FOREST PRODUCT MARKET DEVELOPMENTS

THE OUTLOOK FOR FOREST PRODUCT MARKETS TO 2010 AND THE IMPLICATIONS FOR IMPROVING MANAGEMENT OF THE GLOBAL FOREST ESTATE

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FOREST PRODUCT MARKET DEVELOPMENTS: THE OUTLOOK FOR FOREST PRODUCT MARKETS TO 2010 AND THE IMPLICATIONS FOR IMPROVING MANAGEMENT OF THE GLOBAL FOREST ESTATE

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FOREWORD

There is a considerable amount of knowledge available about the techniques to achieve various dimensions of sustainable forest management. Thus, although there is some uncertainty about the precise effects of forest management over the long-term, it is generally believed that enough is known to manage forests on a more sustainable basis. However, it is also estimated that a significant proportion of the world's forests is not managed in a way that could be described as sustainable. The questions facing forestry policymakers around the world therefore, are: why is this the case and what actions would encourage the wider implementation of sustainable forest management practices?

It is against this background, that this working paper has been prepared as part of an FAO input to the World Bank Forest Policy Implementation Review and Strategy. The paper discusses the future market conditions that may have an impact on the development of sustainable forest management and describes the implications of these for future action by governments, FAO, the World Bank and other international agencies to support its implementation.

The first part of the report describes broad global trends in supply and demand and then the analysis focuses on the likely future developments in markets by region and forest product. Part two of the report describes some of the implications of these trends for the management of forest resources then examines important issues in forest product processing, marketing and trade.

Some specific topics covered in the report include: the future availability of forest resources; future land-use changes (in terms of both expansion of agricultural land and reservation of natural forest areas); the development of forest plantations and other non-forest resources such as trees outside of forests; trends in technology; the impact of globalisation on forest products markets and forest management; the importance of issues such as forest certification; and the impact of sustainable forest management prescriptions on future potential wood and fibre supply.

A number of background papers have been prepared on some of the specific topics covered in this report. Papers on technological developments were produced by experts from the US Forest Service Forest Products Laboratory in Madison, Wisconsin, the Forest Research Institute of Malaysia in Kuala Lumpur and FAO's Wood and Non-wood Products Utilization Branch. A separate forest plantations study has been produced by one of this reports authors and a study of future wood fuel supply and demand is currently being produced. These reports will be issued separately as part of the FAO Global Forest Products Outlook Study working paper series.

The main forest products supply and demand projections used in this report were produced by the University of Wisconsin at Madison and future fibre availability was assessed using FAO's Global Fibre Supply Model. Draft versions of this report have also been reviewed by a number of external experts in this field, including: J Ball; A Baudin; J Bourke; D Boulter; D Brooks; and A Contreras.

FAO would like to express its gratitude to all the contributors to this paper and to thank everyone that has provided comments on earlier drafts of this work. FAO will continue to

explore, with member countries, the ways in which sustainable forest management can be implemented with greater success and to assist with implementation through its technical and normative work programmes. In this respect, we would welcome comments on all aspects of this study from readers.

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LIST OF ACRONYMS AND ABBREVIATIONS USED IN THE REPORT

AAC	Annual allowable cut - the amount of timber which may be cut in a given period, usually determined by considerations of standing volume of growing stock, rate of growth and forest condition.
APEC	Asia-Pacific Economic Co-operation forum
ASEAN	Association of Southeast Asian Nations
APFSOS	Asia-Pacific Forestry Sector Outlook Study (FAO, 1998)
CARICOM	Caribbean Community
CIFOR	Center for International Forestry Research
ETTS V	The Fifth European Timber Trends Study (UN, 1996a)
EQ (m^3 EQ)	Cubic metres of roundwood equivalent - i.e. the volume of roundwood required to produce a specific volume or weight of forest products
EU	European Union
Exp	Exports
FAO	Food and Agriculture Organisation of the United Nations
FRA (FRA 90)	Forest Resource Assessment (the 1990 Forest Resource Assessment) - a periodic assessment of the area and condition of the world's forests carried-out by FAO (see, for example: FAO, 1995).
FSC	Forest Stewardship Council
GDP	Gross Domestic Product
GFPM	Global Forest Products Model (see: Tomberlin *et al*, 1999)
GFPOS	Global Forest Products Outlook Study (see: Whiteman, in prep)
GFSM	Global Fibre Supply Model (see: FAO, 1999a)
HRD	Human resources development
IRR	Internal rate of return - the percentage rate of return given by an investment during its life
IRW	Industrial roundwood (roundwood used for purposes other than as a source of energy)
MERCOSUR	*Mercado Comun del Sur* or "Common Market of the South"
mt or MT	Metric tonnes
NAFTA	North American Free Trade Agreement
NATTS	North American Timber Trends Study (UN, 1996b)
NGOs	Non-governmental organisations
OECD	Organisation of Economic Co-operation and Development
OSB	Oriented strandboard

LIST OF ACRONYMS AND ABBREVIATIONS USED IN THE REPORT (CONTINUED)

Prod	Production
SFM	Sustainable forest management
SME	Small and medium-sized enterprises
UN	United Nations
UNECE	United Nations Economic Commission for Europe
WCMC	World Conservation Monitoring Centre
WTO	World Trade Organisation
WTP	Willingness to pay
WWF	World Wildlife Fund

FUTURE DEVELOPMENTS IN FOREST PRODUCTS MARKETS

EXECUTIVE SUMMARY

This paper has been prepared by staff from the Forestry Department of the Food and Agriculture Organisation of the United Nations, for the World Bank Forest Policy Implementation Review and Strategy. The paper is in two parts. The first part presents projections of wood and wood product supply and demand to the year 2010. The second part of the paper discusses emerging developments in the availability and management of forest resources and in forest products processing and trade, which have the potential to affect forest products markets in the future. The paper concludes by discussing areas where the World Bank could justify involvement in the forestry sector on the basis of the sector's linkages to its key policy objectives of poverty alleviation, environmentally sustainable development and private sector development.

Global supply and demand for industrial roundwood and wood products

The first point worth noting about global supply and demand is the dominance of developed countries in world timber markets, both in terms of production and consumption. Total global production of industrial roundwood is currently around 1.5 billion m^3/year. Around 62% of this industrial roundwood is produced in developed countries[1] which, incidentally, contain less than 20% of the world's forest resources. In terms of consumption, developed countries account for an even greater share of world markets, accounting for over 65% of industrial roundwood consumption and between 70% and 75% of wood product consumption.

The difference between industrial roundwood production and wood product consumption is balanced by a net trade flow of industrial roundwood and wood products from developing to developed countries. This flow is equal to about 70 million m^3/year of roundwood. Generally, most international trade takes the form of trade in wood products, but 70% of the net trade from developing to developed countries (or 50 million m^3/year) is in the form of industrial roundwood.

By 2010, total global production and consumption of industrial roundwood is expected to reach around 1.9 billion m^3 or roughly 25% higher than in 1996. The dominance of developed countries in global forest products markets is not expected to change by very much. However, the developed country share of industrial roundwood production is expected to fall slightly to 58%. The total share of global consumption held by developed countries is also expected to fall to 62% of industrial roundwood and 65% to 75% of wood products markets. The only wood product market where the developed country share of total consumption is not expected to fall significantly is the market for paper and paperboard. The net trade flow from developing to developed countries is expected to increase slightly to about 100 million m^3/year.

[1] For the purpose of this analysis, "developed countries" has been defined as countries which are members of the OECD. This includes all the countries of Western Europe and North America, plus: Japan; Australia; New Zealand; Mexico; Republic of Korea; Poland; and Czech Republic.

In terms of individual product markets, the highest rate of growth over the period to 2010 is expected to occur in the market for paper and paperboard, which is projected to increase by just under 40%. Consumption of wood-based panels will be the next fastest growing sector, with a total expected increase in consumption of 20% by 2010. In contrast, global consumption of sawnwood and pulp is expected to increase by only 17% and 16% respectively.

The difference between the high rate of growth in paper consumption and relatively low rate of growth in pulp consumption will be filled by the increased use of recycled paper in the total fibre furnish in the future. From 1970 to 1995, the share of the total fibre furnish accounted for by pulp declined from over 80% to around 65%. A large part of this decline can be attributed to the increased use of recycled paper. By 2010, it is expected that pulp will account for just under 50% of the total fibre furnish.

The outlook for future roundwood requirements and availability

In order to meet future demands for wood products, it is expected that total industrial roundwood production will have to increase by around 25%. This is slightly higher than the average expected increase in product demand and reflects the fact that developing countries are expected to gain a greater share of forest product production in the future and their industries generally use wood less efficiently (i.e. they require more wood input per unit of wood product output than in developed countries).

The supply and demand analysis has shown that this increase in global wood production can be achieved without significant upward pressure on prices. In other words, it is believed that global industrial roundwood and fibre supplies will expand to meet the increased demand without too much difficulty. However, there will be some changes in the relative abundance of all the different types of wood and fibre available in the future. It is anticipated that some types of wood, for example large high quality logs from the natural forest, will become more scarce, while other material such as recycled fibre and smaller pieces of roundwood from fast-growing plantations will become more abundant. It is also anticipated that, although at the global level supplies will be adequate, scarcity may become a problem in some regions.

Statistics about wood fuel use are currently highly unreliable and many are best estimates made by organisations such as FAO, based on what little data is available in individual countries. However, it is believed that the use of wood for fuel is currently the largest use of roundwood around the world and that global consumption might be in the order of around 1.8 billion m^3/year (or roughly 20% higher than industrial roundwood use). Wood fuel consumption is projected to increase by 25% over the period to 2010 to about 2.2 billion m^3/year. Most of this increase in demand is expected to occur in developing countries. In contrast, developed country consumption of wood fuel is expected to decline over the period.

The supply and demand analysis has also made a preliminary attempt to try to examine whether the future world's wood requirements will be broadly within the biological capacity of the world's forest resources to supply them. This analysis has indicated that future industrial roundwood needs are probably within the biological production potential of the world's forests under expected future changes in the areas which will be available for wood

supply. It must be stressed however, that these calculations are subject to a great deal of uncertainty and that there are regions, such as Africa and Asia, where future demands may come close to or even exceed the sustainable level of production potential. In terms of wood fuel production, an important point to note is that a vast proportion of the world's wood fuel needs are believed to be met from non-forest sources (e.g. trees outside of forests), deadwood and branches. In as much as this harvesting does not have a significant negative impact on forest resources, it is believed that wood fuel collection is not a major cause of deforestation except in some localised areas.

