Total Forest	Undisturbed Forest	Disturbed Forest	Total Forest
Belize	**1 960**	0	1 960	**1 215**	0	1 215
Canada	**244 571**	96 987	147 584	**147 584**	0	147 584
Costa Rica	**1 200**	600	600	**230**	0	230
Cuba	**1 591**	0	1 591	**660**	0	660
Dominican Republic	**1 575**	0	1 575	**715**	0	715
El Salvador	**101**	0	101	**0**	0	0
Guatemala	**3 813**	1 100	2 713	**1 683**	0	1 683
Honduras	**4 112**	1 200	2 912	**2 269**	0	2 269
Mexico	**55 476**	0	55 476	**18 000**	0	18 000
Nicaragua	**5 546**	1 600	3 946	**2 786**	0	2 786
Panama	**2 794**	794	2 000	**850**	0	850
United States of America	**298 129**	61 095	237 034	**156 176**	0	156 176
North and Central America	**620 868**	**163 376**	**457 492**	**332 168**	**0**	**332 168**

SOUTH AMERICA

	Total Natural Forest Area (1 000 ha)			Natural Forest Available for Wood Supply (1 000 ha)		
Country and Region	Undisturbed Forest	Disturbed Forest	Total Forest	Undisturbed Forest	Disturbed Forest	Total Forest
Argentina	**33 000**	1 000	32 000	**10 000**	0	10 000
Bolivia	**48 200**	10 800	37 400	**18 200**	3 500	14 700
Brazil	**546 000**	374 000	172 000	**68 000**	14 000	54 000
Chile	**13 443**	4 000	9 443	**3 900**	200	3 700
Colombia	**52 862**	41 362	11 500	**6 000**	1 500	4 500
Ecuador	**11 092**	5 142	5 950	**3 000**	708	2 292
French Guiana	**8 000**	7 000	1 000	**2 150**	1 150	1 000
Guyana	**18 500**	13 500	5 000	**6 000**	1 000	5 000
Paraguay	**11 500**	7 500	4 000	**1 500**	650	850
Peru	**67 400**	44 300	23 100	**17 300**	4 300	13 000
Suriname	**14 700**	13 600	1 100	**2 200**	1 100	1 100
Uruguay	**658**	0	658	**0**	0	0
Venezuela	**43 742**	28 742	15 000	**21 742**	6 742	15 000
South America	**869 097**	**550 946**	**318 151**	**159 992**	**34 850**	**125 142**
Grand Total:	**3 220 907**	**1 726 093**	**1 494 814**	**1 563 457**	**665 553**	**897 904**

NORTH AND CENTRAL AMERICA

Natural Forest Not Available for Wood Supply

(1000 ha)

Undisturbed Forest	Disturbed Forest	Total Forest	Inaccessible Area I	Inaccessible Area II	Inaccessible Area III	Legally protected areas	Country and Region
0	745	**745**	0	0	500	245	Belize
96 982	0	**96 987**	0	88 004	0	8 983	Canada
600	370	**970**	0	0	0	970	Costa Rica
0	931	**931**	400	0	241	290	Cuba
0	860	**860**	60	0	400	400	Dominican Republic
0	101	**101**	0	0	96	5	El Salvador
1 100	1 030	**2 130**	0	0	1 300	830	Guatemala
1 200	643	**1 843**	800	0	400	643	Honduras
0	37 476	**37 476**	0	0	37 476	0	Mexico
1 600	1 160	**2 760**	0	0	2 000	760	Nicaragua
794	1 150	**1 944**	644	0	0	1 300	Panama
61 095	80 858	**141 953**	41 817	0	80 925	19 211	United States of America
163 371	**125 324**	**288 700**	**43 721**	**88 004**	**123 338**	**33 637**	**North and Central America**

SOUTH AMERICA

Natural Forest Not Available for Wood Supply

(1000 ha)

Undisturbed Forest	Disturbed Forest	Total Forest	Inaccessible Area I	Inaccessible Area II	Inaccessible Area III	Legally protected areas	Country and Region
1 000	22 000	**23 000**	7 000	0	14 200	1 800	Argentina
7 300	22 700	**30 000**	4 000	8 000	13 500	4 500	Bolivia
360 000	118 000	**478 000**	56 800	168 000	229 570	23 630	Brazil
3 800	5 743	**9 543**	1 643	0	4 000	3 900	Chile
39 862	7 000	**46 862**	7 000	24 862	10 000	5 000	Colombia
4 434	3 658	**8 092**	3 000	2 500	612	1 980	Ecuador
5 850	0	**5 850**	1 300	4 400	150	0	French Guiana
12 500	0	**12 500**	5 000	7 440	0	60	Guyana
6 850	3 150	**10 000**	800	0	9 100	100	Paraguay
40 000	10 100	**50 100**	15 000	20 000	12 950	2 150	Peru
12 500	0	**12 500**	1 700	9 500	500	800	Suriname
0	658	**658**	0	0	658	0	Uruguay
22 000	0	**22 000**	4 000	6 000	2 000	10 000	Venezuela
516 096	**193 009**	**709 105**	**107 243**	**250 702**	**297 240**	**53 920**	**South America**
1 060 535	**596 910**	**1 657 450**	**256 087**	**365 109**	**746 270**	**289 984**	**Grand Total:**

Table 2: Summary of average volume, growth and harvesting intensity by region and country

AFRICA

(Volumes pertain to the Forest Available for Wood Supply in m³/ha)

	Standardized Growing Stock			Standardized Commercial Species Growing Stock		
Country and Region	Undisturbed	Disturbed	Diameter Class (cm)	Undisturbed	Disturbed	Diameter Class (cm)
Angola	0	30	*10*	0	11	*10*
Botswana	0	18	*10*	0	3	*10*
Cameroon	262	258	*10*	97	85	*10*
Central African Republic	63	518	*10*	20	193	*10*
Congo, Democratic Republic of	250	167	*10*	133	69	*10*
Congo, Republic of	345	224	*10*	128	172	*10*
Côte d'Ivoire	0	126	*10*	0	74	*10*
Equatorial Guinea	205	160	*10*	65	40	*10*
Gabon	250	210	*10*	85	45	*10*
Ghana	0	122	*10*	0	111	*10*
Guinea	0	55	*10*	0	31	*10*
Guinea-Bissau	109	34	*10*	82	30	*10*
Kenya	0	43	*10*	0	29	*10*
Liberia	170	155	*10*	85	77	*10*
Madagascar	0	80	*10*	0	40	*10*
Malawi	0	15	*10*	0	2	*10*
Morocco	0	60	*10*	0	60	*10*
Mozambique	0	40	*10*	0	11	*10*
Nigeria	0	44	*10*	0	39	*10*
Sierra Leone	0	45	*10*	0	31	*10*
Somalia	0	0	*10*	0	0	*10*
South Africa	0	0	*10*	0	0	*10*
Tanzania, United Republic	30	8	*10*	15	4	*10*
Uganda	0	13	*10*	0	6	*10*
Zambia	0	70	*10*	0	24	*10*
Zimbabwe	0	15	*10*	0	2	*10*
Africa	**227**	**124**	***10***	**105**	**53**	***10***

ASIA

(Volumes pertain to the Forest Available for Wood Supply in m³/ha)

	Standardized Growing Stock			Standardized Commercial Species Growing Stock		
Country and Region	Undisturbed	Disturbed	Diameter Class (cm)	Undisturbed	Disturbed	Diameter Class (cm)
Afghanistan	0	140	*10*	0	130	*10*
Bangladesh	0	0	*10*	0	0	*10*
Bhutan	260	103	*10*	202	76	*10*
Brunei Darussalam	260	130	*10*	200	60	*10*
Cambodia	153	87	*10*	89	86	*10*
China (Mainland)	0	73	*10*	0	70	*10*
India	23	68	*10*	19	49	*10*
Indonesia	144	75	*10*	48	37	*10*
Iran, Islamic Republic of	0	0	*10*	0	0	*10*
Japan	0	119	*10*	0	110	*10*
Korea, DPR	0	80	*10*	0	50	*10*
Korea, Republic of	0	65	*10*	0	40	*10*
Laos	200	130	*10*	140	90	*10*
Malaysia	244	145	*10*	169	118	*10*
Myanmar	146	110	*10*	89	72	*10*
Nepal	92	38	*10*	56	23	*10*
Pakistan	209	127	*10*	209	124	*10*
Philippines	0	128	*10*	0	100	*10*
Sri Lanka	0	0	*10*	0	0	*10*
Thailand	0	0	*10*	0	0	*10*
Turkey	0	114	*10*	0	114	*10*
Viet Nam	0	102	*10*	0	70	*10*
Asia	**151**	**84**		**62**	**65**	

AFRICA

(Volumes pertain to the Forest Available for Wood Supply in m^3/ha)

Gross Annual Increment		Harvesting Intensity			
All Species	Commercial Species	Undisturbed forest	Disturbed Forest	Cutting Cycle Annual or Periodic *(years)*	Country and Region
0.4	0.1	0.0	1.2	*45-60*	Angola
0.2	0.1	0.0	0.5	*60*	Botswana
1.8	0.6	7.0	2.5	*30-50*	Cameroon
2.5	0.8	3.4	7.0	*25-50*	Central African Republic
1.9	0.6	15.0	6.0	*25-50*	Congo, Democratic Republic of
2.5	1.9	7.8	4.6	*40*	Congo, Republic of
1.6	1.5	0.0	9.4	*25-50*	Côte d'Ivoire
2.5	0.8	25.0	12.0	*25*	Equatorial Guinea
2.5	0.8	25.0	12.0	*30*	Gabon
1.4	0.4	0.0	5.3	*40-60*	Ghana
2.0	0.6	0.0	1.8	*25-50*	Guinea
0.5	0.3	4.5	0.8	*25-50*	Guinea-Bissau
0.3	0.2	0.0	3.0	*35-50*	Kenya
2.5	1.3	7.5	3.0	*25*	Liberia
2.5	1.6	0.0	10.0	*30*	Madagascar
0.2	0.0	0.0	0.2	*60*	Malawi
1.0	1.0	0.0	2.0	*50*	Morocco
0.7	0.4	0.0	3.8	*45-60*	Mozambique
0.6	0.5	0.0	3.8	*30-50*	Nigeria
0.7	0.2	0.0	2.2	*25-50*	Sierra Leone
0.0	0.0	0.0	0.0		Somalia
0.0	0.0	0.0	0.0		South Africa
0.3	0.0	1.0	0.3	*25-50*	Tanzania, United Republic
0.3	0.1	0.0	0.7	*25-50*	Uganda
0.5	0.2	0.0	0.8	*40-60*	Zambia
0.2	0.0	0.0	0.5	*80*	Zimbabwe
1.4	**0.5**				**Africa**

ASIA

(Volumes pertain to the Forest Available for Wood Supply in m^3/ha)

Gross Annual Increment		Harvesting Intensity			
All Species	Commercial Species	Undisturbed forest	Disturbed Forest	Cutting Cycle Annual or Periodic *(years)*	Country and Region
0.8	**0.6**	**0.0**	**10.0**	*70*	Afghanistan
0.0	0.0	0.0	0.0	*44105*	Bangladesh
2.1	1.7	77.4	26.5	*40-50*	Bhutan
3.0	2.0	60.0	45.0	*45*	Brunei Darussalam
0.5	0.3	21.6	14.4	*35-40*	Cambodia
2.7	2.5	0.0	15.0		China (Mainland)
0.7	0.4	2.1	19.4	*20-50*	India
1.4	1.0	33.4	15.2	*25-35*	Indonesia
		0.0	0.0		Iran, Islamic Republic of
2.0	1.7	0.0	30.0	*40*	Japan
1.7	1.4	0.0	30.0	*70*	Korea, DPR
1.3	1.0	0.0	15.0	*50*	Korea, Republic of
0.5	0.4	20.0	15.0	*40*	Laos
1.7	1.3	63.0	32.3	*25-60*	Malaysia
1.7	1.0	17.6	12.0	*11232*	Myanmar
0.8	0.5	20.9	8.8	*50-60*	Nepal
1.9	1.8	71.4	34.4	*20-25*	Pakistan
2.1	1.7	0.0	34.9	*35-50*	Philippines
0.0	0.0	0.0	0.0	*30*	Sri Lanka
0.0	0.0	0.0	0.0	*30*	Thailand
3.8	3.8	0.0	0.0	*30*	Turkey
1.9	1.3	0.0	17.6	*22-40*	Viet Nam
1.8	**1.5**				**Asia**

Table 2: Summary of average volume, growth and harvesting intensity by region and country (continued)

OCEANIA

(Volumes pertain to the Forest Available for Wood Supply in m³/ha)

	Standardized Growing Stock			Standardized Commercial Species Growing Stock		
Country and Region	Undisturbed	Disturbed	Diameter Class (cm)	Undisturbed	Disturbed	Diameter Class (cm)
Australia	0	105	*10*	0	88	*10*
Fiji	300	120	*10*	220	100	*10*
New Zealand	250	150	*10*	165	100	*10*
Papua New Guinea	130	80	*10*	80	40	*10*
Solomon Islands	190	110	*10*	120	45	*10*
Vanuatu	120	70	*10*	90	40	*10*
Oceania	**139**	**103**		**87**	**84**	

EUROPE

(Volumes pertain to the Forest Available for Wood Supply in m³/ha)

	Standardized Growing Stock			Standardized Commercial Species Growing Stock		
Country and Region	Undisturbed	Disturbed	Diameter Class (cm)	Undisturbed	Disturbed	Diameter Class (cm)
Albania	0	79	*10*	0	79	*10*
Austria	0	290	*10*	0	290	*10*
Belgium	0	145	*10*	0	145	*10*
Bulgaria	0	126	*10*	0	126	*10*
Croatia	0	151	*10*	0	151	*10*
Czech Republic	0	235	*10*	0	235	*10*
Denmark	0	132	*10*	0	132	*10*
Estonia	0	126	*10*	0	126	*10*
Finland	0	92	*10*	0	92	*10*
France	0	133	*10*	0	133	*10*
Germany	0	275	*10*	0	275	*10*
Greece	0	65	*10*	0	65	*10*
Hungary	0	172	*10*	0	172	*10*
Ireland	0	98	*10*	0	98	*10*
Italy	0	169	*10*	0	169	*10*
Latvia	0	156	*10*	0	156	*10*
Lithuania	0	179	*10*	0	179	*10*
Netherlands	0	175	*10*	0	175	*10*
Norway	0	95	*10*	0	95	*10*
Poland	0	164	*10*	0	164	*10*
Portugal	0	65	*10*	0	65	*10*
Romania	0	222	*10*	0	222	*10*
Slovakia	0	194	*10*	0	194	*10*
Slovenia	0	221	*10*	0	205	*10*
Spain	0	72	*10*	0	72	*10*
Sweden	0	116	*10*	0	116	*10*
Switzerland	0	305	*10*	0	305	*10*
United Kingdom	0	106	*10*	0	106	*10*
Europe	**0**	**142**		**0**	**142**	

FORMER USSR

(Volumes pertain to the Forest Available for Wood Supply in m³/ha)

	Standardized Growing Stock			Standardized Commercial Species Growing Stock		
Country and Region	Undisturbed	Disturbed	Diameter Class (cm)	Undisturbed	Disturbed	Diameter Class (cm)
Russian Federation	111	133	*10*	165	195	*10*
USSR ,former area of	**111**	**133**		**165**	**195**	

OCEANIA

(Volumes pertain to the Forest Available for Wood Supply in m³/ha)

Gross Annual Increment		Harvesting Intensity			
All Species	Commercial Species	Undisturbed forest	Disturbed Forest	Cutting Cycle Annual or Periodic *(years)*	Country and Region
2.5	2.1	0.0	40.0	*40*	Australia
2.0	1.0	40.0	12.0	*35*	Fiji
2.5	2.0	45.0	20.0	*30*	New Zealand
1.0	0.5	30.0	10.0	*35*	Papua New Guinea
1.0	0.6	35.0	5.0	*35*	Solomon Islands
0.8	0.6	20.0	5.0	*35*	Vanuatu
2.4	**1.9**				**Oceania**

EUROPE

(Volumes pertain to the Forest Available for Wood Supply in m³/ha)

Gross Annual Increment		Harvesting Intensity			
All Species	Commercial Species	Undisturbed forest	Disturbed Forest	Cutting Cycle Annual or Periodic *(years)*	Country and Region
1.4	1.4	0.0	2.0	*1*	Albania
9.1	9.1	0.0	6.0	*1*	Austria
7.2	7.2	0.0	5.0	*1*	Belgium
3.3	3.3	0.0	1.0	*1*	Bulgaria
4.4	4.4	0.0	2.0	*1*	Croatia
8.4	7.2	0.0	5.0	*1*	Czech Republic
8.0	7.6	0.0	5.0	*1*	Denmark
4.4	4.4	0.0	2.0	*1*	Estonia
4.3	4.2	0.0	3.0	*1*	Finland
5.3	5.0	0.0	4.0	*1*	France
8.3	8.2	0.0	7.0	*1*	Germany
1.9	1.5	0.0	1.0	*1*	Greece
6.6	5.9	0.0	4.0	*1*	Hungary
10.8	10.8	0.0	5.0	*1*	Ireland
3.1	3.1	0.0	2.0	*1*	Italy
3.1	3.1	0.0	3.0	*1*	Latvia
4.8	4.8	0.0	2.0	*1*	Lithuania
8.3	7.9	0.0	5.0	*1*	Netherlands
3.3	3.1	0.0	2.0	*1*	Norway
4.7	3.6	0.0	3.0	*1*	Poland
4.9	4.9	0.0	5.0	*1*	Portugal
5.9	5.8	0.0	3.0	*1*	Romania
5.8	5.8	0.0	3.0	*1*	Slovakia
5.9	5.9	0.0	0.0	*1*	Slovenia
4.9	4.5	0.0	2.0	*1*	Spain
5.8	4.1	0.0	3.0	*1*	Sweden
5.1	4.9	0.0	6.0	*1*	Switzerland
5.3	5.3	0.0	3.0	*1*	United Kingdom
5.2	**4.7**				**Europe**

FORMER USSR

(Volumes pertain to the Forest Available for Wood Supply in m³/ha)

Gross Annual Increment		Harvesting Intensity			
All Species	Commercial Species	Undisturbed forest	Disturbed Forest	Cutting Cycle Annual or Periodic *(years)*	Country and Region
5.0	3.5	122.3	166.4	*95-124*	Russian Federation
5.0	**3.5**				**USSR ,former area of**

Table 2: Summary of average volume, growth and harvesting intensity by region and country (continued)

NORTH AND CENTRAL AMERICA

(Volumes pertain to the Forest Available for Wood Supply in m^3/ha)

	Standardized Growing Stock			Standardized Commercial Species Growing Stock		
Country and Region	Undisturbed	Disturbed	Diameter Class (cm)	Undisturbed	Disturbed	Diameter Class (cm)
Belize	0	60	*10*	0	40	*10*
Canada	0	115	*10*	0	115	*10*
Costa Rica	0	125	*10*	0	100	*10*
Cuba	0	50	*10*	0	50	*10*
Dominican Republic	0	30	*10*	0	20	*10*
El Salvador	0	0	*10*	0	0	*10*
Guatemala	0	110	*10*	0	60	*10*
Honduras	0	100	*10*	0	60	*10*
Mexico	0	74	*10*	0	63	*10*
Nicaragua	0	115	*10*	0	105	*10*
Panama	0	130	*10*	0	80	*10*
United States of America	0	90	*10*	0	84	*10*
North and Central America	**0**	**100**		**0**	**96**	

SOUTH AMERICA

(Volumes pertain to the Forest Available for Wood Supply in m^3/ha)

	Standardized Growing Stock			Standardized Commercial Species Growing Stock		
Country and Region	Undisturbed	Disturbed	Diameter Class (cm)	Undisturbed	Disturbed	Diameter Class (cm)
Argentina	0	108	*10*	0	75	*10*
Bolivia	150	117	*10*	85	101	*10*
Brazil	147	101	*10*	50	27	*10*
Chile	0	122	*10*	0	122	*10*
Colombia	130	80	*10*	69	50	*10*
Ecuador	160	109	*10*	82	89	*10*
French Guiana	210	170	*10*	72	95	*10*
Guyana	210	170	*10*	72	63	*10*
Paraguay	140	110	*10*	60	75	*10*
Peru	190	160	*10*	100	85	*10*
Suriname	192	210	*10*	48	21	*10*
Uruguay	0	0	*10*	0	0	*10*
Venezuela	160	120	*10*	70	30	*10*
South America	**158**	**116**		**70**	**48**	

NORTH AND CENTRAL AMERICA

(Volumes pertain to the Forest Available for Wood Supply in m^3/ha)

Gross Annual Increment		Harvesting Intensity			
All Species	Commercial Species	Undisturbed forest	Disturbed Forest	Cutting Cycle Annual or Periodic *(years)*	Country and Region
1.0	0.7	0.0	10.0	*40*	Belize
2.4	2.4	0.0	151.4	*50-90*	Canada
2.0	1.5	0.0	50.0	*35*	Costa Rica
1.5	1.2	0.0	15.0	*40*	Cuba
1.5	1.2	0.0	10.0	*40*	Dominican Republic
0.0	0.0	0.0	0.0	*35*	El Salvador
2.5	1.8	0.0	10.0	*25*	Guatemala
2.5	1.8	0.0	10.0	*25*	Honduras
1.5	1.2	0.0	13.5	*40-60*	Mexico
2.5	1.8	0.0	10.0	*30*	Nicaragua
2.5	1.5	0.0	15.0	*25*	Panama
3.2	3.2	0.0	2.4	*1*	United States of America
1.9	**1.5**				**North and Central America**

SOUTH AMERICA

(Volumes pertain to the Forest Available for Wood Supply in m^3/ha)

Gross Annual Increment		Harvesting Intensity			
All Species	Commercial Species	Undisturbed forest	Disturbed Forest	Cutting Cycle Annual or Periodic *(years)*	Country and Region
1.7	1.2	0.0	18.0	*40*	Argentina
4.6	1.4	14.3	13.6	*40-50*	Bolivia
4.8	1.1	20.7	8.7	*30-50*	Brazil
4.0	4.0	0.0	121.9	*60*	Chile
3.0	1.0	25.0	5.0	*30*	Colombia
3.0	0.8	24.9	15.0	*30*	Ecuador
5.0	1.2	7.0	3.0	*40*	French Guiana
5.0	1.2	15.0	7.0	*25*	Guyana
4.0	1.2	20.0	5.0	*40*	Paraguay
2.0	1.0	15.0	15.0		Peru
5.0	1.2	20.0	5.0	*30*	Suriname
0.0	0.0	0.0	0.0		Uruguay
2.0	0.8	20.0	5.0	*40*	Venezuela
3.7	**1.1**				**South America**

Table 3: Summary of total volume and growth by region and country

AFRICA

Volumes pertain to the Forest Available for Wood Supply in 1 000 000 m³

	Standardized Growing Stock				Standardized Commercial Species Growing Stock				Total Annual Growth	
Country and Region	Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	All Species	Commercial Species
Angola	357	0	357	*10*	124	0	124	*10*	4.8	1.0
Botswana	18	0	18	*10*	3	0	3	*10*	0.2	0.1
Cameroon	3 328	1 810	1 519	*10*	1 174	672	502	*10*	10.4	3.2
Central African Republic	1 792	571	1 222	*10*	639	184	455	*10*	5.9	1.9
Congo, Democratic Republic of	12 965	8 050	4 915	*10*	6 314	4 283	2 031	*10*	56.5	17.7
Congo, Republic of	3 374	2 389	986	*10*	1 640	883	757	*10*	11.0	8.2
Côte d'Ivoire	162	0	162	*10*	95	0	95	*10*	2.1	2.0
Equatorial Guinea	190	30	160	*10*	50	10	40	*10*	2.5	0.8
Gabon	2 365	580	1 785	*10*	580	197	383	*10*	21.3	6.8
Ghana	410	0	410	*10*	375	0	375	*10*	4.9	1.5
Guinea	53	0	53	*10*	29	0	29	*10*	1.9	0.6
Guinea-Bissau	16	4	12	*10*	13	3	10	*10*	0.2	0.1
Kenya	19	0	19	*10*	13	0	13	*10*	0.1	0.1
Liberia	406	34	372	*10*	202	17	185	*10*	6.0	3.0
Madagascar	94	0	94	*10*	47	0	47	*10*	2.9	1.9
Malawi	15	0	15	*10*	2	0	2	*10*	0.2	0.0
Morocco	9	0	9	*10*	9	0	9	*10*	0.2	0.2
Mozambique	200	0	200	*10*	55	0	55	*10*	3.4	1.8
Nigeria	345	0	345	*10*	305	0	305	*10*	4.5	4.1
Sierra Leone	15	0	15	*10*	10	0	10	*10*	0.2	0.1
Somalia	0	0	0	*10*	0	0	0	*10*	0.0	0.0
South Africa	0	0	0	*10*	0	0	0	*10*	0.0	0.0
Tanzania, United Republic	128	53	76	*10*	64	26	38	*10*	2.9	0.4
Uganda	19	0	19	*10*	8	0	8	*10*	0.4	0.2
Zambia	510	0	510	*10*	176	0	176	*10*	3.8	1.3
Zimbabwe	8	0	8	*10*	1	0	1	*10*	0.1	0.0
Africa	**26 796**	**13 519**	**13 277**		**11 927**	**6 274**	**5 653**		**146.3**	**56.9**