The regional supply and demand picture

Given the dominance of developed countries in global forest products markets, another aim of this study has been to highlight the main implications of the future for forest products markets, for developing countries. Four developing country regions have been used in this study: non-OECD countries in Europe (including the Russian Federation); Africa; non-OECD countries in South and Central America; and non-OECD countries in Asia and Oceania. The size of forest product markets and future expected market developments in each of these regions are briefly summarised below.

At the global scale, forest products markets in developing countries account for around 40% of the total global market for wood and wood products. The largest developing region is Asia and Oceania, which has a forest products market just slightly smaller than Western Europe's (around 15% to 20% for most products). By 2010, production and consumption in this region are expected to grow by around 50% and 35% respectively, making this market slightly bigger than that of Western Europe.

Non-OECD countries in South and Central America are the next largest developing region market, accounting for about 7% to 10% of the global market for industrial roundwood and sawnwood. A slightly smaller share of the global market for these products is held by non-OECD countries in Europe. The shares of the global market for these products held by these two regions is expected to increase very slightly by 2010. The non-OECD countries in Europe region is also expected to grow to a slightly larger size than the non-OECD countries in South and Central America region. Both of these regions hold very small shares of the global markets for pulp and paper production and consumption and this situation is not expected to change by very much.

Africa is the least significant producer of wood and wood products, accounting for only 4% to 5% of global industrial roundwood production and consumption and 1% to 3% of production and consumption of wood products. Furthermore, within Africa, by far the greatest share of the continent's wood and wood product production and consumption is held by South Africa. However, the forestry sector makes important contributions to gross domestic product and exports in many African countries. For example, exports of forest products account for more than 10% of merchandise exports in nine African countries and account for a much greater share of trade in several of these. If the importance on non-wood forest products is taken into account, then the importance of the forestry sector in Africa is even greater.

Trade and the developing regions

Three of the developing regions are net exporters of forest products. Net exports account for about one-third of production in non-OECD Europe and non-OECD South and Central America. Developing countries in Asia and Oceania are small net exporters on balance. This region has some large exporters of forest products (e.g. Indonesia and Malaysia) but also has some very large importers of forest products (e.g. China and Thailand). Africa is a major exporter of industrial roundwood, but is a net importing region overall, when its imports of wood products are taken into account.

Wood products exported from the developing regions tend to be relatively low-value products such as industrial roundwood, sawnwood and, to a lesser extent, wood-based panels (e.g. plywood from Indonesia). Exports of pulp and paper are also significant in a few countries in South America.

Production and consumption in all four developing regions are expected to grow faster than in the developed regions. Production is expected to grow fastest in non-OECD Europe, followed by non-OECD Asia and Oceania, Africa and non-OECD South and Central America. Consumption is expected to grow at similar rates to production in all of these regions except Africa, where very little consumption growth is foreseen. The net effect of this will be that two of the three net exporting developing regions, Europe and South and Central America, will continue to export roughly the same amounts in 2010 as they do today. Non-OECD Asia and Oceania will become a small net importer and Africa will remain a small net importer.

The three biggest inter-regional trade flows of forest products are as follows: North America to Europe; North America to Asia and Oceania; and Europe to Asia and Oceania. Developed countries within these regions account for most of these trade flows. However, in Asia and Oceania, a large proportion of the imports into the region are accounted for by imports into both China and Japan. In terms of the developing country exporters, South American and Southeast Asian countries are major exporters to Japan. South American countries also export some products to North America. The volume of exports of forest products from African countries is tiny in comparison to this trade (although, as noted above this trade is very important to some of these countries).

Changes in the future availability of forest resources for wood production

Three broad changes in the availability of forest resources affect future wood supplies. Firstly, there are changes in the overall area of the world's forests due to deforestation and the establishment of forest plantations. Secondly, as forest harvesting proceeds, new areas of previously undisturbed natural forest are opened-up for future harvesting and existing undisturbed areas are harvested. The latter generally results in a reduction in the standing stock of commercial timber species and a reduction in the long-run potential supply from such areas in the future. The third change which takes place is that some areas of forest are taken out of production for environmental reasons either through logging bans or the placement of forest into legally protected areas such as national parks.

The projections of supply and demand summarised earlier have already taken most of these factors into account. For example, the industrial roundwood supply projections were made

assuming that deforestation will continue in the future at much the same rate as it has in the past. It has also been assumed that the expansion of forest harvesting into new areas of forest will continue to follow past trends and that new plantation establishment will continue at current rates. However, three of the most important components of this changing pattern of forest land-use have been examined in greater detail in this analysis: the future demand for agricultural land; the future placement of forests into legally protected areas; and the potential future supply of wood from plantations and trees outside of forests.

Current estimates of the future demand for agricultural land suggest that about 90 million ha of land might be required for conversion to agriculture by the year 2010. The 1990 Forest Resource Assessment suggests that around 65 million ha of this might come from forests over the period 1995 - 2010, if past forest land-use changes are repeated in the future. This is less than one-half of the deforestation estimate already built into the forecasts of future wood supply presented earlier. Therefore, unless the future demand for conversion of forest land to agriculture is significantly higher than expected, this should have already been taken into account in these projections.

The baseline projections of future wood supply presented earlier have assumed that the area of forest in legally protected areas will not change over the forecast period. Undoubtedly there will be more areas of forest put into legally protected areas so, as a sensitivity analysis, this analysis has examined what would be the impact of increasing the global area of forests in protected areas to 10% of the total forest area. The results of this analysis depend on the types of forest that are put into legally protected areas. If areas that are currently unavailable for wood supply (for technical or economic reasons) are put into legally protected areas, this would have almost no effect on the future supply projection (i.e. there is a sufficient area already excluded from production in the model in most regions, to meet the 10% target). However, if some areas currently used for wood supply were also to be put into legally protected areas, this would reduce the global potential wood supply by around 6%. Potential wood supply would still be sufficient to meet future demand needs at a global level, but such a move would put increasing pressure on future wood supplies in Asia, Africa and South America.

As noted above, the baseline supply forecast has already taken into account the expected potential increase in production from forest plantations in the future. It has not however, taken any account of the potential contribution of trees outside of forests to future wood supplies. Forest plantations currently account for about 13% of global wood supplies (26% of industrial roundwood production and 4% of wood fuel production). In some regions, plantations are a particularly important source of supply. For example, up to 80% of wood supplies in Oceania may come from forest plantations. By 2010, the potential supply of wood from plantations is expected to increase by almost 60% to 630 million m^3/year. Globally, this could account for about 27% of future industrial roundwood and fibre requirements.

Trees outside of forests are a resource about which very little is known. However, they are believed to have tremendous potential for future wood supply. They are already very important sources of wood supply in South Asian countries, which have relatively small forest resources. For example, India is the world's third largest producer of roundwood, much of which is believed to come from trees outside of forests. Trees outside of forests are also believed to supply about 60% of Bangladesh's wood needs. The baseline projections of supply and demand have not included any specific forecasts for future supplies from trees outside of

forests, but it is believed that this resource will play a greater role in future wood supplies as more restrictions are placed on harvesting in the natural forest.

The impact of sustainable forest management on future wood supply

Of all the possible changes in the way forest resources are managed in the future, changes in forest harvesting practices as a result of the implementation of sustainable forest management (SFM) have the greatest potential to diminish future wood supplies. A literature review of several case studies from around the world suggest that harvesting volumes might be reduced by up to 20% to 60% in tropical regions (generally less in temperate and boreal regions) with the introduction of more sustainable harvesting practices. The same studies also indicate that production costs could rise by 5% to 25%.

It is not known however, whether the results of these studies are generally applicable to the wide range of different types of forest present in the world. Certainly, if they are, they would suggest that there could be scarcity in future wood supply in many regions in the future. Perhaps the most significant implication of these figures is that they cast doubt on whether SFM will be widely implemented in the long-run. Given the potential impacts on costs and harvesting volumes described above, the implementation of SFM will present a significant challenge to many forest policymakers in both developing and developed countries.

Future technological change

One way in which future demand for wood can be more easily reconciled with supply is through greater efficiency in the use of wood. Historically, the wood processing industry in developed countries has continually improved product recovery rates through improvements in processing technology and the development of products which can use residues, recycled materials and non-wood fibres. New processes have also been developed to utilise formerly non-commercial species and take advantage of new sources of supply such as fast-growing plantation species.

Technology has generally advanced by less in most developing countries, where it has been traditionally cheaper to extend harvesting into new areas of natural forest rather than use existing resources more efficiently. The one exception to this is the development of the rubberwood processing sector in Southeast Asia which has developed to take advantage of the abundance of this resource.

The baseline projections of supply and demand presented in this analysis have not assumed any changes in technology in the future except for an increasing use of recycled fibre in the total fibre furnish for papermaking. However, a sensitivity analysis of future potential gains from technological improvements has suggested that maybe up to 70% of future demand growth in the solidwood products sector in developed countries could be met by improvements in processing efficiency. The potential for improvements in developing countries is currently unknown but is believed to be even greater than this.

Globalisation and forest certification

Two final aspects of the future outlook for forest products markets, which have been examined in greater detail in this analysis, are: the potential impacts of greater globalisation on forest products markets; and the potential for forest certification to affect future markets.

Three aspects of globalisation are believed to have the most potential to affect future forest products markets. Firstly, it is believed that trade liberalisation will continue to stimulate forest products trade to the benefit of all countries. Trade liberalisation will help all countries to continue their drive to export higher value-added wood products and may be particularly beneficial to developing countries in this respect. It may also however, reduce some of the protection given to domestic industries in some developing countries, causing them to downsize or increase the efficiency of their industries in some other way.

The second impact of globalisation will be that it should support the continued development of forest management and processing facilities in developing countries through increased foreign investment and transfer of skills and technology. Foreign direct investment has played an important role in the development of the forestry sector in many developing countries, but the benefits of such development have not always been distributed very fairly. There will continue to be a strong demand for foreign investment in the forestry sector in many developing countries and forestry policymakers in these countries should consider how they can achieve an appropriate transfer of skills and technology to help them with their long-term development plans.

The third expected trend in globalisation is the continued globalisation of environmental advocacy and concern. International non-governmental organisations (NGOs) have increased their interest in forestry issues over the last decade and are now a major force in international forestry policy discussions. Their most recent significant contribution to this debate has been the development and promotion of forest certification in the markets for forest products in developed countries. It can be expected that they will continue to attempt to influence forestry policymaking through moves such as this.

However, the outlook for forest certification is currently uncertain. As noted above, the implementation of SFM may prove to be rather expensive and what little evidence is available to date suggests that consumers are not currently willing to pay significantly more for certified forest products. It seems likely therefore, that the market for certified forest products is only ever going to account for a relatively small share of the total wood market.

Implications for future action

The final part of this analysis has examined the implications of the future supply and demand outlook for future involvement in the forestry sector by the World Bank and others. It has concluded that there are five main areas where involvement may be justified on the grounds of the forestry sector's linkages to the World Bank's key objectives of poverty alleviation, sustainable development and private-sector development. These are briefly outlined below.

Information. The supply and demand analysis has shown that there is a continuing need for better information about the forestry sector in many developing countries. Given the desire to

implement SFM in many countries, this information need is even greater. The World Bank and others should consider what role they should play in supporting this process as part of their strategies to support sustainable development more generally.

Pricing. Many of the desirable changes discussed in this report, such as the implementation of SFM and greater efficiency in wood use, require that the correct price signals are given to forestry concessionaires and industrial wood users. However, there are many examples of countries where the stumpage price of roundwood has been set artificially low in order to stimulate the development of domestic processing industries. The World Bank and others should continue to encourage countries to improve their forest revenue collection systems on the grounds of greater economic efficiency and in order to improve the sustainability of their forest industry developments. To some extent, countries could also be encouraged to use some of this money to improve the effectiveness of their forestry administrations to monitor and control forest operations.

Human resource development. Many of the issues discussed in this report have tremendous implications for human resource development (HRD). Policies to implement SFM and the general level of industry restructuring towards more technologically complex production processes expected in the future, will all have to be supported by a significant and prolonged programme of HRD in many developing countries. The upgrading of human resources in the forestry sector in many countries will require a substantial amount of funding and technical assistance. The World Bank and others should consider the best way in which these investment needs can be met on a sustainable basis in the long-run.

Industrial restructuring. The supply and demand outlook has suggested that there will be a significant need for industrial restructuring. At a policy level, the World Bank, FAO and others should consider how they can best help countries to re-align their industrial policies to take into account the expected future changes in wood availability and forest products markets. Such changes will have cross-sectoral implications, so the World Bank can also play a useful role by trying to influence the relevant parts of government administrations outside of the forestry sector (e.g. industry, energy and planning ministries) where appropriate.

Institutional development. Many forestry administrations in developing countries have evolved to fulfil fairly limited roles. Mostly they have largely taken on the tasks of planning, encouraging or developing, then monitoring, roundwood production from the natural forest. The changing pattern of future wood supply and developments such as SFM and greater needs for HRD, research and better management of protected areas, will all require forestry administrations to broaden their activities. The World Bank and others should support this at the policy level in their regular dialogues with countries and consider how technical assistance can best be provided to facilitate this process.

1. INTRODUCTION

Several studies of global wood and wood products supply and demand have recently been produced[2]. These have all contained projections of product supply and demand of roughly the same order of magnitude. In contrast, however, many of the studies have arrived at different conclusions about the adequacy of forest resources to meet the wood raw material requirements underlying their forest product supply projections. Most of the studies broadly agree that, at the global level, raw material supplies will expand to meet production requirements. However, few of the studies foresee plentiful wood supplies and several have suggested that it may be difficult to meet future requirements in some regions or for some types of wood.

FAO has recently completed two major global studies relevant to this subject: the Global Forest Products Outlook Study (GFPOS), which presents forecasts of forest product supply and demand to 2010; and the Global Fibre Supply Model (GFSM), which examines potential future fibre supplies based on likely future developments in forest resources and alternative sources of fibre supply. This paper, drawing from these two studies, has been prepared by staff of the FAO Forestry Department as a background paper to the World Bank Forest Policy Implementation Review and Strategy.

The paper is in two main parts. The first part presents FAO's projections of wood and wood product supply and demand to 2010 and discusses the potential of the global forest resource and alternative supply sources to fulfil the wood and fibre raw material requirements underlying these projections. This sets the scene for a discussion of market developments in part two of the paper. In this section, emerging developments in the forest sector that have the potential to affect forest products markets are discussed. In particular, the second part of the paper examines factors that might reduce or extend the availability of wood raw material supplies and policy developments that may affect future trade in forest products.

The paper attempts to give some insight into the broad supply and demand developments that are driving the sector and will shape the future of the sector over the next decade or so. It also discusses areas where the World Bank could justify involvement in forestry on the basis of the sector's linkages to its key objectives of poverty alleviation, environmentally sustainable development and private sector development. The analysis places a greater emphasis on the supply side discussion since generally, issues of supply fall within the purview of forest policymakers while demand issues are more heavily influenced by national economic policies.

[2] See, for example: Margules, Groome and Pöyry (1996); Sedjo and Lyon (1990); Apsey and Reed (1995); Nilsson (1996); FAO (1997a); and Solberg *et al* (1996).

Part 1: the future global supply and demand for wood and wood products

2. FACTORS INFLUENCING THE SUPPLY AND DEMAND FOR WOOD AND WOOD PRODUCTS

2.1 Factors driving the demand for wood and wood products

A range of factors affect the demand for wood and wood products, including: the price of the products themselves; the price of substitute products; population and income levels; and trends in consumer preferences. In addition to these factors, most forest products are intermediate goods. They are used in other industrial processes or commercial activities (e.g. construction), such that technological changes in these processing or end-use sectors can have a major impact on the demand for forest products through the efficiency with which they are transformed into other products.

The use of wood products in the future will continue be challenged by substitute products from the metals, plastics, agricultural, cement, and chemical industries. A correlation between increasing incomes and preferences for environmentally friendly products and outcomes suggests a future of increasingly complex interplay in the demands placed on forests and the relative acceptability to consumers of forest products and competing non-forest substitutes. Several of these factors will be examined later in this paper. This first section concentrates on the two main forces that tend to drive the demand for forest products over time: population and income growth.

2.1.1 Population growth

Population growth broadly acts to increase the demand for forest products by increasing the number of forest product consumers.[3] World population has roughly doubled in the last four decades, and growth in the consumption of roundwood (including wood fuel) has increased at only a marginally lower rate. Rates of population growth in most developed countries have declined (and are indeed now negative in many developed countries) and it is expected that a changing distribution of global population, from developed towards less developed countries, will have a moderate impact on future forest product demand patterns.

The distribution of world population and expected population growth is shown in *Table 1*. This shows that developed countries currently account for just under one-fifth of world population. The latest population projections from the UN Population Division, indicate that world population will probably increase by just under 20% over the next 15 years. It is expected that most growth will occur in less developed countries, led by African countries where population is expected to grow by over 40% or over twice the world average. In contrast, population in developed countries is expected to grow by only 6% and the share of world population in developed countries is expected to decline to 17%. Asia is and will remain the world's most populous region with over half of the world's population.

[3] Other more complex demographic factors may also affect demand in more subtle ways. For example, the age structure of a country's population will affect household formation and, consequently, demand for construction materials such as sawnwood.

Table 1: World population in 1995 and projection for 2010 (medium fertility variant)

Region	1995		2010		Growth 1995 - 2010	
	(millions)	(%)	(millions)	(%)	(annual)	(total)
Countries within OECD						
Europe	432	8%	431	6%	+0.0%	-0.3%
Asia and Oceania	252	4%	270	4%	+0.5%	+7.0%
The Americas	388	7%	440	7%	+0.8%	+13.4%
Subtotal	**1,072**	**19%**	**1,141**	**17%**	**+0.4%**	**+6.4%**
Non-OECD countries						
Europe	295	5%	282	4%	-0.3%	-4.6%
Asia and Oceania	3,214	57%	3,819	57%	+1.2%	+18.8%
The Americas	386	7%	465	7%	+1.3%	+20.7%
Africa	719	13%	1,028	15%	+2.4%	+42.8%
Subtotal	**4,614**	**81%**	**5,593**	**83%**	**+1.3%**	**+21.2%**
World total	**5,687**		**6,734**		**+1.1%**	**+18.4%**

Source: UN (1998)

2.1.2 Income growth

The second principal factor influencing the demand for forest products is wealth or income. Leaving aside the issue of income distribution, demand for most forest products generally increases as countries become richer and can afford to buy more of all goods and services. In the context of markets for wood products, the only major exception to this is wood fuel. Per capita consumption of wood fuel tends to decline as incomes increase, because people switch towards using more convenient types of energy[4].

Current and projected gross domestic product (GDP) for all the main regions of the world is shown in *Table 2*. GDP is currently very unevenly distributed. For example, 80% of world GDP is accounted for by the 29 OECD countries, in stark contrast to their 20% share of world population. Asian developing countries account for 13% of world GDP and 7% of world GDP is produced in other less developed countries.

It is expected, however, that GDP will grow at the highest future growth rates in less developed countries. Many less developed countries are expected to sustain GDP growth at over 3% per annum (and some much faster than this) compared with growth of only 2% to 3% in most developed countries[5]. Thus, by 2010, the share of world GDP produced in less developed countries is expected to increase from 20% to around 35%. Also, compared with the size of their economies in 1995, less developed countries are expected to double in size by 2010, whereas developed countries are expected to increase by only around 50%. These developments may have a profound effect on the demand for forest products.

4 Total consumption of wood fuel may still increase however, if population increases faster than per capita consumption declines.

5 The current economic turmoil in Asia has the potential to alter some of the projections used in this analysis and the eventual long-run outcome of recent events is currently unpredictable. However, it is believed that the effects of recent events will not significantly alter the main conclusions of this analysis, but are more likely to merely delay some of the expected outcomes by a few years.

Table 2: World GDP in 1995 and projection for 2010

Region	1995		2010		Growth 1995 - 2010	
	(billions)	(%)	(billions)	(%)	(annual)	(total)
Countries within OECD						
Europe	5,997	30%	8,797	27%	2.6%	46.7%
Asia and Oceania	3,664	18%	6,049	18%	3.4%	65.1%
The Americas	6,147	31%	8,941	27%	2.5%	45.5%
Subtotal	**15,807**	**79%**	**23,786**	**72%**	**2.8%**	**50.5%**
Non-OECD countries						
Europe	523	3%	958	3%	4.1%	83.2%
Asia and Oceania	2,369	12%	5,864	18%	6.2%	147.5%
The Americas	785	4%	1,411	4%	4.0%	79.7%
Africa	476	2%	860	3%	4.0%	80.6%
Subtotal	**4,153**	**21%**	**9,092**	**28%**	**5.4%**	**118.9%**
World total	**19,961**		**32,879**		**3.4%**	**64.7%**

Source: FAO (1997b) *GDP figures have been converted to US$ at 1987 prices and exchange rates*

2.1.3 Other impacts of population and income growth

Population and income growth may not only affect the demand for forest products, but also affect the supply of wood raw materials. For example, increasing population density increases the pressure to convert forestland into other uses and higher incomes tend to result in higher demands for environmental services from forests (Solberg *et al* 1996). Thus, the changes outlined above are likely to put pressure on forest resources both in terms of the wood and fibre products that will be desired from them and the other non wood goods and services that they will be expected to produce (which may consequently reduce their availability for timber supply).