ASIA

Volumes pertain to the Forest Available for Wood Supply in 1 000 000 m³

	Standardized Growing Stock				Standardized Commercial Species Growing Stock				Total Annual Growth	
Country and Region	Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	All Species	Commercial Species
Afghanistan	42	0	42	*10*	39	0	39	*10*	0.2	0.2
Bangladesh	0	0	0	*10*	0	0	0	*10*	0.0	0.0
Bhutan	198	115	83	*10*	150	89	61	*10*	1.7	1.3
Brunei Darussalam	81	50	30	*10*	53	39	14	*10*	0.7	0.5
Cambodia	504	160	344	*10*	430	93	338	*10*	1.9	1.1
China (Mainland)	4 757	0	4 757	*10*	4 561	0	4 561	*10*	175.9	162.9
India	1 477	4	1 473	*10*	1 079	3	1 075	*10*	15.0	8.8
Indonesia	8 182	5 502	2 681	*10*	3 149	1 834	1 315	*10*	49.9	37.4
Iran, Islamic Republic of	0	0	0	*10*	0	0	0	*10*		
Japan	770	0	770	*10*	711	0	711	*10*	12.9	11.0
Korea, DPR	224	0	224	*10*	140	0	140	*10*	4.8	3.9
Korea, Republic of	143	0	143	*10*	88	0	88	*10*	2.9	2.2
Laos	359	99	260	*10*	249	69	180	*10*	1.0	0.8
Malaysia	1 905	675	1 230	*10*	1 471	468	1 003	*10*	14.6	10.9
Myanmar	2 376	482	1 894	*10*	1 531	294	1 237	*10*	28.6	17.9
Nepal	137	53	85	*10*	84	32	52	*10*	1.8	1.2
Pakistan	171	22	149	*10*	168	22	146	*10*	2.3	2.1
Philippines	282	0	282	*10*	220	0	220	*10*	4.6	3.8
Sri Lanka	0	0	0	*10*	0	0	0	*10*	0.0	0.0
Thailand	0	0	0	*10*	0	0	0	*10*	0.0	0.0
Turkey	752	0	752	*10*	752	0	752	*10*	3.8	3.8
Viet Nam	312	0	312	*10*	213	0	213	*10*	5.7	4.1
Asia	**22 670**	**7 160**	**15 510**		**15 089**	**2 942**	**12 147**		**328.3**	**273.7**

OCEANIA

Volumes pertain to the Forest Available for Wood Supply in 1 000 000 m³

Country and Region	Standardized Growing Stock: Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Standardized Commercial Species Growing Stock: Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Total Annual Growth: All Species	Commercial Species
Australia	1 670	0	1 670	*10*	1400	0	1 400	*10*	39.8	33.4
Fiji	74	62	12	*10*	56	46	10	*10*	0.2	0.1
New Zealand	47	17	30	*10*	31	11	20	*10*	0.5	0.4
Papua New Guinea	1 095	975	120	*10*	660	600	60	*10*	1.5	0.8
Solomon Islands	106	94	11	*10*	64	60	5	*10*	0.1	0.1
Vanuatu	21	17	4	*10*	15	13	2	*10*	0.0	0.0
Oceania	**3 013**	**1 166**	**1 847**		**2 226**	**729**	**1 496**		**42.1**	**34.7**

EUROPE

Volumes pertain to the Forest Available for Wood Supply in 1 000 000 m³

Country and Region	Standardized Growing Stock: Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Standardized Commercial Species Growing Stock: Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Total Annual Growth: All Species	Commercial Species
Albania	72	0	72	*10*	72	0	72	*10*	1.3	1.3
Austria	907	0	907	*10*	907	0	907	*10*	28.6	28.6
Belgium	82	0	82	*10*	82	0	82	*10*	4.1	4.1
Bulgaria	398	0	398	*10*	398	0	398	*10*	10.4	10.4
Croatia	277	0	277	*10*	277	0	277	*10*	8.2	8.2
Czech Republic	458	0	458	*10*	458	0	458	*10*	16.3	14.0
Denmark	53	0	53	*10*	53	0	53	*10*	3.2	3.1
Estonia	228	0	228	*10*	228	0	228	*10*	8.0	8.0
Finland	1 716	0	1 716	*10*	1 716	0	1 716	*10*	79.5	78.0
France	1 689	0	1 689	*10*	1 689	0	1 689	*10*	66.9	63.8
Germany	2 152	0	2 152	*10*	2 152	0	2 152	*10*	64.7	64.1
Greece	149	0	149	*10*	149	0	149	*10*	4.3	3.3
Hungary	280	0	280	*10*	280	0	280	*10*	10.7	9.7
Ireland	31	0	31	*10*	31	0	31	*10*	3.4	3.4
Italy	742	0	742	*10*	742	0	742	*10*	13.6	13.6
Latvia	351	0	351	*10*	351	0	351	*10*	7.0	7.0
Lithuania	288	0	288	*10*	288	0	288	*10*	7.7	7.7
Netherlands	48	0	48	*10*	48	0	48	*10*	2.3	2.2
Norway	631	0	631	*10*	631	0	631	*10*	22.2	20.7
Poland	1 222	0	1 222	*10*	1 222	0	1 222	*10*	35.0	26.7
Portugal	150	0	150	*10*	150	0	150	*10*	11.4	11.3
Romania	1 202	0	1 202	*10*	1 202	0	1 202	*10*	31.9	31.6
Slovakia	249	0	249	*10*	249	0	249	*10*	7.4	7.4
Slovenia	221	0	221	*10*	221	0	221	*10*	6.4	6.4
Spain	355	0	355	*10*	355	0	355	*10*	24.1	22.3
Sweden	2 558	0	2 558	*10*	2 558	0	2 558	*10*	128.8	91.3
Switzerland	326	0	326	*10*	326	0	326	*10*	5.4	5.3
United Kingdom	196	0	196	*10*	196	0	196	*10*	9.8	9.7
Europe	**17 029**	**0**	**17 029**		**17 029**	**0**	**17 029**		**622.5**	**562.9**

FORMER USSR

Volumes pertain to the Forest Available for Wood Supply in 1 000 000 m³

Country and Region	Standardized Growing Stock: Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Standardized Commercial Species Growing Stock: Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Total Annual Growth: All Species	Commercial Species
Russian Federation	59 112	57 319	1 794	*10*	87 371	84 744	2 627	*10*	946.0	946.0
USSR, former area of	**59 112**	**57 319**	**1 794**		**87 371**	**84 744**	**2 627**		**946.0**	**946.0**

Table 3: Summary of total volume and growth by region and country (continued)

NORTH AND CENTRAL AMERICA

Volumes pertain to the Forest Available for Wood Supply in 1 000 000 m³

	Standardized Growing Stock				Standardized Commercial Species Growing Stock				Total Annual Growth	
Country and Region	Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	All Species	Commercial Species
Belize	73	0	73	*10*	49	0	49	*10*	1.2	0.9
Canada	16 946	0	16 946	*10*	16 946	0	16 946	*10*	349.2	349.2
Costa Rica	29	0	29	*10*	23	0	23	*10*	0.5	0.3
Cuba	33	0	33	*10*	26	0	26	*10*	1.0	0.8
Dominican Republic	21	0	21	*10*	14	0	14	*10*	1.1	0.9
El Salvador	0	0	0	*10*	0	0	0	*10*	0.0	0.0
Guatemala	185	0	185	*10*	101	0	101	*10*	4.2	3.0
Honduras	227	0	227	*10*	136	0	136	*10*	5.7	4.1
Mexico	1 340	0	1340	*10*	1 135	0	1 135	*10*	26.3	22.1
Nicaragua	320	0	320	*10*	293	0	293	*10*	7.0	5.0
Panama	111	0	111	*10*	68	0	68	*10*	2.1	1.3
United States of America	13 980	0	13 980	*10*	13 072	0	13 072	*10*	309.7	309.7
North and Central America	**33 265**	**0**	**33 265**		**31 863**	**0**	**31 863**		**707.9**	**697.1**

SOUTH AMERICA

Volumes pertain to the Forest Available for Wood Supply in 1 000 000 m³

	Standardized Growing Stock				Standardized Commercial Species Growing Stock				Total Annual Growth	
Country and Region	Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	Total Forest	Undisturbed Forest	Disturbed Forest	Diameter Class (cm)	All Species	Commercial Species
Argentina	1080	0	1080	*10*	750	0	750	*10*	17.0	12.0
Bolivia	2278	560	1718	*10*	812	211	601	*10*	69.1	20.0
Brazil	7495	2060	5435	*10*	2166	696	1470	*10*	257.0	60.1
Chile	476	24	451	*10*	476	24	451	*10*	14.8	14.8
Colombia	555	195	360	*10*	329	104	225	*10*	13.5	4.5
Ecuador	362	113	249	*10*	263	58	204	*10*	6.8	1.8
French Guiana	412	242	170	*10*	177	83	95	*10*	5.0	1.2
Guyana	1060	210	850	*10*	387	72	315	*10*	25.0	6.0
Paraguay	185	91	94	*10*	103	39	64	*10*	3.4	1.0
Peru	2897	817	2080	*10*	1535	430	1105	*10*	26.0	13.0
Suriname	442	211	231	*10*	76	53	23	*10*	5.5	1.3
Uruguay	0	0	0	*10*	0	0	0	*10*	0.0	0.0
Venezuela	2879	1079	1800	*10*	922	472	450	*10*	30.0	12.0
South America	**20 120**	**5 602**	**14 518**		**7 995**	**2 241**	**5 753**		**473.1**	**147.7**
Grand Total	**182 005**	**84 766**	**97 240**	***10***	**173 499**	**96 931**	**76 567**	***10***	**3 266**	**2 719**

Table 4: Summary of industrial plantations area and growth by species group and country

AFRICA

		Total Plantation Area 1995		Estimated Annual Growth		
		1 000 ha		m^3/ha	1 000 000 m^3	
Country	Species Group	Reported Industrial Plantations	Net Industrial Plantations	Currently Available for Wood Supply	Gross Annual Increment (Delivered to the mill)	Total Annual Growth
Burkina Faso	Populus	8	8	0.4	7.5	0.00
Burkina Faso	Tectona	8	8	0.4	2.3	0.00
Senegal	All Species	160	160	8.0	0.0	0.00
West Sahelian Africa		**176**	**176**	**8.8**	**0.4**	**0.00**
Kenya	Pinus	53	37	1.9	7.5	0.01
Kenya	Conifers (Other)	63	44	2.2	3.8	0.01
Kenya	Eucalyptus	18	13	0.7	15.0	0.01
Kenya	Non-Conifers (Other)	20	14	0.7	3.8	0.00
Sudan	All Species	290	290	14.5	0.0	0.00
East Sahelian Africa		**444**	**398**	**19.9**	**1.7**	**0.03**
Benin	Tectona	10	10	0.5	2.3	0.00
Ghana	Populus	1	1	0.1	15.0	0.00
Ghana	Tectona	10	10	0.5	2.3	0.00
Ghana	Non-Conifers (Other)	3	3	0.2	3.8	0.00
Nigeria	Tectona	43	30	1.5	0.0	0.00
Nigeria	Non-Conifers (Other)	97	68	3.4	0.0	0.00
West Moist Africa		**164**	**122**	**6.1**	**0.6**	**0.00**
Burundi	All Species	132	132	6.6	0.0	0.00
Cameroon	Non-Conifers (Other)	23	16	0.8	3.8	0.00
Rwanda	All Species	125	125	6.3	0.0	0.00
Uganda	Conifers (Other)	4	3	0.2	3.8	0.00
Uganda	Eucalyptus	18	12	0.6	15.0	0.01
Uganda	Pinus	10	7	0.4	11.3	0.00
Central Africa		**312**	**295**	**14.8**	**1.1**	**0.02**
Angola	Eucalyptus	100	100	5.0	3.8	0.02
Malawi	Pinus	71	71	3.6	7.5	0.03
Malawi	Eucalyptus	3	3	0.2	15.0	0.00
Malawi	Conifers (Other)	2	2	0.1	3.8	0.00
Mozambique	All Species	40	40	2.0	0.0	0.00
Tanzania, United Republic	Eucalyptus	4	3	0.2	15.0	0.00
Tanzania, United Republic	Non-Conifers (Other)	3	2	0.1	3.8	0.00
Tanzania, United Republic	Pinus	52	36	1.8	11.3	0.02
Tanzania, United Republic	Tectona	13	9	0.5	2.3	0.00
Tanzania, United Republic	Conifers (Other)	17	12	0.6	11.3	0.01
Zambia	Pinus	43	30	1.5	10.5	0.02
Zambia	Non-Conifers (Other)	1	1	0.1	3.8	0.00
Zambia	Eucalyptus	13	9	0.5	13.5	0.01
Zimbabwe	Eucalyptus	16	16	0.8	15.0	0.01
Zimbabwe	Non-Conifers (Other)	4	4	0.2	3.8	0.00
Zimbabwe	Pinus	71	71	3.6	11.3	0.04
Southern Africa-Tropical		**453**	**409**	**20.5**	**7.5**	**0.15**
Madagascar	All Species	310	310	15.5	0.0	0.00
Insular East Africa		**310**	**310**	**15.5**	**0.0**	**0.00**
Morocco	Pinus	199	140	7.0	5.3	0.04
North Africa		**199**	**140**	**7.0**	**5.3**	**0.04**
South Africa	Pinus	758	758	37.9	11.3	0.43
South Africa	Non-Conifers (Other)	8	8	0.4	3.8	0.00
South Africa	Eucalyptus	557	557	27.9	11.3	0.31
Non-tropical southern Africa		**1 323**	**1 323**	**66.2**	**11.2**	**0.74**
Africa- Total		**3 381**	**3 173**	**158.7**		**1.0**

(plantation estimates – November 1997)