2.2 Factors likely to affect the supply of wood and other fibre

A large number of economic, technical and biological factors are likely to influence the future supply of wood and other fibre. *Box 1* lists some of the factors most likely to have a significant impact on supply.

The factors listed in *Box 1* have been identified and considered as part of this analysis. The list is not an exhaustive collection, but rather a subset of a larger set of variables that have been identified as affecting wood supplies in various studies within the last decade (see footnote on page 1). These variables have been chosen because of their suspected importance and the availability of information about their presence and likely impacts on forests around the world.

Box 1: Factors most likely to affect future wood and other fibre supplies

Wood supply from the natural forest:

Management regime *(as expressed by cutting cycle and intensity);*
Forest loss *- e.g. Unplanned and planned deforestation; and*
Forest change *- e.g. forest degradation, conversion to legally protected areas or expansion of the exploitation frontier.*

Wood supply from industrial forest plantations:

Afforestation rate*; and*
Development gains *in rates of growth and fibre yields.*

Non-wood fibre supply:

Capacity to collect and process non-wood fibre sources.

Recovered fibres:

Capacity to collect and process recovered paper*.*

2.2.1 Changes to natural forest management regimes

The implications of Sustainable Forest Management (SFM) for wood and other fibre supply are frequently mentioned in forest policy discussion. The concept of SFM has been broadened in recent years and, as a result, the objectives of natural forest management in many countries are gradually shifting emphasis away from predominantly management for timber production towards management that balances timber production with ecological and social sustainability. These changes could have significant impacts on the amount of timber which can be harvested from the world's natural forests in the future.

2.2.2 Forest loss

Deforestation remains a serious forestry policy issue for most regions. The main direct impact of deforestation on future wood availability is that it reduces the area of forest available for wood supply. A more subtle impact it has, is that it increases the pressure on forestry policymakers to place forest areas in legally protected areas (see below) or prevent harvesting in some other way (e.g. logging bans), thus further reducing the amount of wood that can be harvested from the remaining forest areas.

2.2.3 Forest change

A more subtle change that has occurred within many of the world’s forests in recent years is the process of gradual forest degradation. Forest degradation can manifest itself in many ways including: loss of site fertility; soil erosion; reduction in biological diversity; and fragmentation of forest areas, but probably the single most important indicator of degradation (and one of the most important in terms of future timber supply) is the gradual loss of standing biomass.

Forest degradation will affect timber supplies by reducing the amount of standing commercial timber available for harvest in the future. Thus, for example, as countries move from harvesting old-growth or primary forest stands into second growth forest, it can be expected that harvesting volumes per unit of area will decline. Such shifts are likely to take place over several decades in countries where virgin forest still accounts for a major share of current wood production (e.g. many tropical countries) and they have been taken into account in this analysis.

Partly in response to the problems of deforestation and forest degradation, countries are also placing more natural forest into legally protected areas. As areas of forest are placed into protected areas, they are taken out of production and this reduces the long-run sustainable supply of timber that can be harvested from the natural forest. This is another aspect of forest change that has been examined in the analysis.

2.2.4 Afforestation rate and development gains in industrial forest plantations

Increasing the forest area by establishing forest plantations is one way in which future supply of wood from forests can be increased. *Table 3* shows the current estimated rates of afforestation in some of the main countries actively pursuing vigorous plantation establishment policies. Because tree growth in plantations is generally much higher than in natural forests, policy developments that promote the establishment and use of plantations can have a significant impact on future wood supplies.

There is frequently a significant difference between planned and actual afforestation rates, due to poor establishment practices. But, for the purposes of this study, the planned rates were used as a starting point for the analysis. A more detailed examination of the outlook for plantations is given in Part 2 of this report.

Table 3: Estimated annual rate of afforestation in selected countries

Africa		South America		Asia-Pacific	
Country	**Area 1,000 ha**	**Country**	**Area 1,000 ha**	**Country**	**Area 1,000 ha**
South Africa	24	Argentina	25	Australia	20
Zimbabwe	5	Brazil	200	Bangladesh	50
		Chile	120	China	500
		Uruguay	20	India	500
				Indonesia	250
				Malaysia	50
				New Zealand	50
				Pakistan	50
				Philippines	44
				Sri Lanka	10

Source: FAO (1999a)

Development gains, particularly in industrial forest plantations, are another key factor that will affect future potential wood supply. Such gains will include both silvicultural and genetic gains. Vichnevetskaia (1997) provides a partial survey of studies published on factors affecting productivity in tropical forest plantations. Such gains are a further potential source

of increased wood supply, although they have not been included in the analysis presented later.

2.2.5 Development of non-wood and recovered fibre supplies

Currently, wood is the major raw material input to the global pulp and paper industry. Significant levels of non-wood fibres are currently used in a handful of countries, most notably in: China; India; and a few other Asian countries. However, there are also currently indications of increasing interest in non-wood fibres, particularly in North America.

At present, the most common non-wood fibre used to make pulp and paper is straw (see *Table 4*), which accounts for 46 % of total non-wood fibre consumption (Atchison, 1995). This is followed by bagasse (14 %) and bamboo (6 %). Other non-wood fibres, such as cotton, hemp, sisal, and kenaf, are gradually becoming more important in the manufacture of pulp and paper.

Table 4: Global non-wood fibre papermaking capacity

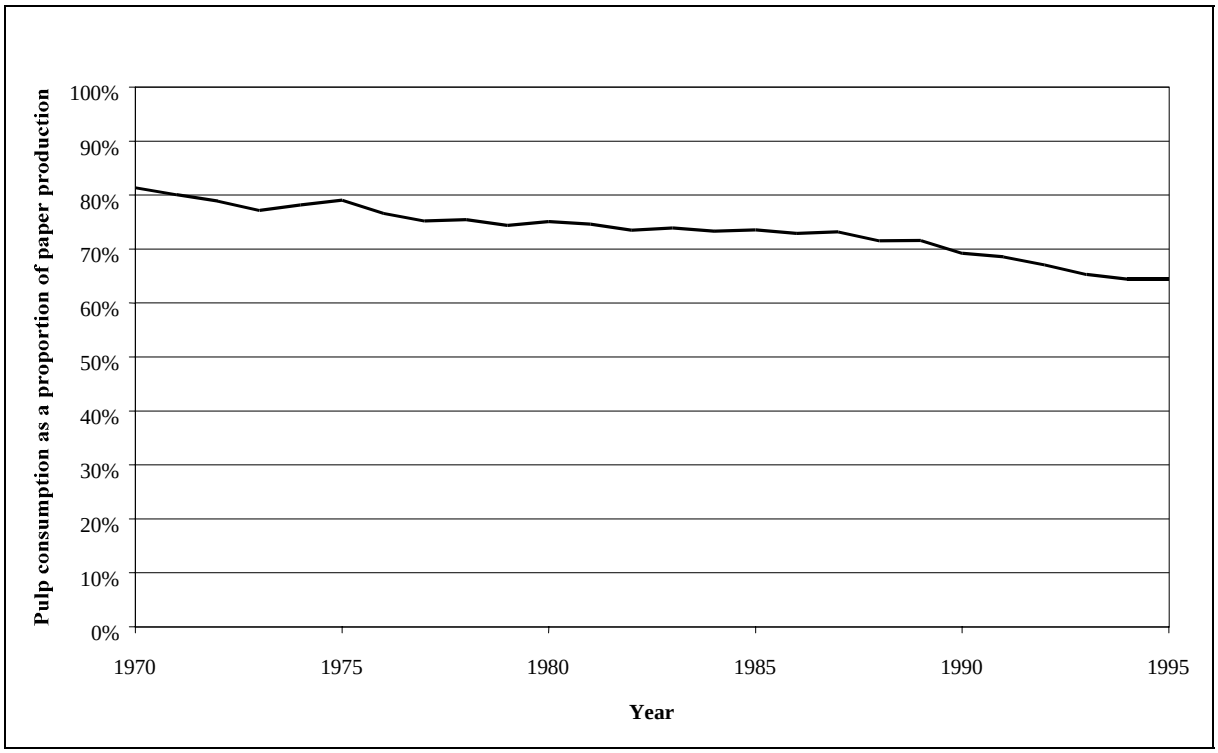
Material	**Capacity (thousand metric tons)**			
	1985	**1988**	**1990**	**1993**
Straw	6,166	5,260	7,623	9,566
Bagasse	2,339	2,267	2,646	2,984
Bamboo	1,545	1,674	1,468	1,316
Miscellaneous	3,302	6,366	6,870	6,870
Total non-wood fibre papermaking capacity	13,352	15,567	18,607	20,736
Total paper and paperboard production	178,558	225,887	238,939	250,359
Estimated production from non-wood fibres	**7.4%**	**6.9%**	**7.8%**	**8.3%**

Source: Mabee and Pande (1997)

In total, it is estimated that non-wood fibres currently account for around 8% of global pulp and paper production. Given the world's area of agricultural crops, their potential contribution to meet future demands for fibre is vast, but much will depend on the economic, environmental and technical feasibility of collection and processing the resource. For example, pollution from non-wood fibre pulp mills is becoming an increasing environmental concern in China.

More important to the future wood product supply and demand balance is the outlook for wastepaper recovery and utilisation. *Figure 1* shows how the utilisation of wood and non-wood fibre pulp in the manufacture of paper has declined over the last 25 years, largely due to the increased use of recovered paper in the total fibre furnish.

Figure 1: Trend in the utilisation of pulp in the manufacture of paper



Source: FAO (1999b)

Table 5 shows that currently, most regions of the world are recovering around 40% of the paper they consume.[6] The exceptions to this are Africa and the countries of the former USSR. Poor infrastructure may be the cause of low recovery rates in Africa and the abundance of forest resources is almost certainly the cause of the very low recovery rate in the countries of the former USSR. Because of the size of its domestic market for paper products, North America is by far the largest producer of recovered paper in the world.

Table 5: Global wastepaper recovery in 1995

Region	Wastepaper recovery 1,000 MT	Recovery as a proportion of paper consumption %	Wastepaper consumption 1,000 MT	Consumption as a proportion of paper production %
Europe	31,923	45	32,297	46
Asia-Pacific	35,603	40	40,946	40
North America	41,999	40	34,427	45
Latin America	4,354	42	5,853	31
Africa	901	26	924	23
Former USSR	40	1	629	2
World	**115,820**	**41**	**116,076**	**41**

Source: Mabee and Pande (1997)

[6] The technical limit to wastepaper recovery will depend upon a number of factors and can not currently be determined. Some countries already recover much higher proportions of their paper consumption than are shown here (Japan, for example, which recovered over 50% of consumption in 1995). Another factor that will confound any analysis of future recovered paper supply is the trend in some countries to use this resource for the production of energy. However, the projections for the recovery of wastepaper presented later on are believed to be feasible, given current policies governing the collection and use of this resource.

In terms of wastepaper utilisation, the table shows that North America and Europe lead the world in terms of the share of paper produced from recycled fibre, while the Asia-Pacific region is the largest consumer of recovered paper overall. However, even though North America has the highest rate of utilisation, the region has consistently recovered more wastepaper than it uses (due to domestic recycling and waste management policies) and has become the world's dominant exporter of recovered paper. Much of this material is sold to the Asia-Pacific region.

Europe, Africa, Latin America and the Former USSR each have a lower levels of imports and demand that could easily be met by increases in national recovery levels in these regions.

2.3 Synthesis: major issues surrounding future supply and demand drivers

The above analysis has described the main factors that are likely to affect forest products supply and demand patterns in the future.

On the demand side, consumption patterns are expected to switch somewhat towards less developed countries. Also, as incomes rise, other forest functions are likely to become increasingly important and this will have an impact on future wood supplies.

On the supply side, the description given above has shown that there is a wide range of factors which might affect future supplies. The challenge for policymakers, will be to influence these factors to satisfy market needs while, at the same time, pursuing wider forestry policy objectives such as SFM.

Following-on from these general themes, several particularly important topics have been chosen for more detailed examination in this analysis. These include:

1. the effect on wood supplies of competing demands for forest-land;

2. the potential for plantations and non-forest supply sources to meet future wood and fibre demands;

3. the potential for technological change to help balance future wood and wood product supply and demand; and

4. the impact of trends such as globalisation and forest certification on forest products markets

These themes are covered in Part 2 of the report.

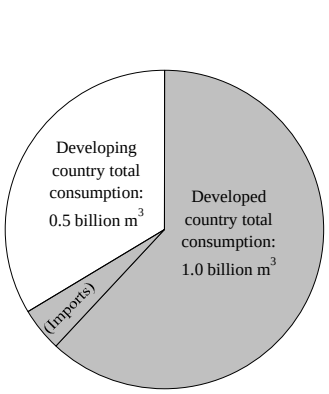
3. GLOBAL SUPPLY AND DEMAND ANALYSIS

This section of the report presents a brief description of the main global supply and demand developments which are expected to occur over the period to 2010.[7] The first four subsections discuss the outlook for industrial wood products and the fifth discusses the wood fuel outlook. Expected wood production and biological productivity are then compared in part six of this section, which is followed by a final synopsis of the main expected market developments.

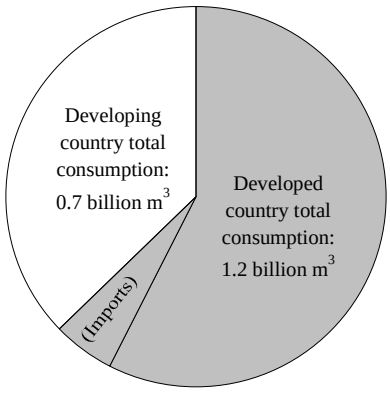
3.1 Global supply and demand at a glance

The current and future expected level of global supply and demand for wood and wood products is shown in *Figure 2*. Developed countries[8] currently account for about 1 bn m^3 EQ[9] of annual wood and wood product consumption or two-thirds of the global total of 1.5 bn m^3 EQ/year. Their share of global industrial roundwood production is slightly lower, such that about 6% (or around 0.07 billion m^3 EQ/year) of their wood and wood product requirements have to be imported from less developed countries each year. About half of this net trade from developing to developed countries is in the form of wood products and the remainder is accounted for by trade in industrial roundwood.

Figure 2: Industrial roundwood supply and forest product demand - 1996 and 2010



Total global production and consumption in 1996: 1.5 bn m^3 EQ



Total expected global production and consumption in 2010: 1.9 bn m^3 EQ

7 A brief description of the supply and demand models used to make all the projections presented here is given in *Box 3* later on.

8 Defined, for the purposes of this analysis, as members of the OECD.

9 Wood raw material equivalent or m^3 EQ is calculated as the amount of industrial roundwood required to produce a given quantity of final forest products (i.e. sawnwood, panels and paper). This conversion is used to make countries forest product consumption projections comparable with their industrial roundwood production projections.

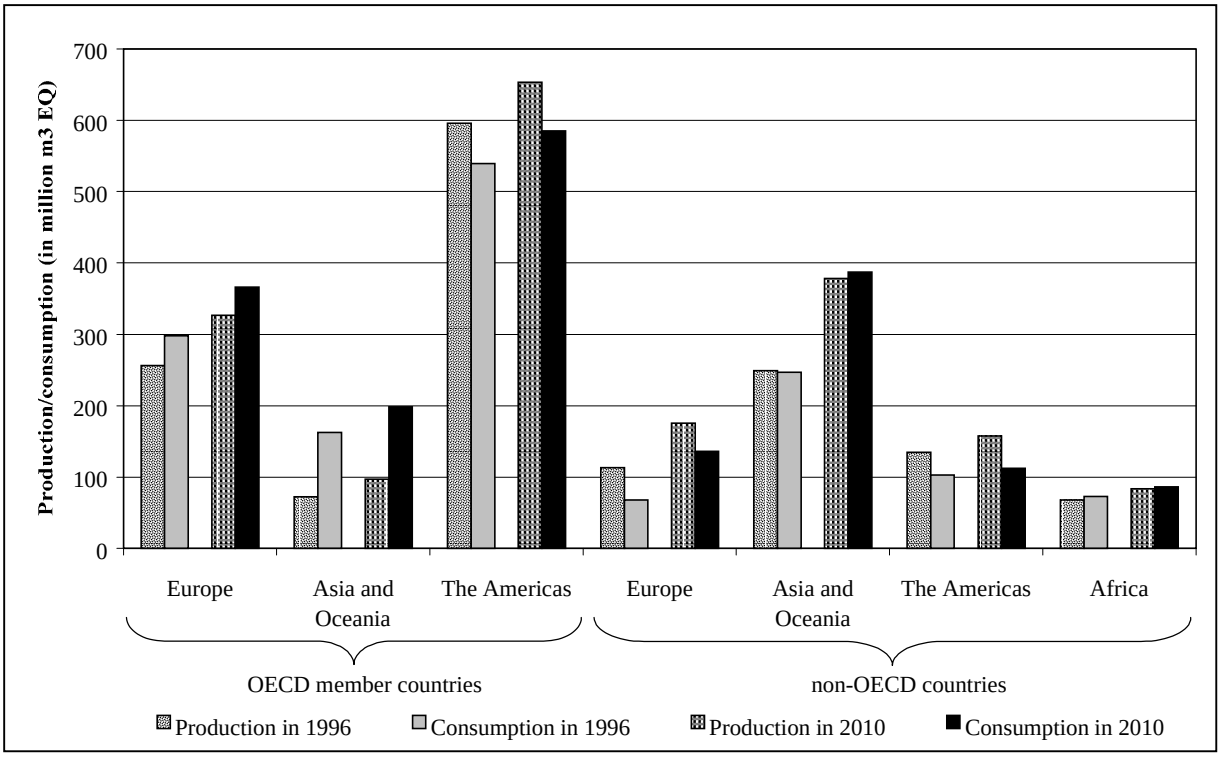
Global demand for industrial wood and wood products is expected to increase by 25% to 1.9 bn m^3 EQ/year by 2010. By far the greatest increase in demand is expected to occur in less developed countries, where demand is expected to rise by about 40% to 0.7 bn m^3 EQ. In contrast, demand in developed countries is expected to increase by only about 20%. This will increase the developing countries share of global industrial wood and wood product consumption from about one-third to just under 40%.

Net trade from developing to developed countries is expected to increase very slightly to around 0.1 bn m^3 EQ. However, with greater market opportunities at home, some developing countries with currently high exports may reduce their levels of exports in the future.

3.2 Supply and demand for industrial wood and wood products by region

Greater regional detail about wood production and wood products consumption in 1996 and a forecast for 2010 are shown in *Figure 3.* Reflecting their shares of world GDP, consumption of wood products is dominated by OECD countries. Non-OECD countries in Asia and Oceania also account for a major share of world production and consumption. In contrast, Africa and Non-OECD countries in Europe and South and Central America together account for less than 10% of global wood product consumption.[10]

Figure 3: Global industrial roundwood production and forest product consumption in 1996 and the forecast for 2010



[10] To avoid the complexities of including the use of recovered paper in these calculations, wherever wood product production and consumption is compared with industrial roundwood production and consumption, wood products has been defined as including only: sawnwood; wood based panels and wood pulp. This is, of course, slightly misleading in situations where recovered paper and non-wood fibres are an important component of the total fibre supply used to make paper.

Notwithstanding the present economic difficulties in Asia, continued increases in wealth in this most populous region are expected to result in the Asia and Oceania region (including developed and developing countries) maintaining its position as the region with the greatest share of global consumption and future demand growth.

3.2.1 Current supply and demand by geographical region

North America and Asia each account for about one-third of current global forest products consumption. The two OECD members in Asia (Japan and Republic of Korea) account for one-third of Asia's share of consumption, China accounts for just under one-third and the other non-OECD countries in the region account for the remainder

Europe follows closely, accounting for about one-quarter of global consumption. Of this, three-quarters is consumed in European OECD countries. South America, Africa and Oceania are currently relatively insignificant consumer regions, although South America does consume slightly more wood products than non-OECD countries in Europe.

In terms of industrial roundwood production in each of the regions, the pattern is slightly different. North America supplies about 40% of the global market and Europe again accounts for about 25%. Asia provides about half of the remaining production, or about 18% of the global total and the other regions account for the remainder.

In terms of net trade, the picture is more complicated. At the regional level, the developed countries of Europe and the Asia region consume more than they produce. However, the two developed economies in Oceania (Australia and New Zealand) are both large net exporters. North America is also a large net exporter of wood and wood products. Of the developing regions, Asia is the only region which consumes more than it produces. Africa and developing countries in Oceania export more than half of their production (as both processed products and roundwood) and around one-third of production in non-OECD European and South and Central American countries is currently exported.