ASIA AND OCEANIA

Country	Species Group	Total Plantation Area 1995 (1 000 ha) Reported Industrial Plantations	Net Industrial Plantations	Currently Available for Wood Supply	Estimated Annual Growth (m³/ha) Gross Annual Increment (Delivered to the mill)	(1 000 000 m³) Total Annual Growth
Bangladesh	Non-Conifers (Other)	29	17	0.9	3.8	0.00
Bangladesh	Tectona	163	100	5.0	2.3	0.01
Bhutan	Tectona	6	6	0.3	2.3	0.00
Bhutan	Eucalyptus	2	2	0.1	11.3	0.00
Bhutan	Pinus	10	10	0.5	7.5	0.00
Bhutan	Populus	10	10	0.5	7.5	0.00
India	Non-Conifers (Other)	3 880	2 716	135.8	3.8	0.51
India	Pinus	35	25	1.3	7.5	0.01
India	Eucalyptus	3 815	2 670	133.5	15.0	2.00
India	Tectona	770	539	27.0	2.3	0.06
Nepal	All Species	80	80	4.0	0.0	0.00
Pakistan	Non-Conifers (Other)	270	189	9.5	3.8	0.04
Pakistan	Conifers (Other)	30	21	1.1	3.8	0.00
Pakistan	Pinus	60	42	2.1	7.5	0.02
Pakistan	Eucalyptus	240	168	8.4	15.0	0.13
Sri Lanka	Non-Conifers (Other)	7	7	0.4	3.8	0.00
Sri Lanka	Pinus	17	17	0.9	11.3	0.01
Sri Lanka	Tectona	16	16	0.8	2.3	0.00
Sri Lanka	Eucalyptus	10	10	0.5	11.3	0.01
South Asia		**9 450**	**6 645**	**332.3**	**8.4**	**2.80**
Myanmar	Tectona	92	64	3.2	3.8	0.01
Myanmar	Pinus	4	3	0.2	12.8	0.00
Myanmar	Non-Conifers (Other)	165	116	5.8	3.8	0.02
Thailand	All Species	756	756	37.8	0.0	0.00
Viet Nam	Eucalyptus	330	202	10.1	0.0	0.00
Viet Nam	Pinus	540	329	16.5	0.0	0.00
Continental Southeast Asia		**1 887**	**1 470**	**73.5**	**0.5**	**0.04**
Indonesia	Tectona	1 107	1 107	55.4	2.3	0.12
Indonesia	Populus	1 417	1 417	70.9	15.0	1.06
Indonesia	Pinus	597	597	29.9	7.5	0.22
Indonesia	Non-Conifers (Other)	4 438	4 438	221.9	2.3	0.50
Indonesia	Acacia	758	758	37.9	15.0	0.57
Malaysia	Acacia	172	172	8.6	15.0	0.13
Malaysia	Non-Conifers (Other)	2 299	2 299	115.0	3.8	0.43
Malaysia	Pinus	5	5	0.3	7.5	0.00
Malaysia	Tectona	2	2	0.1	2.3	0.00
Philippines	Non-Conifers (Other)	133	93	4.7	3.8	0.02
Philippines	Eucalyptus	100	70	3.5	15.0	0.05
Philippines	Pinus	100	70	3.5	11.3	0.04
Philippines	Acacia	150	105	5.3	15.0	0.08
Insular Southeast Asia		**11 278**	**11 133**	**556.7**	**5.8**	**3.23**
China (Mainland)	Conifers (Other)	6 889	4 822	241.1	7.5	1.81
China (Mainland)	Eucalyptus	391	274	13.7	15.0	0.21
China (Mainland)	Non-Conifers (Other)	2 909	2 036	101.8	7.5	0.76
China (Mainland)	Pinus	7 629	5 340	267.0	11.3	3.00
China (Mainland)	Populus	2 468	1 728	86.4	11.3	0.97
Japan	Conifers (Other)	6 996	6 996	349.8	7.5	2.62
Japan	Non-Conifers (Other)	159	159	8.0	2.3	0.02
Japan	Pinus	795	795	39.8	7.5	0.30
Korea, Republic of	Non-Conifers (Other)	1 158	811	40.6	3.8	0.15
Korea, Republic of	Pinus	922	645	32.3	7.5	0.24
Korea, Republic of	Conifers (Other)	1 734	1 214	60.7	7.5	0.46
East Asia		**32 050**	**24 820**	**1 241.0**	**8.5**	**10.54**

Table 4: Summary of industrial plantations area and growth by species group and country (continued)

ASIA AND OCEANIA (continued)

		Total Plantation Area 1995		Estimated Annual Growth		
			1 000 ha		m^3/ha	1 000 000 m^3
Country	Species Group	Reported Industrial Plantations	Net Industrial Plantations	Currently Available for Wood Supply	Gross Annual Increment (Delivered to the mill)	Total Annual Growth
Fiji	Pinus	42	42	2.1	11.3	0.02
Fiji	Non-Conifers (Other)	46	46	2.3	3.8	0.01
Papua New Guinea	All Species	43	43	2.2	0.0	0.00
Tropical Oceania		**131**	**131**	**6.6**	**4.9**	**0.03**
Australia	Eucalyptus	297	297	148.5	7.5	1.11
Australia	Pinus	743	743	371.5	13.5	5.02
Australia	Conifers (Other)	60	60	30.0	12.0	0.36
New Zealand	Pinus	1 338	1 338	669.0	18.0	12.04
New Zealand	Non-Conifers (Other)	41	41	20.5	7.5	0.15
New Zealand	Conifers (Other)	99	99	49.5	15.0	0.74
Temperate Oceania		**2 578**	**2 578**	**1 289.0**	**15.1**	**19.43**
Asia and Oceania		**57 374**	**46 777**	**3 499.0**		**36.07**

NORTH AND CENTRAL AMERICA

		Total Plantation Area 1995		Estimated Annual Growth		
			1 000 ha		m^3/ha	1 000 000 m^3
Country	Species Group	Reported Industrial Plantations	Net Industrial Plantations	Currently Available for Wood Supply	Gross Annual Increment (Delivered to the mill)	Total Annual Growth
Costa Rica	All Species	40	40	2.0	0.0	0.00
Guatemala	All Species	40	40	2.0	0.0	0.00
Mexico	Conifers (Other)	18	15	0.8	0.0	0.00
Mexico	Eucalyptus	44	37	1.9	0.0	0.00
Mexico	Pinus	72	60	3.0	0.0	0.00
Nicaragua	Pinus	15	15	0.8	7.5	0.01
Nicaragua	Eucalyptus	6	6	0.3	11.3	0.00
Nicaragua	Non-Conifers (Other)	2	2	0.1	3.8	0.00
Central America and Mexico		**237**	**215**	**10.8**	**0.9**	**0.01**
Cuba	Pinus	183	154	7.7	0.0	0.00
Cuba	Eucalyptus	70	59	3.0	0.0	0.00
Caribbean		**253**	**213**	**10.7**	**0.0**	**0.00**
North and Central America		**490**	**428**	**21.4**	**0.9**	**0.01**

SOUTH AMERICA

		Total Plantation Area 1995		Estimated Annual Growth		
		1 000 ha		m³/ha	1 000 000 m³	
Country	Species Group	Reported Industrial Plantations	Net Industrial Plantations	Currently Available for Wood Supply	Gross Annual Increment (Delivered to the mill)	Total Annual Growth
Bolivia	All Species	40	40	2.0	0.0	0.00
Brazil	Acacia	124	124	62.0	11.3	0.70
Brazil	Pinus	1 690	1 690	845.0	11.3	9.51
Brazil	Non-Conifers (Other)	119	119	59.5	3.8	0.22
Brazil	Eucalyptus	2 921	2 921	1 460.5	15.0	21.91
Brazil	Conifers (Other)	110	110	55.0	11.3	0.62
Colombia	Eucalyptus	42	35	1.8	0.0	0.00
Colombia	Pinus	118	99	5.0	0.0	0.00
Colombia	Conifers (Other)	27	22	1.1	0.0	0.00
Ecuador	All Species	64	64	3.2	0.0	0.00
Peru	Pinus	14	12	0.6	0.0	0.00
Peru	Non-Conifers (Other)			0.0	15.8	0.00
Venezuela	Eucalyptus	139	117	5.9	0.0	0.00
Venezuela	Pinus	325	273	13.7	0.0	0.00
Tropical South America		**5 733**	**5 626**	**2 515.1**	**13.1**	**32.95**
Argentina	Populus	152	152	7.6	15.0	0.11
Argentina	Pinus	384	384	19.2	18.8	0.36
Argentina	Non-Conifers (Other)	28	28	1.4	3.8	0.01
Argentina	Eucalyptus	242	242	12.1	22.5	0.27
Chile	Eucalyptus	300	300	150.0	18.8	2.81
Chile	Pinus	1 380	1 380	690.0	15.0	10.35
Uruguay	Pinus	44	31	1.6	11.3	0.02
Uruguay	Eucalyptus	251	176	8.8	15.0	0.13
Uruguay	Populus	2	1	0.1	15.0	0.00
Temperate South America		**2 783**	**2 694**	**890.7**	**15.8**	**14.06**
South America		**8 516**	**8 320**	**3 405.8**		**47.02**
Grand Total		**69 761**	**58 698**	**7 085**		**84.09**

Table 5: Summary of alternative fibres - recovered and non-wood by region and country

AFRICA

	Recovered Fibres			Nonwood Fibres		
		1 000 000 MT	1 000 000 m^3		1 000 000 MT	1 000 000 m^3
Country and Subregion	Paper and Paperboard Production	Wastepaper Recovery	Fibre Availability (equivalent volume)	Pulp Production	% Nonwood Used in Total Capacity	Fibre Availability (equivalent volume)
Angola	0.00	0.00	0.00	0.02	0.00	0.00
Botswana	0.00	0.00	0.00	0.00	0.00	0.00
Cameroon	0.01	0.00	0.00	0.00	0.00	0.00
Central African Republic	0.00	0.00	0.00	0.00	0.00	0.00
Congo, Democratic Republic of	0.00	0.00	0.00	0.00	0.00	0.00
Congo, Republic of	0.00	0.00	0.00	0.00	0.00	0.00
Côte d'Ivoire	0.01	0.01	0.02	0.00	0.00	0.00
Equatorial Guinea	0.00	0.00	0.00	0.00	0.00	0.00
Gabon	0.00	0.00	0.00	0.00	0.00	0.00
Ghana	0.00	0.00	0.00	0.00	0.00	0.00
Guinea	0.00	0.00	0.00	0.00	0.00	0.00
Guinea-Bissau	0.00	0.00	0.00	0.00	0.00	0.00
Kenya	0.11	0.04	0.10	0.07	0.00	0.00
Liberia	0.00	0.00	0.00	0.00	0.00	0.00
Madagascar	0.00	0.00	0.00	0.00	0.00	0.00
Malawi	0.00	0.00	0.00	0.00	0.00	0.00
Morocco	0.11	0.03	0.08	0.10	0.00	0.00
Mozambique	0.00	0.01	0.01	0.00	0.00	0.00
Nigeria	0.06	0.01	0.02	0.01	0.00	0.00
Sierra Leone	0.00	0.00	0.00	0.00	0.00	0.00
Somalia	0.00	0.00	0.00	0.00	0.00	0.00
South Africa	1.87	0.59	1.48	1.55	0.10	0.25
Tanzania, United Republic	0.03	0.00	0.00	0.05	0.00	0.00
Uganda	0.00	0.00	0.00	0.00	0.00	0.00
Zambia	0.00	0.00	0.00	0.00	0.00	0.00
Zimbabwe	0.08	0.03	0.07	0.04	0.00	0.00
Total Africa	**2.27**	**0.70**	**1.76**	**1.84**	**0.10**	**0.25**

ASIA

	Recovered Fibres			Nonwood Fibres		
		1 000 000 MT	1 000 000 m^3		1 000 000 MT	1 000 000 m^3
Country and Subregion	Paper and Paperboard Production	Wastepaper Recovery	Fibre Availability (equivalent volume)	Pulp Production	% Nonwood Used in Total Capacity	Fibre Availability (equivalent volume)
Afghanistan	0.00	0.00	0.00	0.00	0.00	0.00
Bangladesh	0.00	0.00	0.00	0.00	0.00	0.00
Bhutan	0.16	0.00	0.00	0.12	0.00	0.00
Brunei Darussalam	0.00	0.00	0.00	0.00	0.00	0.00
Cambodia	0.00	0.00	0.00	0.00	0.00	0.00
China (Mainland)	24.00	8.25	20.62	19.14	15.88	39.70
India	3.03	0.40	1.00	1.87	1.59	3.96
Indonesia	3.88	0.34	0.85	2.25	0.27	0.67
Iran, Islamic Republic of	0.21	0.08	0.20	0.25	0.09	0.23
Japan	29.66	14.84	37.10	10.98	0.00	0.00
Korea, DPR	0.08	0.00	0.00	0.11	0.00	0.00
Korea, Republic of	6.88	2.85	7.13	0.55	0.00	0.00
Laos	0.00	0.00	0.00	0.00	0.00	0.00
Malaysia	0.67	0.10	0.26	0.11	0.00	0.00
Myanmar	0.00	0.00	0.00	0.00	0.00	0.00
Nepal	0.01	0.00	0.00	0.02	0.00	0.00
Pakistan	0.42	0.06	0.14	0.16	0.42	1.04
Philippines	0.61	0.05	0.14	0.15	0.00	0.00
Sri Lanka	0.03	0.02	0.05	0.00	0.00	0.00
Thailand	1.96	0.33	0.82	0.29	0.33	0.82
Turkey	1.24	0.06	0.14	0.35	0.10	0.26
Viet Nam	0.13	0.15	0.37	0.13	0.09	0.23
Asia	**72.95**	**27.52**	**68.79**	**36.49**	**18.76**	**46.90**