Given that the net imports into European OECD countries is almost exactly balanced by net exports from the non-OECD countries in Europe, Asia is the only region which is a major net importer of wood and wood products. The countries of Asia consume a volume of products equal to about 100 million m^3 of industrial roundwood more than they produce each year (or they import roughly 20% of their wood and wood product requirements). Asia imports a wide range of forest products each year, from raw logs and pulp through to sawnwood, panels and paper. To a large extent Japan is the major driving force behind this phenomenon, but other large economies in the region (such as China, Republic of Korea and Thailand) are also becoming significant net importers.

3.2.2 Growth in supply and demand by region

During the period 1996 to 2010, annual global industrial forest product production and consumption is projected to increase at a rate of about 1.7% per year, giving a total increase of 26% over the whole period. However, the expected level of consumption in 2010 (1.9 billion m^3 EQ/year) will only be about 10% higher than the peak in consumption (of 1.7 billion m^3 EQ/year) experienced around 1990.[11]

The low overall rate of growth in production and consumption expected in OECD countries is largely due to expected low growth in North America (see *Table 6*). Growth in European OECD countries is expected to match the global rate of growth and growth in the OECD Asia and Oceania region is expected to exceed it.

The highest rates of growth in production and consumption in non-OECD countries is expected in Europe, followed by Asia and Oceania. Growth in production and consumption in Africa will be slightly less than the global average, and growth in South and Central America will be lowest of all.

Table 6: Expected growth in production and consumption over the period 1995 to 2010

Region	Expected total growth in production 1995 - 2010	Expected total growth in consumption 1995 - 2010
Countries within OECD		
Europe	27%	23%
Asia and Oceania	34%	22%
The Americas	10%	8%
Subtotal	**17%**	**15%**
Non-OECD countries		
Europe	55%	100%
Asia and Oceania	52%	57%
The Americas	17%	9%
Africa	23%	18%
Subtotal	**41%**	**47%**
World total	**26%**	**26%**

The relative shares of global consumption and production held by each of the world regions is not expected to change much by 2010. The only slight change is that Asia and Europe are expected to increase their shares of global consumption and production by 2-3%, largely at the expense of North America. Asia is projected to have the highest rate of growth of industrial roundwood production at 3.0% per annum. Consumption in Asia is projected to grow at only 2.1%, but the region overall is expected to remain the world's main net importing region, and will still have to import a volume of forest products equal to roughly 20% of its consumption requirements each year by 2010.

[11] The global decline in production and consumption since 1990 is largely attributable to falls in production and consumption in the countries of the former USSR. This may be, in part, a statistical anomaly.

3.2.3 The distribution of wood processing by region

From the point of view of examining forest resources as a base for industrial development, it is also useful to compare the production of industrial roundwood with the production of processed products and this is shown in *Table 7*. This table compares industrial roundwood and processed forest product production[12] between the various developed and developing regions in 1996 and the projection for 2010.

Table 7: Industrial roundwood and forest product production by region in 1996 and 2010

Region	Industrial roundwood and product production in 1996 (million m^3 EQ)			Industrial roundwood and product production in 2010 (million m^3 EQ)		
	IRW	Products	Export/import level	IRW	Products	Export/import level
Countries within OECD						
Europe	256	276	-7%	327	361	-9%
Asia and Oceania	72	116	-38%	97	156	-38%
The Americas	596	580	+3%	653	634	+3%
Subtotal	**924**	**972**	**-5%**	**1,077**	**1,151**	**-6%**
Non-OECD countries						
Europe	113	91	+24%	175	148	+18%
Asia and Oceania	249	241	+3%	378	362	+4%
The Americas	135	124	+9%	157	136	+15%
Africa	68	61	+11%	84	74	+14%
Subtotal	**565**	**517**	**+9%**	**795**	**721**	**+10%**
World total	**1,490**	**1,490**		**1,872**	**1,872**	

Notes: For the purposes of this comparison, product production has been defined as the production of sawnwood, wood-based panels and wood pulp. Negative percentages indicate the proportion of wood products manufactured from imported industrial roundwood and positive percentages indicate the proportion of industrial roundwood production which is exported.

The table shows that wood product production is currently higher than industrial roundwood production in all of the OECD countries together (i.e. the OECD countries are net importers of industrial roundwood). Within the three OECD regions, the exception is the North America region which is a net exporter of industrial roundwood (Australia and New Zealand are also major net exporters). In contrast, all of the non-OECD regions are net exporters of industrial roundwood. For example, non-OECD Europe exports one-quarter of its industrial roundwood production in the form of unprocessed wood.

The discrepancy between industrial roundwood and processed product production is currently highest in Asia and Oceania (developed and developing countries), where 321 million m^3 of industrial roundwood is currently produced, but the region produces processed products equal to a volume of about 357 million m^3. Thus, through industrial roundwood trade (net imports of 36 million m^3 per year), Asia produces a proportionately greater share of its processed forest product consumption requirements than the industrial roundwood production figures given above would suggest. If processing of imported pulp and wastepaper were taken into account, Asia and Oceania would be shown to have an even greater share of global processing capacity. Asia and Oceania is the world's major net industrial roundwood importing region and this situation (net industrial roundwood imports into Asia and Oceania supporting the

[12] For the purposes of this comparison, processed product production has been defined as the production of sawnwood, wood-based panels and wood pulp.

wood processing sector there) is also expected to continue in the future at roughly the same level.

With the exception of OECD countries in Europe, the other regions all produce more industrial roundwood than processed products and, hence, supply Asia and Oceania with its industrial roundwood imports. The only main change expected in the future is that the sources of industrial roundwood imports for Asia and Oceania may diversify away from North America to include greater shares from other countries (e.g. the Russian Federation and countries in South America).

3.3 Supply and demand for industrial forest products by product category

Current and projected estimates of global forest product production and consumption by product category are shown in *Table 8*. As in the past, consumption of paper and paperboard is expected to have the most rapid growth of all the product sectors, at an annual rate of 2.4%. In contrast, consumption of pulp for paper is projected to grow by only 1.1% per year, reflecting the increased use of recovered paper in the total fibre furnish which, it is expected, will take place in the future.

Moderate growth in solid wood product consumption is expected, at rates of 1.1% per annum in the case of sawnwood and 1.3% per annum in the case of wood-based panels. Most growth in wood-based panels production and consumption is expected in the reconstituted wood panels sector rather than the plywood sector.

Table 8: Production and consumption by product category in 1995 and 2010

Product category	Production/consumption		Total growth	Annual growth
	in 1996	in 2010	1996 - 2010	1996 - 2010
Industrial roundwood	1,490	1,872	26%	1.7%
Sawnwood	430	501	17%	1.1%
Wood-based panels	149	180	20%	1.3%
Pulp	179	208	16%	1.1%
Paper and paperboard	284	394	39%	2.4%

Note: all volume figures for roundwood, sawnwood and wood-based panels are in million m^3, figures for pulp and paper are in million MT.

A major significance of the difference in growth rates between the different product categories shown above is that these changes in consumption patterns will affect the types of raw material inputs which can be processed in the future. The highest rates of growth will be for products which can be produced from smaller sizes of wood and alternative fibre sources (i.e. paper and reconstituted panels). In contrast, consumption of products which require large logs as raw material inputs (i.e. sawnwood and plywood) will grow only slowly. Thus, changing future demand patterns will increase the scope for input substitution away from large logs, which have traditionally come from the natural forest or long rotation plantations, to other fibre inputs, which can come from a wide variety of sources. This is a major structural change which is expected to continue to take place in the future and, as will be shown later, could have profound implications for the relative importance of different sources of wood and fibre supply in the future.

3.4 Trade in industrial forest products

Given that the geographical distribution of industrial roundwood production and processing capacity is quite different to the distribution of forest product demand, international trade accounts for a relatively large share of forest product production. *Table 9* shows the share of forest product production that was internationally traded in 1995 by region and product category.

In line with most countries desires to add-value to domestic resources, the proportion of industrial roundwood and pulp production that is traded is generally lower than the proportion of the other forest products that are traded.[13] However, this is less so in Africa, Asia and South America. Thus, for example, pulp exports account for a major share of pulp production in Africa and Latin America & the Caribbean and industrial roundwood exports are relatively important in Africa and Asia. In contrast, North America exports a major share of its sawnwood production and Europe is a major trader of all products.

Table 9: Forest products trade as a proportion of production in 1995

Region	Industrial roundwood			sawnwood			wood-based panels			pulp			paper		
	million m^3		%	million m^3		%	million m^3		%	million mt		%	million mt		%
	Prod	Exp		Prod	Exp		Prod	Exp		Prod	Exp		Prod	Exp	
Africa	67	7	10	9	1	15	2	0	21	2	1	27	3	1	20
Asia and Oceania	309	34	11	103	8	8	46	16	35	44	1	3	81	7	8
Latin America & the Caribbean	141	13	9	33	4	12	7	2	33	10	4	38	12	2	14
North America	592	24	4	166	55	33	47	9	19	85	17	20	104	22	21
Europe	401	55	14	116	42	36	45	15	33	42	9	21	82	44	53
World	**1,510**	**131**	**9**	**427**	**111**	**26**	**146**	**42**	**29**	**183**	**32**	**17**	**282**	**75**	**27**

Source: FAO (1999b)

Earlier sections have already alluded to the major wood product trade flow into Asia from the other world regions. A fuller picture of global forest products trade flows is given in *Table 10*. As the table shows, Europe accounts for nearly one-half of total world forest products trade (by value). North America accounts for about one-third of world exports and Asia accounts for about one-third of world imports.

However, much of the trade in forest products at this scale is within regions. For example, 80% of Europe's trade is between European countries, 85% of exports from countries in Asia are to countries in the same region and 80% of North American imports come from within the region. The only major (over US$ 5 billion) inter-regional trade flows are from North America to Europe and from North America and Europe to Asia and Oceania.

[13] There are also certain production economies from using pulp in integrated mills (i.e. mills that produce pulp and then use it straight away to produce paper and paperboard).

Table 10: Direction of global trade in forest products in 1995 (value in US$ billions)

	From						
To	**Africa**	**Asia and Oceania**	**Latin America & Caribbean**	**North America**	**Europe**	**World total**	
Africa	0.3	0.2	0.1	0.5	2.0	**3.1**	**2%**
Asia and Oceania	1.2	17.9	1.7	15.3	6.4	**42.6**	**30%**
Latin America & the Caribbean	0.1	0.0	1.2	4.1	0.7	**6.1**	**4%**
North America	0.1	1.0	1.7	20.4	1.6	**24.9**	**18%**
Europe	2.1	1.4	2.3	8.5	49.4	**63.8**	**45%**
World total	**3.9**	**20.7**	**6.9**	**48.8**	**62.1**	**142.4**	
	3%	**16%**	**5%**	**34%**	**43%**		

Source: estimated from UN COMTRADE database by FAO

Since the 1950's, trade in forest products has steadily increased as a proportion of total production. In the future however, growth in trade in forest products may lag behind growth in production and consumption. This may occur for two reasons. Firstly, because countries will continue to develop value-added industries in their own countries (e.g. to process rather than export roundwood and pulp), which will reduce exports of semi-processed products.[14] Secondly, because it is expected that several currently large exporters in less developed countries, particularly in Asia, will develop significant domestic markets of their own due to strong economic growth export (see *Box 2* for a slightly different view of the future in Asia).

Box 2: The impact of the recent economic downturn in Asia on the supply and demand projections to 2010

The model used to produce the supply and demand forecasts contained here was also used to estimate the potential impact of the recent economic downturn in Asia on global markets. It was not the purpose of this exercise to estimate the immediate effects of the crisis, but the long-term impact on the outlook to 2010. Based on projections of reduced economic growth in Asia available in April 1998, the results of this analysis are briefly summarised below.

With significantly reduced economic growth in: Republic of Korea; Indonesia; Thailand and Malaysia, plus knock-on effects in some other countries in the region, overall consumption of wood products is expected to follow a slower growth trajectory. This will result in estimates of consumption which are roughly 4-5% lower than the baseline projection for the year 2010 across all wood product categories. Because of the effects of competitive devaluation and the fact that the region is such a large importer, it is projected that most of this reduction in consumption growth will be reflected in lower imports to the region. However, some countries in the region that have been less badly affected by the crisis (e.g. Australia and Japan) may increase forest product imports if prices in the region generally fall. Production in major exporter countries is expected to remain on a similar trajectory to the baseline projection due to the effect of these devaluations.

In summary therefore, the impact of the crisis is likely to result in only slightly less consumption in the long-term. The crisis is not projected to have a major impact on suppliers in the region, but is expected to result in lower imports to the region from countries outside.

Source: FAO (1998)

If the above developments do occur, they will put pressure on importing countries, particularly those (predominantly in Asia), which have built large forest product processing industries that rely on imports of raw materials (i.e. industrial roundwood) and partly

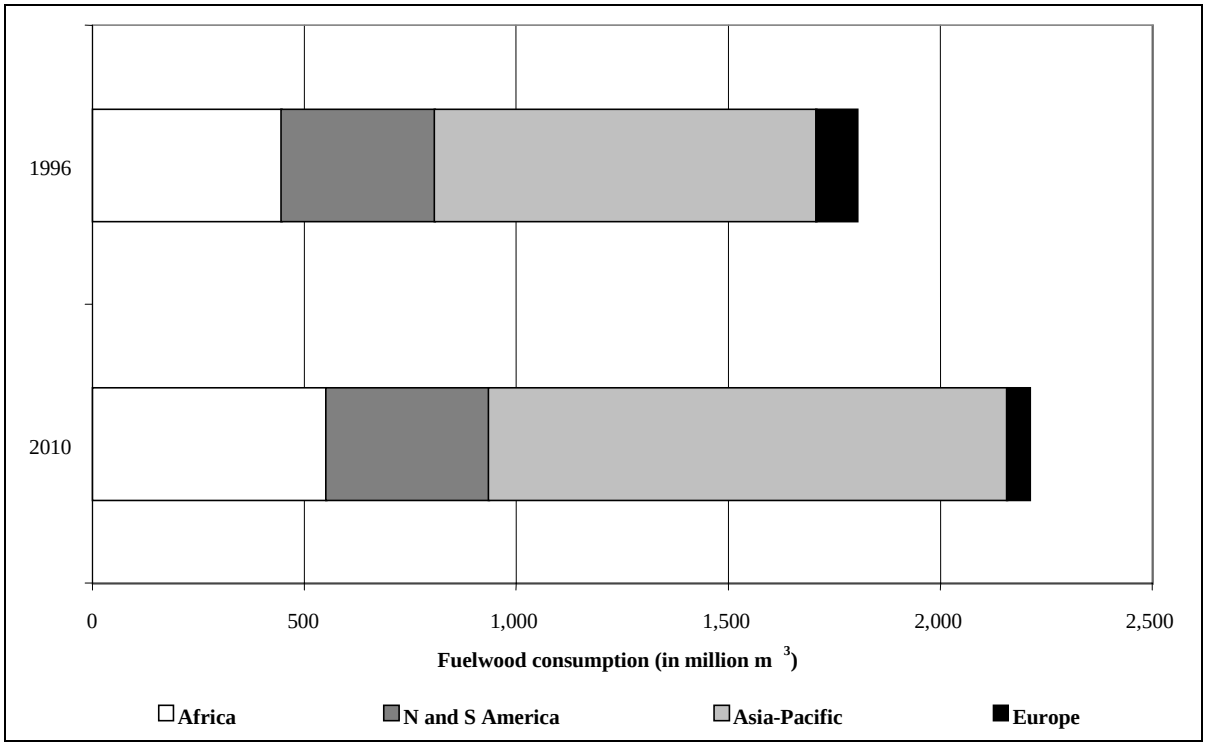
[14] Countries may also, in the future, export more wood products as finished products such as furniture, doors and window frames, which will not show-up in forest product statistics.

processed forest products (such as pulp and rough sawn timber). This will have implications for the future location of processing facilities in these countries and may require that they restructure some of their domestic processing industries.

3.5 The supply and demand for wood fuel

Projecting wood fuel supply and demand is a difficult task because statistics about this forest product are currently only partial and quite unreliable. However, as part of this study, FAO has conducted a literature search to collect and enhance its existing databases on wood fuel use. This has included collecting new information about wood fuel consumption and revising FAO's models of wood fuel demand.[15] More importantly however, it has also involved collecting better information about the utilisation of various sources of supply.

Figure 4: Wood fuel consumption in 1996 and projection for 2010



[15] The projections given here are based on FAO's WAICENT statistics. Revised projections will be produced later as part of the FAO's Global Forest Products Outlook Study working paper series.

3.5.1 Projections of wood fuel demand

Current and projected wood fuel consumption is shown in *Figure 4*. World wood fuel consumption currently stands at around 1.8 billion m^3, or roughly 20% higher than industrial roundwood consumption. This is projected to increase by 1.5% per annum (or just under 25% in total) over the period to 2010, at which point consumption will amount to around 2.2 billion m^3. (More detailed projections are given in Annex 1).

In line with the size of its population, Asia accounts for around half of world wood fuel consumption and consumption in Asia is projected to increase by over 2% per annum (or over one third in total) over the period. In contrast, consumption in Europe is expected to almost halve over the same period. The differences between the projections of consumption growth in Asia and Europe show how sensitive consumption growth is to income. As countries in Asia become richer, they may, at first, be expected to consume more fuel generally, as incomes rise. As part of this, wood fuel consumption would be expected to increase and the supply of wood fuel may also become more formalised (i.e. from collection for own use towards commercial collection for resale) as consumers can afford to buy wood fuel rather than have to collect it themselves. However, as income continue to rise, consumers will tend to switch to other types of fuel (usually charcoal first, then kerosene, followed by LPG and electricity), which are cleaner, easier to use and quicker to heat or cook.

A range of other supply-side factors will also affect fuel-switching (from wood to other types of fuel) and it is uncertain at what level of income fuel-switching will start to occur. Thus, for example, increased incomes in Asia, combined with future investment in rural energy supply infrastructure may result in less consumption growth than is shown here.

3.5.2 Sources of wood fuel supply

A key question which is often asked is: what sources of wood are used for wood fuel supply and what role does wood fuel collection play in deforestation? Research by FAO indicates that a wide range of forest and other land types are used for wood fuel supply. It also shows that deforestation due to wood fuel collection is often very localised and generally only occurs in areas that are already under stress due to other ecological factors such as drought..

Extensive research in Asia (FAO, 1998), suggests that only about one-third of wood fuel comes from forest land. The majority of wood fuel is collected from individual trees and shrubs, or from shelterbelts and woodlots on agricultural land. The same research indicated that wood fuel collected for own-use is rarely transported more than 20 km, but may be transported for up to 100 km if it is being collected for resale. Further research has also shown that charcoal may be transported for even greater distances due to its higher value. Thus, as people move up the "fuel-ladder" from wood fuel to charcoal, wood fuel collection (and on-site conversion into charcoal) may move into forest areas that were previously economically inaccessible.

Another point to note is that the collection of wood fuel often does not compete with production of industrial roundwood and may not greatly harm standing trees. For a start, all over the world, research indicates that deadwood is preferred to greenwood as a wood fuel source because it is lighter, does not require drying and burns more easily. Furthermore, if

deadwood is not available, branches are often preferred to whole trees because they are easier to cut and require less cutting to the sizes suitable for stoves and domestic fireplaces. Again, however, in commercial wood fuel collection operations it may be more efficient to utilise whole trees.

In conclusion, wood fuel supply comes from a variety of sources and utilises a range of types of wood apart from whole trees. There are examples of local wood fuel scarcity and deforestation due to wood fuel collection around some of the world's largest and poorest towns and cities. However, it is likely that the increased demand for wood fuel projected earlier will not, on its own, lead to greater deforestation except in a few localised areas. A more important mechanism by which wood fuel demand may lead to greater deforestation is the likely commercialisation of wood fuel collection and greater conversion of wood fuel into charcoal, as wood fuel consumers incomes rise.

The challenge for policymakers will be to plan for the increased energy needs expected in developing countries and respond with appropriate strategies to supply these needs in the most efficient way and with minimal disturbance to the most highly valued forest areas. This is likely to require increased capacity of government institutions to identify and analyse these needs and develop an appropriate framework whereby wood fuel markets can develop alongside the maintenance of natural forest areas.

3.6 Comparison of roundwood supply with supply potential

In order to assess current and future potential fibre supply, it is necessary to examine trends in forest area, forest volume and forest removals and consider other developments such as the expansion of forest plantations and the development of new potential fibre sources. To compound the challenges in assessment, it is also necessary to consider the impacts of constantly shifting market forces and forest policies on these factors and the way they interact with one another.

Based on the information collected as part of the GFSM, APFSOS, and GFPM modelling exercises, FAO has started to examine these issue in more detail. (A brief description of the supply models used in these models is given in *Box 3*). A comparison of roundwood production with production potential in the Asia-Pacific region is given in *Box 4* and a more general comparison of industrial roundwood production and fibre supply potential for the whole of the world is given in *Table 11*.