OCEANIA

	Recovered Fibres			Nonwood Fibres		
		1 000 000 MT	1 000 000 m³		1 000 000 MT	1 000 000 m³
Country and Subregion	Paper and Paperboard Production	Wastepaper Recovery	Fibre Availability (equivalent volume)	Pulp Production	% Nonwood Used in Total Capacity	Fibre Availability (equivalent volume)
Australia	2.22	1.08	2.70	1.01	0.00	0.00
Fiji	0.00	0.00	0.00	0.00	0.00	0.00
New Zealand	0.90	0.12	0.29	1.41	0.00	0.00
Papua New Guinea	0.00	0.00	0.00	0.00	0.00	0.00
Solomon Islands	0.00	0.00	0.00	0.00	0.00	0.00
Vanuatu	0.00	0.00	0.00	0.00	0.00	0.00
Oceania	**3.13**	**1.20**	**2.99**	**2.42**	**0.00**	**0.00**

EUROPE

	Recovered Fibres			Nonwood Fibres		
		1 000 000 MT	1 000 000 m³		1 000 000 MT	1 000 000 m³
Country and Subregion	Paper and Paperboard Production	Wastepaper Recovery	Fibre Availability (equivalent volume)	Pulp Production	% Nonwood Used in Total Capacity	Fibre Availability (equivalent volume)
Albania	0.04	0.00	0.00	0.02	0.00	0.00
Austria	3.60	0.93	2.33	1.47	0.00	0.00
Belgium	1.09	0.69	1.72	0.38	0.00	0.00
Bulgaria	0.15	0.13	0.32	0.11	0.00	0.00
Croatia	0.21	0.05	0.13	0.12	0.00	0.00
Czech Republic	0.74	0.27	0.66	0.52	0.00	0.00
Denmark	0.35	0.47	1.17	0.18	0.00	0.00
Estonia	0.04	0.01	0.02	0.04	0.00	0.00
Finland	10.94	0.49	1.23	10.09	0.00	0.00
France	8.62	3.70	9.25	2.82	0.00	0.00
Germany	14.83	10.53	26.33	1.95	0.00	0.00
Greece	0.75	0.18	0.44	0.03	0.15	0.39
Hungary	0.32	0.25	0.63	0.03	0.00	0.00
Ireland	0.00	0.17	0.44	0.00	0.00	0.00
Italy	6.80	2.35	5.88	0.61	0.12	0.30
Latvia	0.01	0.03	0.06	0.01	0.00	0.00
Lithuania	0.03	0.02	0.06	0.02	0.00	0.00
Netherlands	2.97	2.31	5.77	0.15	0.00	0.00
Norway	2.26	0.18	0.45	2.42	0.00	0.00
Poland	1.73	0.17	0.42	0.82	0.00	0.00
Portugal	0.98	0.30	0.75	1.63	0.00	0.00
Romania	0.36	0.12	0.29	0.29	0.10	0.26
Slovakia	0.33	0.10	0.25	0.29	0.00	0.00
Slovenia	0.46	0.06	0.16	0.10	0.00	0.00
Spain	3.68	2.12	5.29	1.58	0.14	0.35
Sweden	9.17	1.43	3.57	10.19	0.00	0.00
Switzerland	1.45	0.88	2.19	0.26	0.00	0.00
United Kingdom	6.10	3.68	9.19	0.64	0.00	0.00
Europe	**77.99**	**31.58**	**78.96**	**36.75**	**0.52**	**1.29**

FORMER USSR

	Recovered Fibres			Nonwood Fibres		
		1 000 000 MT	1 000 000 m³		1 000 000 MT	1 000 000 m³
Country and Subregion	Paper and Paperboard Production	Wastepaper Recovery	Fibre Availability (equivalent volume)	Pulp Production	% Nonwood Used in Total Capacity	Fibre Availability (equivalent volume)
Russian Federation	4.07	1.09	2.73	4.89	0.00	0.00
USSR, Former area of	**4.07**	**1.09**	**2.73**	**4.89**	**0.00**	**0.00**

Table 5: Summary of alternative fibres - recovered and non-wood by region and country (continued)

NORTH AND CENTRAL AMERICA

	Recovered Fibres			Nonwood Fibres		
		1 000 000 MT	1 000 000 m^3		1 000 000 MT	1 000 000 m^3
Country and Subregion	Paper and Paperboard Production	Wastepaper Recovery	Fibre Availability (equivalent volume)	Pulp Production	% Nonwood Used in Total Capacity	Fibre Availability (equivalent volume)
Belize	0.00	0.00	0.00	0.00	0.00	0.00
Canada	18.69	2.69	6.74	25.36	0.00	0.00
Costa Rica	0.02	0.01	0.03	0.01	0.00	0.00
Cuba	0.06	0.06	0.15	0.05	0.11	0.27
Dominican Republic	0.01	0.00	0.00	0.00	0.00	0.00
El Salvador	0.02	0.01	0.01	0.00	0.00	0.00
Guatemala	0.03	0.02	0.05	0.00	0.00	0.00
Honduras	0.00	0.05	0.13	0.00	0.00	0.00
Mexico	3.05	0.92	2.30	0.42	0.32	0.81
Nicaragua	0.00	0.00	0.00	0.00	0.00	0.00
Panama	0.03	0.01	0.03	0.00	0.00	0.00
United States of America	89.29	32.19	80.48	66.03	0.19	0.47
North and Central America	**111.19**	**35.96**	**89.90**	**91.87**	**0.62**	**1.55**

SOUTH AMERICA

	Recovered Fibres			Nonwood Fibres		
		1 000 000 MT	1 000 000 m^3		1 000 000 MT	1 000 000 m^3
Country and Subregion	Paper and Paperboard Production	Wastepaper Recovery	Fibre Availability (equivalent volume)	Pulp Production	% Nonwood Used in Total Capacity	Fibre Availability (equivalent volume)
Argentina	1.02	0.46	1.16	0.84	0.14	0.35
Bolivia	0.00	0.00	0.00	0.00	0.00	0.00
Brazil	5.86	1.29	3.22	5.91	0.21	0.53
Chile	0.57	0.14	0.34	2.11	0.00	0.00
Colombia	0.69	0.31	0.79	0.31	0.22	0.55
French Guiana	0.00	0.00	0.00	0.00	0.00	0.00
Guyana	0.00	0.00	0.00	0.00	0.00	0.00
Paraguay	0.00	0.00	0.00	0.00	0.00	0.00
Ecuador	0.08	0.06	0.16	0.00	0.00	0.00
Suriname	0.00	0.00	0.00	0.00	0.00	
Peru	0.14	0.07	0.18	0.05	0.30	0.74
Uruguay	0.09	0.05	0.11	0.03	0.00	0.00
Venezuela	0.74	0.26	0.66	0.17	0.19	0.47
South America	**9.18**	**2.64**	**6.61**	**9.42**	**1.05**	**2.64**
Grand Totals	**280.78**	**100.69**	**251.74**	**183.67**	**21.05**	**52.62**

Table 6: Summary of potential fibre availability by selected region and country

AFRICA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

	Potential Fibre Availability 1996					
Country and Subregion	Forest Undisturbed by Man	Forest Disturbed by Man	Industrial Plantations	Nonwood Fibres	Recovered Fibres	Total
Angola	0.00	1.05	0.06	0.00	0.00	1.11
Botswana	0.00	0.03	0.00	0.00	0.00	0.03
Cameroon	1.61	1.71	0.01	0.00	0.00	3.33
Central African Republic	0.92	0.97	0.00	0.00	0.00	1.89
Congo, Democratic Republic of	19.32	9.35	0.00	0.00	0.00	28.67
Congo, Republic of	1.35	4.29	0.00	0.00	0.00	5.63
Côte d'Ivoire	0.00	0.98	0.00	0.00	0.00	0.98
Equatorial Guinea	0.15	0.40	0.00	0.00	0.00	0.55
Gabon	1.93	3.43	0.00	0.00	0.00	5.36
Ghana	0.00	1.47	0.01	0.00	0.00	1.48
Guinea	0.00	0.58	0.00	0.00	0.00	0.58
Guinea-Bissau	0.01	0.10	0.00	0.00	0.00	0.11
Kenya	0.00	0.08	0.10	0.00	0.10	0.28
Liberia	0.06	3.01	0.00	0.00	0.00	3.07
Madagascar	0.00	0.94	0.00	0.00	0.00	0.94
Malawi	0.00	0.00	0.09	0.00	0.00	0.09
Morocco	0.00	0.08	0.11	0.00	0.08	0.26
Mozambique	0.00	0.92	0.00	0.00	0.00	0.92
Nigeria	0.00	2.07	0.00	0.00	0.02	2.09
Sierra Leone	0.00	0.08	0.00	0.00	0.00	0.08
Somalia	0.00	0.00	0.00	0.00	0.00	0.00
South Africa	0.00	0.00	2.26	0.25	1.51	4.02
Tanzania, United Republic	0.04	0.23	0.09	0.00	0.00	0.35
Uganda	0.00	0.15	0.04	0.00	0.00	0.20
Zambia	0.00	0.63	0.07	0.00	0.00	0.70
Zimbabwe	0.00	0.00	0.16	0.00	0.07	0.23
Africa	**25.38**	**32.54**	**3.00**	**0.25**	**1.77**	**62.95**

ASIA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

	Potential Fibre Availability 1996					
Country and Subregion	Forest Undisturbed by Man	Forest Disturbed by Man	Industrial Plantations	Nonwood Fibres	Recovered Fibres	Total
Afghanistan	0.00	0.18	0.00	0.00	0.00	0.18
Bangladesh	0.00	0.00	0.06	0.00	0.00	0.06
Bhutan	0.77	1.34	0.03	0.00	0.00	2.14
Brunei Darussalam	0.26	0.48	0.00	0.00	0.00	0.73
Cambodia	0.65	1.10	0.00	0.00	0.00	1.75
China (Mainland)	0.00	162.90	20.44	38.51	21.68	243.53
India	0.02	8.77	8.32	4.21	1.05	22.36
Indonesia	32.10	38.39	7.50	0.59	0.90	79.49
Iran, Islamic Republic of	0.00	0.00	0.00	0.25	0.21	0.46
Japan	0.00	11.00	8.90	0.00	38.07	57.96
Korea, DPR	0.00	3.92	0.00	0.00	0.00	3.92
Korea, Republic of	0.00	2.20	2.57	0.00	7.48	12.25
Laos	0.25	0.80	0.00	0.00	0.00	1.05
Malaysia	6.26	11.08	1.70	0.00	0.27	19.31
Myanmar	1.94	17.94	0.11	0.00	0.00	19.99
Nepal	0.23	1.16	0.00	0.00	0.00	1.39
Pakistan	0.29	2.10	0.59	1.04	0.15	4.17
Philippines	0.00	3.80	0.59	0.00	0.14	4.53
Sri Lanka	0.00	0.00	0.06	0.00	0.05	0.11
Thailand	0.00	0.00	0.00	0.88	0.86	1.74
Turkey	0.00	0.00	0.00	0.25	0.15	0.40
Viet Nam	0.00	4.11	0.53	0.25	0.23	5.12
Asia	**42.76**	**271.27**	**51.40**	**45.98**	**71.24**	**482.65**

AFRICA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

Potential Fibre Availability 2010			Potential Fibre Availability 2050			
Future 1	Future 2	Future 3	Future 1	Future 2	Future 3	Country and Subregion
1.18	1.19	1.22	0.90	0.80	1.15	Angola
0.02	0.02	0.02	0.02	0.02	0.02	Botswana
4.12	5.77	4.89	2.75	2.10	3.60	Cameroon
2.06	2.61	2.49	1.28	1.04	1.52	Central African Republic
31.38	39.10	41.17	13.66	10.35	17.68	Congo, Democratic Republic of
7.73	10.48	8.22	9.24	8.30	10.15	Congo, Republic of
0.91	0.93	0.89	0.73	0.57	0.83	Côte d'Ivoire
0.53	0.54	0.61	0.34	0.26	0.39	Equatorial Guinea
5.33	6.42	6.27	3.19	2.49	3.78	Gabon
1.27	1.26	1.28	0.78	0.46	1.10	Ghana
0.49	0.48	0.50	0.31	0.17	0.44	Guinea
0.11	0.12	0.12	0.09	0.08	0.11	Guinea-Bissau
0.72	0.76	0.76	0.81	0.98	1.05	Kenya
2.95	3.02	3.02	2.34	1.75	2.80	Liberia
0.83	0.82	0.85	0.60	0.39	0.76	Madagascar
0.43	0.48	0.45	0.47	0.70	0.52	Malawi
0.69	0.74	0.73	0.75	0.98	0.91	Morocco
0.84	0.82	0.85	0.64	0.45	0.78	Mozambique
1.87	1.85	1.89	1.34	0.86	1.73	Nigeria
0.05	0.05	0.06	0.02	0.00	0.04	Sierra Leone
0.00	0.00	0.00	0.00	0.00	0.00	Somalia
13.08	13.97	13.75	15.28	19.56	19.27	South Africa
0.68	0.74	0.70	0.63	0.82	0.72	Tanzania, United Republic
0.33	0.36	0.34	0.31	0.38	0.36	Uganda
0.89	0.91	0.91	0.76	0.79	0.91	Zambia
0.86	0.94	0.90	0.98	1.32	1.19	Zimbabwe
79.38	**94.38**	**92.87**	**58.22**	**55.62**	**71.83**	**Africa**

ASIA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

Potential Fibre Availability 2010			Potential Fibre Availability 2050			
Future 1	Future 2	Future 3	Future 1	Future 2	Future 3	Country and Subregion
0.07	0.05	0.08	0.00	0.00	0.03	Afghanistan
0.21	0.24	0.22	0.23	0.35	0.25	Bangladesh
2.36	2.76	2.58	1.80	1.61	2.04	Bhutan
0.77	0.90	0.85	0.53	0.38	0.69	Brunei Darussalam
1.43	1.60	1.66	0.52	0.24	0.89	Cambodia
303.32	309.41	311.44	312.57	340.39	363.61	China (Mainland)
56.81	60.91	58.13	78.81	94.47	89.98	India
111.03	133.72	123.33	79.33	84.03	103.80	Indonesia
1.07	0.97	1.18	3.99	2.85	5.50	Iran, Islamic Republic of
105.70	100.49	117.10	131.93	113.77	166.34	Japan
3.92	3.99	3.85	3.92	3.99	3.85	Korea, DPR
27.14	26.12	29.95	29.84	28.53	41.10	Korea, Republic of
0.94	1.01	1.04	0.48	0.27	0.73	Laos
21.09	19.64	22.40	12.76	14.71	18.59	Malaysia
17.56	18.15	18.91	9.73	5.41	14.90	Myanmar
1.24	1.28	1.32	0.70	0.39	1.03	Nepal
4.90	5.15	4.97	3.73	4.68	4.98	Pakistan
5.28	5.35	5.62	3.84	4.72	5.47	Philippines
0.35	0.37	0.37	0.39	0.48	0.43	Sri Lanka
3.35	3.01	3.68	7.79	5.97	10.53	Thailand
0.23	0.23	0.58	0.58	0.43	0.86	Turkey
6.90	7.06	7.10	7.39	7.24	9.28	Viet Nam
675.65	**702.42**	**716.36**	**690.87**	**714.89**	**844.92**	**Asia**

Table 6: Summary of potential fibre availability by selected region and country (continued)

OCEANIA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

	Potential Fibre Availability 1996					
Country and Subregion	Forest Undisturbed by Man	Forest Disturbed by Man	Industrial Plantations	Nonwood Fibres	Recovered Fibres	Total
Australia	0.00	33.40	7.01	0.00	2.76	43.18
Fiji	0.24	0.11	0.10	0.00	0.00	0.44
New Zealand	0.10	0.40	14.43	0.00	0.29	15.23
Papua New Guinea	6.43	0.86	0.00	0.00	0.00	7.29
Solomon Islands	0.50	0.07	0.00	0.00	0.00	0.57
Vanuatu	0.08	0.03	0.00	0.00	0.00	0.11
Oceania	**7.34**	**34.87**	**21.54**	**0.00**	**3.06**	**66.81**

FORMER USSR

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

	Potential Fibre Availability 1996					
Country and Subregion	Forest Undisturbed by Man	Forest Disturbed by Man	Industrial Plantations	Nonwood Fibres	Recovered Fibres	Total
Russian Federation	556.90	116.88	0.00	0.00	2.73	676.51
USSR, former area of	**556.90**	**116.88**	**0.00**	**0.00**	**2.73**	**676.51**

NORTH AND CENTRAL AMERICA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

	Potential Fibre Availability 1996					
Country and Subregion	Forest Undisturbed by Man	Forest Disturbed by Man	Industrial Plantations	Nonwood Fibres	Recovered Fibres	Total
Belize	0.00	0.85	0.00	0.00	0.00	0.85
Costa Rica	0.00	0.35	0.00	0.00	0.03	0.37
Cuba	0.00	0.79	0.00	0.27	0.10	1.16
Dominican Republic	0.00	0.86	0.00	0.00	0.00	0.86
El Salvador	0.00	0.00	0.00	0.00	0.01	0.01
Guatemala	0.00	3.03	0.00	0.00	0.05	3.07
Honduras	0.00	4.08	0.00	0.00	0.00	4.08
Mexico	0.00	22.05	0.00	0.76	2.35	25.16
Nicaragua	0.00	5.01	0.03	0.00	0.00	5.04
Panama	0.00	1.28	0.00	0.00	0.03	1.30
North and Central America (excluding Canada and the United States of America)	**0.00**	**38.30**	**0.03**	**1.03**	**2.57**	**41.92**

OCEANIA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

Potential Fibre Availability 2010			Potential Fibre Availability 2050			
Future 1	Future 2	Future 3	Future 1	Future 2	Future 3	Country and Subregion
47.30	48.33	47.72	49.94	53.03	52.39	Australia
0.87	1.10	0.97	0.74	0.95	0.83	Fiji
21.01	23.40	21.62	21.82	31.86	24.42	New Zealand
8.22	12.25	10.71	3.32	2.82	3.94	Papua New Guinea
0.66	1.00	0.86	0.31	0.28	0.34	Solomon Islands
0.12	0.18	0.16	0.05	0.04	0.86	Vanuatu
78.18	**86.26**	**82.03**	**76.18**	**88.98**	**82.78**	**Oceania**

FORMER USSR

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

Potential Fibre Availability 2010			Potential Fibre Availability 2050			
Future 1	Future 2	Future 3	Future 1	Future 2	Future 3	Country and Subregion
928.07	1044.76	981.26	1646.82	1923.41	1702.49	Russian Federation
928.07	**1044.76**	**981.26**	**1646.82**	**1923.41**	**1702.49**	**USSR, former area of**

NORTH AND CENTRAL AMERICA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

Potential Fibre Availability 2010			Potential Fibre Availability 2050			
Future 1	Future 2	Future 3	Future 1	Future 2	Future 3	Country and Subregion
0.81	0.81	0.81	0.71	0.61	0.78	Belize
0.26	0.25	0.27	0.12	0.04	0.22	Costa Rica
1.04	1.02	1.05	0.77	0.55	0.95	Cuba
0.69	0.67	0.70	0.36	0.16	0.57	Dominican Republic
0.01	0.01	0.02	0.02	0.01	0.03	El Salvador
2.32	2.23	2.41	1.05	0.37	1.88	Guatemala
2.94	2.80	3.09	1.15	0.34	2.31	Honduras
23.32	22.21	24.43	18.95	11.33	27.56	Mexico
3.65	3.47	3.86	1.42	0.56	2.87	Nicaragua
0.98	0.96	1.00	0.45	0.16	0.83	Panama
						North and Central America
						(excluding Canada
36.02	**34.44**	**37.65**	**25.01**	**14.13**	**38.00**	**and the United States of America)**

Table 6: Summary of potential fibre availability by selected region and country (continued)

SOUTH AMERICA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

	Potential Fibre Availability 1996					
Country and Subregion	Forest Undisturbed by Man	Forest Disturbed by Man	Industrial Plantations	Nonwood Fibres	Recovered Fibres	Total
Argentina	0.00	12.00	2.30	0.33	1.18	15.81
Bolivia	3.84	7.54	0.00	0.00	0.00	11.38
Brazil	9.67	30.32	36.58	0.55	3.31	80.42
Chile	0.00	5.60	14.45	0.00	0.35	20.40
Colombia	1.25	4.55	0.00	0.53	0.81	7.14
Ecuador	0.59	1.82	0.00	0.00	0.15	2.57
French Guiana	0.20	1.23	0.00	0.00	0.00	1.44
Guyana	0.60	6.05	0.00	0.00	0.00	6.65
Paraguay	0.33	1.04	0.00	0.00	0.00	1.36
Peru	2.15	13.14	0.00	0.85	0.18	16.32
Suriname	0.73	1.36	0.00	0.00	0.00	2.10
Uruguay	0.00	0.00	0.45	0.00	0.12	0.57
Venezuela	3.37	12.13	0.00	0.44	0.67	16.62
South America	**22.72**	**96.79**	**53.78**	**2.70**	**6.77**	**182.76**
Grand Totals (excludes Europe, Canada and United States of America)	**655.11**	**590.66**	**129.75**	**49.95**	**88.13**	**1513.60**

SOUTH AMERICA

(Volumes pertain to Forest Available for Wood Supply 1 000 000 m³)

Potential Fibre Availability 2010			Potential Fibre Availability 2050			
Future 1	Future 2	Future 3	Future 1	Future 2	Future 3	Country and Subregion
24.12	25.13	24.98	25.01	28.46	28.26	Argentina
13.35	17.22	14.85	7.98	4.34	14.39	Bolivia
96.95	109.04	103.91	89.21	106.30	105.20	Brazil
26.16	28.42	26.83	26.33	35.71	29.61	Chile
7.34	8.27	8.11	6.18	4.39	7.80	Colombia
2.29	2.45	2.55	1.16	0.53	1.80	Ecuador
1.92	2.50	1.98	2.56	2.55	2.57	French Guiana
7.27	8.12	7.67	7.01	6.85	7.11	Guyana
1.04	1.08	1.20	0.24	0.06	0.77	Paraguay
18.92	21.51	20.23	20.82	16.88	24.87	Peru
2.67	3.67	3.03	2.49	2.41	2.57	Suriname
2.36	2.59	2.45	2.63	3.70	2.94	Uruguay
15.62	17.18	16.98	9.73	5.49	15.09	Venezuela
220.01	**247.18**	**234.78**	**201.35**	**217.67**	**242.99**	**South America**
2 017.31	**2 209.44**	**2 144.95**	**2 698.45**	**3 014.70**	**2 983.01**	**Grand Totals (excludes Europe, Canada and United States of America)**

Major definitions

INDEX


4 AII Annex II Major Definitions

MAJOR DEFINITIONS USED IN THE GLOBAL FIBRE SUPPLY STUDY (GFSS)

1. LAND CLASSIFICATION

1.1 TOTAL AREA

Total area of country, including area of inland water bodies.

Excludes: offshore territorial waters

1.1.1 Inland water

Area occupied by major rivers, lakes and reservoirs.

1.1.2 Land area

Total area, excluding inland water.

1.2 OTHER LAND

Land not classified as forest or other wooded land as they are defined in this study.

1.3 FOREST AND OTHER WOODED LAND

1.3.1 Forest

Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity *in situ*.

May consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground; or of open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent. Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 10 percent or tree height of 5 m are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest.

Includes: forest nurseries and seed orchards that constitute an integral part of the forest; forest roads, cleared tracts, firebreaks and other small open areas within the forest; forest in national parks, nature reserves and other protected areas such as those of special environmental, scientific, historical, cultural or spiritual interest; windbreaks and shelterbelts of trees with an area of more than 0.5 ha and width of more than 20 m. Rubberwood

plantations and cork oak stands are included.

Excludes: land predominantly used for agricultural practices.

It is worthwhile pointing out that the definition of forest used in the present study has a minimum vegetation cover requirement and is quite different from a legal definition of forest (i.e. an area proclaimed to be forest under a Forest Act or Ordinance).

1.3.1.1 Natural forest

Forest which are not plantation(s). Natural forest can be:

1.3.1.1.1 Forest undisturbed by man

Forest which shows natural forest dynamics, such as natural tree composition, occurrence of dead wood, natural age structure and natural regeneration processes, the area of which is large enough to maintain its natural characteristics and where there has been no known significant human intervention or where the last significant human intervention was long enough ago to have allowed the natural species composition and processes to have become re-established.

1.3.1.1.2 Forest disturbed by man (or semi-natural forest)

Forest which is neither “forest undisturbed by man” nor “plantation” as defined separately.

1.3.1.2 Plantation(s)

Forest stands established by planting or/and seeding in the process of afforestation or reforestation. They are either:

of introduced species (all planted stands), or

intensively managed stands of indigenous species which meet all the following criteria: one or two species at plantation, even age class, regular spacing.

Excludes: Stands which were established as plantations but which have been without intensive management for a significant period of time. These should be considered semi-natural.

1.3.2 Other wooded land

Land either with a tree crown cover (or equivalent stocking level) of 5-10 percent of trees able to reach a height of at least 5 m at maturity *in situ*; or crown cover (or equivalent stocking level) of more than 10 percent of trees not able to reach a height of 5 m at maturity *in situ* (e.g. dwarf or stunted trees) and shrub or bush cover.

Excludes: areas having the tree, shrub or bush cover specified above but of less than 0.5 ha and width of 20 m, which are classed under “other land”; land predominantly used for agricultural practices.

1.3.2.1 Other wooded land undisturbed by man

Other wooded land which shows natural forest dynamics, such as natural tree composition, occurrence of dead wood, natural age structure and natural regeneration processes, the area of which is large enough to maintain its natural characteristics and where there has been no known significant human intervention or where the last significant human intervention was long enough ago to have allowed the natural species composition and processes to have become re-established.

1.3.2.2 Other wooded land disturbed by man

Other wooded land which is neither “other wooded land undisturbed by man” nor “plantation” as defined separately.

2. FOREST CLASSIFICATION SYSTEM

For the purpose of the present study it has been decided to use the country’s own forest classes as much as possible. The advantage of this approach is that country experts can readily understand our data description and can readily evaluate our estimates. We also anticipate that many countries will continue to maintain their forest inventories using these classes, or at the very least some link to these classes**.**

Countries can classify forests by geographic location, by forest type, or some combinations of these elements. However, where no such classes were available, closed and open forest definitions as developed for the 1980 FAO Tropical Forest Resources Assessment were used. Examples of the classification systems used by the countries and in the GFSS are presented in 2.1, Country classes. Each forest class can also be further subdivided in species groups. The definitions of these groups are presented in 2.2, Species Groups.

2.1 COUNTRY CLASSES

2.1.1 Geographical location

Geographical systems usually refer to the location or the altitude where the forests occur (montane forest, lowland, etc.). An example for a geographical classification is Colombia. Publications that report forestry related data on a national level usually refer to *Pacifico*, *Andina*, *Caribe*, *Orinoquia* and *Amazonia*. Another example is the Republic of Congo, where data is reported according to the major geographical regions: *North*, *Chaillu*, *Kouilou-Mayombe*.

2.1.2 Forest type

Forest type classification systems used by countries usually refer to the forest formation (high forest, shrubs), to the climatic or edaphic conditions under which the forest is growing, to the species composition, to the quality of the timber and to many other factors (harvesting status, etc.).

Examples for such types are: deciduous thornbush, evergreen bushland and thicket, rainforest, swamp forest, etc. Frequently other factors such as the logging status or the timber density and quality become used in the classes. A typical example for such a system is Malaysia, which uses, for example, mixed dipterocarp forest superior, good, medium, poor, and commercial forest superior, good, poor, etc. Frequently forest types are combined with geographical classes.

2.1.3 Closed/open

2.1.3.1 Closed forest

Closed forests are vegetation formations where trees occur in single or multiple stories with crowns interlocking, which, in conjunction with the undergrowth, cover a high proportion of the ground and consequently do not have a continuous dense grass layer at the ground level. They are either managed or unmanaged forests, primary or in advanced state of succession and may have been logged over one or more times, having kept their characteristics of forest stands, possibly with modified structure and composition.

2.1.3.2 Open forest

Open forests are vegetation formations where trees occur with discontinuous, non-interlocking crowns, but with a crown coverage of at least 10 percent. Generally there is a continuous grass layer allowing grazing and spreading of fires. Examples are various form of “cerrado” and “chaco” in Latin America, tree and wooded savannas, and wooded lands in Africa, dry dipterocarp forests and “forêts claires” in Asia.

The division between closed and open forests is more of ecological than of physiognomic nature, not characterized only by a crown cover percentage. A dense forest after logging may look as open forest from crown cover point of view alone; however, it cannot be classified as open forest unless there are some permanent changes in flora, fauna and soil condition due to repeated fire, grazing, etc., which keep the forest in a sub-climax stage.

2.2 SPECIES GROUPS

2.2.1 Predominantly coniferous forest/other wooded land

Forest land on which more than 75 percent of the tree crown cover consists of species classified botanically as *Gymnospermae*. They are sometimes referred to as “softwoods”.

2.2.2 Predominantly broadleaved forest/other wooded land

Forest land on which more than 75 percent of the tree crown cover consists of trees classified botanically as *Angiospermae*. They are sometimes referred to as “non-coniferous” or “hardwoods”.

2.2.3 Predominantly bamboos, palms, etc.

Forest/other wooded land on which more than 75 percent of the crown cover consists of tree species other than coniferous or broadleaved species (e.g. tree-form members of the bamboo, palm, fern families).

2.2.4 Mixed forest/other wooded land

Forest/other wooded land on which neither coniferous, nor broadleaved, nor palms, bamboos, etc., account for more than 75 percent of the tree crown area.

3. FOREST FUNCTION

Forest function is defined with reference to the forest land capability to support land uses like nature conservation, soil and water protection, wood production, etc. For the present study two main classes are defined:

3.1 FOREST AVAILABLE FOR WOOD SUPPLY

Forest where any legal, economic, or specific environmental restrictions (see 3.2.2) do not have a significant impact on the supply of wood

Includes: areas where, although there are no such restrictions, harvesting is not taking place, for example areas included in long-term utilization plans or intentions.

3.2 FOREST NOT AVAILABLE FOR WOOD SUPPLY

Forest where legal or economic restrictions prevent any significant supply of wood.

Includes:

3.2.1 Legal restrictions

Forest with legal restrictions or restrictions resulting from other political decisions, which totally exclude or severely limit wood supply, *inter alia* for reasons of environmental or biodiversity conservation, e.g. protection forest, national parks, nature reserves and other protected areas, such as those of special environmental, scientific, historical, cultural or spiritual interest.

Area under IUCN management categories I or II is considered as protected from wood harvesting (for IUCN management categories see 12).

3.2.2 Economic restrictions

Forest with economic restrictions due to environmental, physical or wood quality factors, e.g. environmental regulation on harvesting systems, steep terrain; terrain dominated by swamps and/or rocks interspersed with some commercial trees; deformed growth of individual trees; and fire, insect and/or disease damaged forests. All restrictions other than legal restrictions can be summarized as economic restrictions. For the purpose of the GFSS, they are subdivided in three classes:

3.2.2.1 Physical reasons (I)

Harvesting is economically unfeasible at the current wood price level because the terrain conditions require extraordinary equipment or time.

3.2.2.2 Transport distance/lack of infrastructure (II)

Remote forests where transport distance for logs or products is too high or where access is currently not provided. The situation can change if, for instance, the government or the industry invests in infrastructure.

3.2.2.3 Other (III)

E.g. low growing stock volume, wood quality too low, no commercial species.

4. OWNERSHIP

Three classes of ownership are distinguished:

4.1 PUBLIC

Forest/other wooded land belonging to the state or other public bodies.

4.1.1 State

Forest/other wooded land owned by national, state and regional governments, or by government-owned corporations; crown forest and other wooded land.

4.1.2 Other public

Forest/other wooded land belonging to cities, municipalities, villages and communes.

Includes: any publicly owned forest and other wooded land not classified as being “in state ownership”.

4.2 INDIGENOUS AND TRIBAL PEOPLES

Indigenous and tribal peoples in independent countries are defined as those who:

(1) are regarded as indigenous on account of their descent from the populations which inhabited the country, or a geographical region to which the country belongs, at a time of conquest or colonization or the establishment of present state boundaries and who, irrespective of their legal status, retain some or all of their own social, economic, cultural and political institutions;

(2) are tribal peoples whose social, cultural and economic conditions distinguish them from other sections of the national community, and whose status is regulated wholly or partly by their own customs or traditions or by special laws and regulations.

For both categories (1) and (2) self-identification as indigenous or tribal shall be regarded as the fundamental criterion for determining the groups. (Source: ILO Convention No. 169 on “indigenous and tribal peoples”).

For the purpose of the Global Fibre Supply Study this data is collected under “private ownership”.

4.3 PRIVATE

Forest/other wooded land owned by individuals, families, cooperatives and corporations which may be engaged in agriculture or other occupations as well as forestry; private forest enterprises and industries; private corporations and other institutions (religious and educational institutions, pension and investment funds, nature conservation societies, etc.).

4.3.1 Individuals

Forest and other wooded land owned by individuals or families, including those who have formed themselves into companies.

Includes: individuals and families who combine forestry with agriculture (farm forests), those who live in or near their forest holdings, and those who live elsewhere (absentee owners).

4.3.2 Other private institutions

Forest/other wooded land owned by private corporations, cooperatives or institutions (religious, educational, pension or investment funds, nature conservation societies, etc.).

5. DEFORESTATION AND DEGRADATION

5.1 DEFORESTATION

Deforestation refers to change of land use with depletion of tree crown cover to less than 10 percent. 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.

5.2 DEGRADATION

Forest degradation takes different forms, particularly in open formations, deriving mainly from human activities such as overgrazing, overexploitation (for firewood in particular), repeated fires, or due to attacks by insects, diseases, plant parasites or other natural sources such as cyclones. In most cases degradation does not show up so much as a decrease in the area of woody vegetation but rather as a gradual reduction of biomass, changes in species composition and soil degradation. The logging of forests for sawlogs and veneer logs without a proper management plan can contribute to degradation if the extraction of mature trees is not accompanied with their regeneration or if the use of heavy machinery causes soil compaction or loss of productive forest area.

6. PLANTATION

6.1 FOREST PLANTATIONS

Forest stands established by planting or/and seeding in the process of afforestation or reforestation. They are either:

of introduced species (all planted stands), or

intensively managed stands of indigenous species which meet all the following criteria: one or two species at plantation, even-age class, regular spacing.

6.1.1 Industrial forest plantations

Forest plantations grown mainly for the production of industrial roundwood (sawtimber, veneer, pulp, reconstituted wood). Note that industrial roundwood may also come from non-forest plantations and trees grown outside the forest.

6.1.2 Non-industrial plantations

Planted trees established mainly for domestic use or for use in non-forest industries, including fuelwood and poles, non-wood forest products and for service functions such as protection. Non-industrial tree plantations are assumed not to make a significant contribution to industrial roundwood supplies and thus data referring to these plantations (where they can be identified) are not used as inputs to the GFSS.

6.1.3 Indigenous tree species

Tree species which have evolved in the same area, region or biotope where the forest stand is growing and are adapted to the specific ecological conditions predominant at the time of the establishment of the stand. May also be termed native species or autochthonous species.

6.1.4 Introduced tree species

Tree species occurring outside their natural vegetation zone, area or region. May also be termed non-indigenous species.

Includes: Hybrids

6.2 TREES OUTSIDE THE FOREST

Trees on land other than forest or other wooded land.

Includes: Trees on land that meets the definitions of forest and of other wooded land except that the area is less than 0.5 ha and the width is less than 20 m; scattered trees in permanent meadows and pastures; permanent tree crops such as fruit tree orchards and coconut palm plantations; trees in parks and gardens, around buildings, in hedgerows and in lines along streets, roads, railways, rivers, streams and canals; trees in shelterbelts and windbreaks of less than 20 m in width and 0.5 ha in area.

6.3 PLANTATION AREA

6.3.1 Reported area

The plantation area reported to be present, either by government, industry, or some outside source. Normally this refers to the area planted or planned, but does not take into account the area actually stocked.

6.3.2 Net area

The reported area reduced by a factor to allow for plantation area losses due to failed plantation areas, fire, etc. In the absence of any specific information or opinion a default value of 0.7 reduction has been used (taken from FAO Forestry Paper #128).

7. FOREST VOLUME AND GROWTH

7.1 BIOMASS

7.1.1 Tree

A woody perennial with a single main stem or, in the case of coppice, with several stems, having a more or less definite crown.

Includes: bamboos, palms and other woody plants meeting the above criterion.

7.1.2 Shrubs and bushes

Woody perennial plants, generally of more than 0.5 m and less than 5 m height, and often without a definite stem and crown.

7.1.3 Woody biomass

The mass of the woody parts (wood, bark, branches, twigs, stumps and roots) of trees, alive and dead, shrubs and bushes, measured to a minimum diameter of 0 mm (dbh).

Includes: Above-stump woody biomass, and stumps and roots.

Excludes: Foliage.

7.1.4 Above-stump woody biomass (tons/ha)

The mass of the woody part (stem, bark, branches, twigs) of trees, alive or dead, shrubs and bushes, excluding stumps and roots

7.1.5 Stumps and roots

Parts of the whole tree volume, which exclude the volume of the above-stump woody biomass. The height of the stump is taken to be that at which the tree would be cut under normal felling practices in that country or region.

Excludes: Small roots.

7.2 VOLUMES

7.2.1 Growing stock (m^3/ha)

Living volume of standing trees, above-stump measured overbark to top. Includes all trees with diameter over a reported reference diameter (diameter at breast height, dbh).

Excludes: branches.

7.2.2 Commercial growing stock (m^3/ha)

Part of the growing stock, that consists of species considered as actually or potentially commercial under current (1995) market conditions, at the reported reference diameter (dbh). Can be identical to the growing stock, but can also be much smaller if only very few species are merchantable or greater if the forest available for supply consists of high volume stands only.

Includes: species which are currently not exported, but potentially commercial having appropriate technological properties; species provided to the local market are included.

7.2.3 Reference diameter [cm]

Inventory diameter at breast height used for determining the growing stock and commercial growing stock. Volumes can be converted to different reference diameters, using conversion factors as presented in 8.1.

7.3 GROWTH

7.3.1 Gross annual increment (mean annual increment) (m^3/ha)

Average annual volume of increment over the reference period of all trees, measured to a minimum diameter breast height (dbh) of 0 centimetres (cm).

7.3.2 Natural losses (m^3/ha)

Average annual losses to the growing stock during the given reference period, measured to a minimum diameter of 0 cm (dbh), due to mortality from causes other than cutting by man, e.g. natural mortality, diseases, insect attacks, fire, windthrow or other physical damage.

7.3.3 Net annual increment (m^3/ha)

Average annual volume over the given reference period of gross increment less that of natural losses on all trees to a minimum diameter of 0 cm (dbh).

7.4 AGE

7.4.1 Cutting cycle (years)

The silvicultural/harvesting cycle chosen for the sustainable harvest of timber. It is dependent on management objectives for the forest.

7.4.2 Rotation age (years)

The planned number of years between the establishment or regeneration of a tree crop or stand and its final cutting at a specified stage of maturity.

8. VOLUME AND BIOMASS CONVERSION

8.1 GROWING STOCK CONVERSION

Where nationwide or local growing stock volumes are not available from the inventory database, or if volume data is reported only for a fraction of species (usually commercial species) special measures will be necessary to obtain standard cubic metre volume estimates.

To obtain growing stock volumes for all dbh classes down to 10 cm dbh, use should be made of appropriate conversion tables. Volume conversion factors, dependent on given minimum limits can be found in the table, which was prepared from data given in the following sources:

Brown, Sandra (1990): *Volume expansion factors for tropical forests*. Paper prepared for the FAO Tropical Forest Resources Assessment 1990 Project. University of Illinois, Department of Forestry, 9pp.

Brown, Sandra (1997): *Estimating biomass and biomass change of tropical forests:* A Primer. FAO Forestry Paper No. 134, Rome.

The equation used to convert total growing stock (m^3/ha) from the reference diameter to the adjusted diameter of 10 cm was as follows:

Total Growing Stock (Adjusted = Total Growing Stock * Volume Expansion Factor

where the volume expansion factor was dependent upon forest type and diameter class, as indicated below.

Undisturbed (Closed) Forest	Disturbed (Closed) Forest	Diameter Range
1	1	If 10<d<20
1.2	2.1	If 25<d<30
1.5	2.5	If 35<d<40
2.2	4.1	If 45<d<50

8.2 BIOMASS CONVERSION

To convert growing stock (m^3/ha) to total forest biomass, the appropriate conversion factor is found using the equation postulated by Brown (1990). This equation is as follows.

Total Forest Biomass = Growing Stock (m^3/ha) Wood Density (t/m^3) Biomass Expansion Factor

where wood density is dependent on the region, as shown below:

(Africa): 0.58 t/m^3

(Latin America): 0.60 t/m^3

(Asia): 0.57 t/m^3

and biomass expansion factor is:

$$e^{\{3.213-0,506*\ln(\text{GrowingStock}(m^3/ha)*\text{WoodDensity}(t/m^3)\}}$$

where {growing stock*wood density} < 190 t/ha

or

1.74 where {growing stock*wood density} e 190 t/ha

This equation provides the total forest biomass, a number which indicates the entire volume of leaf, branch, and stem of all trees and shrubs within the forest ecosystem.

9. FOREST UTILIZATION

9.1 ANNUAL FELLINGS (1 000 M³)

Average annual standing volume of all trees, living or dead, measured over bark to a minimum diameter of 0 cm (dbh), that are felled during the given reference period, including the volume of trees or parts of trees that are not removed from the forest, other wooded land or other felling site.

Includes: silvicultural and pre-commercial thinnings and cleanings left in the forests; and natural losses that are recovered (harvested)

9.2 UNRECOVERED FELLINGS (HARVESTING RESIDUES) (1 000 M³)

Felling residuals, which are left in the forest after felling and not salvaged.

Excludes: parts of the tree left *in situ* after felling, e.g. stumps and roots, and parts of the felled tree not recorded in the volume of fellings (see above). Normally the volume over bark.

9.3 ANNUAL REMOVALS (1 000 M³)

Average annual volume of those fellings that are removed from the forest, other wooded land or other felling site during the given reference period.

Includes: removals during the given reference period of trees felled during an earlier period and removal of trees killed or damaged by natural causes (natural losses), e.g. fire, windblow, insects and diseases.

9.4 HARVESTING INTENSITY (M³/HA)

Volume actually removed from the forest within one cutting cycle. This volume may include wood for industrial purposes (e.g. sawlogs, veneer logs, etc.) and for local domestic use (e.g. rural uses for construction). Use of wood for fuelwood will not be included in this category. May show a significant difference for disturbed and undisturbed forest.

9.5 ROUNDWOOD (CONIFEROUS, NON-CONIFEROUS) (1 000 M³)

Wood in the rough. Wood in its natural state as felled or otherwise harvested, with or without bark, round, split, roughly squared or in other form. It may also be impregnated or roughly shaped or pointed. It comprises all wood obtained from removals, i.e. the quantities removed from forests and from trees outside the forest, including wood recovered from natural, felling and logging losses during the period, calendar year or forest year. Commodities included are sawlogs and veneer logs, pulpwood, other industrial roundwood (including pitprops) and fuelwood. The FAO statistics include recorded volumes, as well as estimated unrecorded volumes.

9.5.1 Industrial roundwood (1 000 m³)

The commodities included are:

Sawlogs and veneer logs

Pulpwood

Other industrial roundwood (includes roundwood used for tanning, distillation, match blocks, gazogenes, poles, piling, posts, pitprops, etc.).

9.5.2 Fuelwood and charcoal

Wood in the rough (from trunks and branches of trees) to be used as fuel for purposes such as cooking, heating or power production. Wood for charcoal, pit kilns and portable ovens is included.

10. ALTERNATIVE FIBRES

Any fibre source that does not come directly from a tree. These fibre sources include:

10.1 NON-WOOD FIBRES

Fibres that come from a non-wood species of plant. Non-woods include abaca (Manila hemp), bagasse, bamboo, corn stalk and sorghum, cotton fibre and stalks, *Crotalaria* (sun Hemp), esparto, flax straw, hemp, jute, kenaf core & bast, rags, reeds, rice straw, sisal and wheat straw.

Nonwoods are scientifically defined as non-woody cellulosic plant materials from which papermaking fibres can be extracted. Most nonwoods are annual plants that develop full fibre potential in one growing season or less. Historically, paper was made almost exclusively from non-woods. Today, most non-woods are used in other industries, such as textiles. Other related terms are:

10.1.1 Non-wood fibre usage rate

The percentage of pulp for paper production that consists of non-wood fibres.

10.1.2 Historical non-wood fibre usage rate of change

The annual percent change in the non-wood fibre usage rate. This is calculated by using the past five years worth of data on non-wood fibre usage and pulp for paper production. Not to be confused with the *Nonwood Fibre Usage Rate of Change* factor (Section 11.2.3.1).

10.1.3 Pulp for paper production

The total production of pulp that is intended for paper or paperboard products.

10.2 RECOVERED FIBRES

Recovered fibre refers to any fibre that is recycled, or used more than once in the manufacture of paper or board products. A recovered fibre may be wood or non-wood in origin. It may be recovered more than once, although the accepted upper limit for recycling is about five times. A recovered fibre is not as strong as a virgin fibre, often possesses less flexibility, and is likely to split along the vertical axis. Most recovered fibre comes from recycled paper sources. Other related terms are:

10.2.1 Wastepaper recovery rate

The percent of overall paper and paperboard consumption that is recovered for recycling. This figure is not always related to the consumption of recycled products.

10.2.2 Historical wastepaper recovery rate of change

The annual percent change in the wastepaper recovery rate. This is calculated by using the past seven years worth of data on wastepaper recovery and paper and paperboard consumption. Not to be confused with the *Wastepaper Recovery Rate of Change* factor (Section 11.2.3.3).

11. GFSM FUTURE PROJECTION TERMS

Quite a number of terms are used in constructing GFSS future potential supply curves. These include:

11.1 FUTURES

This term replaces other misleading or confusing terms such as *scenario* or *outlook*. In the context of the GFSM, futures refers to the different potential supply curves that we can construct by adjusting factors and projecting the results over the next half century. The GFSM will produce three such futures, labelled Future $_1$, Future $_2$, and Future $_3$.

11.2 FACTORS

The variables that are included in the construction of future projections for each component. These variables are listed by component below.

11.2.1 Factors affecting natural forests

11.2.1.1 Land use (deforestation)

The factor which controls the rate of deforestation caused by thinning or conversion of forests to a deforested state, i.e. a permanent crown cover of less than 10%.

11.2.1.2 Land use (conservation)

The factor which controls the amount of forested land with legal restrictions which totally exclude or severely limit wood production, *inter alia* for reasons of environmental and biodiversity conservation, e.g. national parks, nature reserves and other protected areas such as those of special environmental, scientific, historical, cultural or spiritual interest.

11.2.1.3 Harvest efficiency

The factor which controls the efficiency with which timber is removed from the landscape and subsequently utilized. This affects both the amount of unrecovered fellings that one can expect in harvesting, and the yield that individual trees can provide due to better or worse harvesting techniques.

11.2.1.4 Sustainable forest management

The factor which controls the impact of sustainable forest management programmes. The impacts of such programmes affect total fibre yield to change the harvest scheduling in the area available for wood supply. To express sustainable forest management in quantitative terms means changing the silvicultural/harvesting system which in turn means changing the cutting cycle or increasing the rotation age used for forest utilization. Using this approach gives the forest manager a greater ability to address

forest management issues such as riparian zone management, wildlife corridors management, appropriate regeneration programmes, biodiversity and appropriate technology for tree harvesting.

11.2.2 Factors affecting industrial plantations

11.2.2.1 Land use (afforestation)

The factor controlling the rate at which new plantation area is added to the overall reported area.

11.2.2.2 Success rate

The factor which controls the plantation success rate, allowing for improvements in plantation establishment and management to be included in the model.

11.2.2.3 Research and Development gains

R&D gains include improvement in the establishment success rate (i.e. fewer gaps to reduce yields), as well as increases in growth and yield arising from research (especially tree improvement but also establishment techniques, site amelioration, etc.), improved management, and from greater experience of staff and labour.

11.2.3 Factors affecting alternative fibres

11.2.3.1 Non-wood fibre usage rate of change

The factor which controls the change in percent of non-wood fibres used in the manufacture of pulp for paper. This allows for eventual increases or decreases in the percent used.

11.2.3.2 Non-wood fibre yield

The factor which controls the yield of non-wood fibres from a hectare of land. Adjusting this factor allows us to model improvements in agricultural and harvesting practices.

11.2.3.3 Wastepaper recovery rate of change

The factor which controls the change in percent recovery of wastepaper.

11.2.3.4 Wastepaper recovery fibre yield

The factor which controls the amount of fibres that one can receive from a metric ton of wastepaper.

11.3 BASE REFERENCE POINT

The calculated, agreed-upon 1995 figure in the GFSM database that is used as a starting point for all future calculations. Each component of a projected line is somehow constructed from the base reference point.

11.4 STATIC SUPPLY LEVEL

A “flat” projection of fibre supply that is extended into the future. The difference between this and the possible futures is that no factor is adjusted and no trends are included. All the future models are built off of this line. All of the factors listed above are held static at the 1995 level for the construction of the static supply level.

12. IUCN MANAGEMENT CATEGORIES

[I] Strict Nature Reserve / Wilderness Area: protected area managed mainly for science or wilderness protection

These areas possess some outstanding ecosystems, features and/or species of flora and fauna of national scientific importance, or they are representative of particular natural areas. They often contain fragile ecosystems or life forms, areas of important biological or geological diversity, or areas of particular importance to the conservation of genetic resources. Public access is generally not permitted. Natural processes are allowed to take place in the absence of any direct human interference, tourism and recreation. Ecological processes may include natural acts that alter the ecological system or physiographic features, such as naturally occurring fires, natural succession, insect or disease outbreaks, storms, earthquakes and the like, but necessarily excluding man-induced disturbances.

[II] National Park: protected area managed mainly for ecosystem protection and recreation

National parks are relatively large areas, which contain representative samples of major natural regions, features or scenery, where plant and animal species, geomorphological sites and habitats are of special scientific, educational and recreational interest. The area is managed and developed so as to sustain recreation and educational activities on a controlled basis. The area and visitors’ use are managed at a level which maintains the area in a natural or semi-natural state.

[III] Natural Monument: protected area managed mainly for conservation of specific natural features

This category normally contains one or more natural features of outstanding national interest being protected because of their uniqueness or rarity. Size is not of great importance. The areas should be managed to remain relatively free of human disturbance, although they may have recreational and touristic value.

[IV] Habitat/Species Management Area: protected area managed mainly for conservation through management intervention

The areas covered may consist of nesting areas of colonial bird species, marshes or lakes, estuaries, forest or grassland habitats, or fish spawning or seagrass feeding beds for marine animals. The production of harvestable renewable resources may play a secondary role in the management of the area. The area may require habitat manipulation (mowing, sheep or cattle grazing, etc.).

[V] Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation

The diversity of areas falling into this category is very large. They include those whose landscapes possess special aesthetic qualities which are a result of the interaction of man and land or water, traditional practices associated with agriculture, grazing and fishing being dominant; and those that are primarily natural areas, such as coastline, lake or river shores, hilly or mountainous terrains, managed intensively by man for recreation and tourism.

[VI Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems.

Normally covers extensive and relatively isolated and uninhabited areas having difficult access, or regions that are relatively sparsely populated but are under considerable pressure for colonization or greater utilization.