Box 3: A brief description of the supply and demand models used by FAO in recent outlook studies

FAO have two main forecasting models which can be used to produce wood supply and demand projections: the Global Fibre Supply Model (GFSM) and the Global Forest Products Model (GFPM). As will be shown later, the GFSM only examines supply, but forms is an important input to the GFPM, which forecasts both supply and demand. An extension to the GFSM was also constructed for the APFSOS and this is explained below.

The Global Fibre Supply Model (GFSM)

The GFSM is a model of future potential wood and fibre supply, based on detailed information about the area and characteristics of forests, harvesting regimes (i.e. the amount of wood which is harvested per hectare in each cutting) and growth rates, harvesting efficiency, recovery of wastepaper and non-wood fibre pulping capacity. The model contains information about these variables, which can be used to project future supply, for nearly every country of the world.

In terms of forest characteristics, the model mostly contains information which is important for the calculation of future supply including: forest area by type and stocking; area logged and unlogged; and information about the areas which are potentially available for wood supply or unavailable due to legal, economic, or biological factors or reasons of accessibility. For forest plantations the model includes: area and species and potential growth rates.

The model projects future supply as a function of area multiplied by harvesting intensity or yield, depending on the type of forest, for each of the forest types available for wood supply in each country. In the absence of detailed age-structure data, the model also applies various yield reduction factors to the potential yields from forest plantations to take into account the immaturity of some plantation areas. The yield forecasts from all types of forest are also reduced to take into account harvesting efficiencies or the proportion of utilisable yield which is usually taken from the forest. (To a certain extent, the weakest component of this projection framework is the lack of reliable yield estimates from around the world). In addition to these forest-based supply components are added estimates of future potential wastepaper recovery and non-wood fibre utilisation.

The model can be used to project potential supply under a range of alternative assumptions about rates of deforestation, rates of harvesting in the unlogged forest and the expansion of the harvesting frontier into previously inaccessible forest. Changes in future plantation establishment, wastepaper recovery and non-wood pulping capacity are also important variables which affect future potential supply and future scenarios for these variables can be examined in the model. The scenario used in the baseline analysis presented here is one of continuation of past trends in these variables.

The Global Forest Products Model (GFPM)

The GFPM is a market simulation model of future wood and wood product production, consumption and trade for every country of the world. The model takes supply and demand curves for each country, fixes these such that the model roughly replicates global production, consumption and trade in the last year for which actual data is available and then shifts these curves out for every country and each year of the forecast. As part of this process the model identifies the trade flows and price changes necessary to clear all markets within each year of the forecast, using a linear programming algorithm. In contrast to the GFSM, the GFPM produces projections of actual wood production rather than potential production.

The demand curves used in the GFPM were estimated from an econometric analysis of past consumption using data taken from the Forest Products Yearbook (FPY). The analysis gave estimates of price and income elasticity for countries and projections of future income growth were used to shift the demand curves for each year of the forecast. On the supply side, estimates of the price elasticity of industrial roundwood supply were taken from the forest economics research literature. The supply curves for each country were then shifted in each year of the forecast on the basis of the projected changes in future potential supply given by the GFSM.

Box 3 (continued): A brief description of the supply and demand models used by FAO in recent outlook studies

Wood product production and the links between future product demand and roundwood and product supply in the model are specified in the model as functions of a series of technical coefficients such as roundwood to product conversion factors, capacity utilisation and wastepaper recovery rates. The baseline analysis presented here assumes no change in future technology, but does assume that the recovery and utilisation of wastepaper will increase in the future at the same rate as it has in the past.

Supply and demand model used in the Asia-Pacific Forestry Sector Outlook Study (APFSOS)

A considerable amount of in-depth information about wood supply and demand and timber markets generally was collected as part of the APFSOS. Given this wealth of data and the amount of time available, it was possible to examine future supply and demand in this region in greater detail than was possible in the broader global studies. In particular, the study gave a greater insight into future wood supply and supply potential, by examining in greater detail factors such as plantation developments, technology and supply from trees outside of forests. Some of these insights are presented in the following box and the main differences between the APFSOS and GFSM supply analysis are briefly described below.

In terms of forest products markets, the supply and demand projections presented in the APFSOS were constructed in roughly the same way as above. The GFSM was used to project changes in potential industrial roundwood supply and the GFPM was used to translate these into projections of future actual supply and demand. However, in the APFSOS, the industrial roundwood supply projections were also adjusted somewhat to reflect policy statements about future supply and demand from various forestry administrations in the region. These modifications have been included in the analysis presented here for the Asia and Oceania region, but not for any of the other regions.

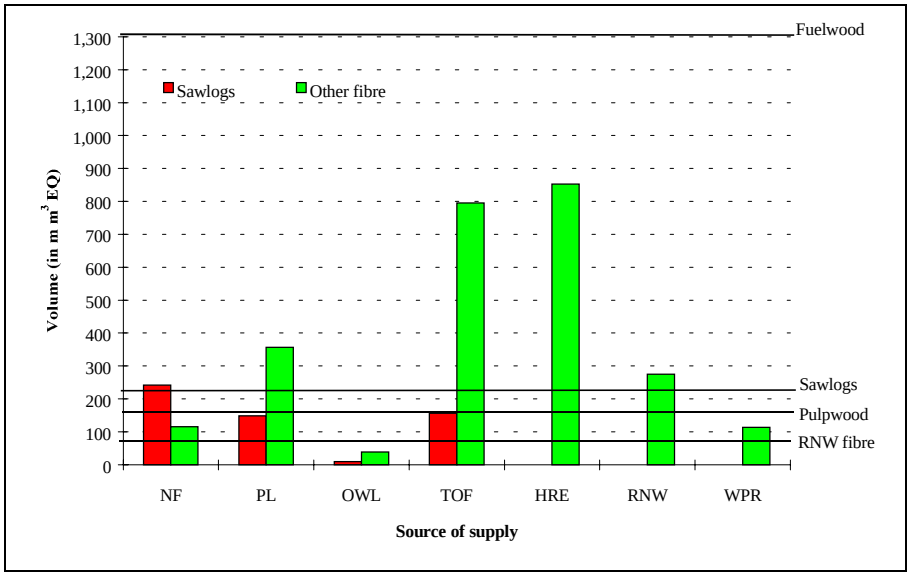
On the supply side, further modifications were made to the GFSM projections in the APFSOS to reflect the greater amount of data available about the region. The basic area statistics and projections contained in the GFSM were used in the APFSOS, but the potential supply projections were modified somewhat to take into account information available about the age structure of plantations and concessions in some countries in the region. Additional potential sources of supply were also considered in the analysis including: harvesting residues; wood processing residues; and trees outside of forests (including agricultural tree crops, for which there was considerable data).

The concluding section of the analysis examined how different sources of wood supply and improvements in harvesting and processing technology could be used to meet future wood demands at the same time as meeting other forestry policy objectives. It also identified the policy changes and investments which might be needed to follow different courses of action. This is the approach which will be attempted on a wider scale in part two of this report.

Source: FAO (1998 and 1999a) and Tomberlin et al (1999)

Box 4: The range of potential wood and fibre supplies in the Asia-Pacific region

An analysis of the supply outlook for all potential sources of wood and fibre supply was carried-out as part of the Asia-Pacific Forestry Sector Outlook Study (FAO, 1998). This analysis incorporated data from the GFSM (plantations, natural forest, recycled and non-wood fibre), an earlier study by Blanchez (1997) which included information about supply potential from trees outside the forest and a separate analysis of the potential volume of harvesting and wood processing residues produced each year. The main findings of the analysis are shown in the graph below.



The bars in the graph show the potential production of sawlogs and other fibre (small roundwood, residues, recovered paper and non-wood fibre) in 2010. Each pair of bars represents one of the following sources: natural forest (NF); plantations (PL); other wooded land (OWL); trees outside forests (TOF); harvesting residues (HRE); recovered and non-wood fibre (RNW); and wood processing residues (WPR). The forecasts were made on the basis of existing technology (except for a trend towards more recovery of wastepaper in the future) and policies (e.g. with respect to the area of forest in legally protected areas). However, historical trends in forest conversion to other land-uses were also incorporated in the forecast. The horizontal lines also show projected production of recycled and non-wood fibre, pulpwood, sawlogs and wood fuel in the region in 2010 from GFPOS 98.

As the graph shows, the region has a large potential to produce sawlogs and other fibre from outside the areas that would be typically considered in forestry supply and demand analysis (i.e. natural forest and plantations). In terms of other fibre production potential, non-forest sources far exceed the potential of the forest to meet production needs. For example trees outside the forest have twice the potential to produce small roundwood as forest plantations, due to the large area of agricultural land (particularly agricultural tree crops) in the area. (However, few reliable statistics on trees outside forests are available, so the exact magnitude of this resource is somewhat uncertain). Recovered paper and wood processing residues could also meet the regions entire needs for pulpwood. In terms of sawlog production, the forest industry typically has to look to forests to get the required high quality of logs. About half of the potential sawlog production in the region is from the natural forest and a further quarter from forest plantations. However, even in this category, trees outside forests account for the remaining one-quarter of production potential and could go a long way towards meeting sawlog production requirements.

Several countries with limited forest resources (e.g. many countries in South Asia) already use a wide variety of sources for sawlog and fibre supply. Countries that currently rely on natural forests to supply much of their needs also generally have the option to do this should they wish to.

Source: FAO (1998)

Box 4 shows that, comparing the forecast roundwood production levels estimated for 2010 for the Asia-Pacific region with production (or estimated biological) potential, future wood production requirements can be easily met within the region. However, a more detailed examination of the results also showed that, in certain countries and for certain types of wood, particularly sawlogs, supplies are going to become increasingly scarce in the future.

FAO does not yet have sufficient data to make an accurate assessment of the total wood and fibre production potential for the whole world. The GFSM, for example, covers a large part of the world, but excludes some regions and the important contribution of trees outside of forests. Another major weakness of the GFSM is the reliability and availability of yield estimates for forests from around the world. However, the GFSM and other official supply projections such as Fifth European Timber Trends Study or ETTS V (UN, 1996a) and North American Timber Trends Study or NATTS (UN, 1996b) can be used to make some sort of comparison between projected levels of actual production with projected future supply potential from the forest and recovered and non-wood fibre sources across some regions. Such a comparison is shown in *Table 11*.

Table 11: Forecast production of wood and fibre from forests, recovered and non-wood fibre sources compared with estimated potential production in 2010

Region	Forecast of actual production in 2010			Forecast of roundwood and other fibre production potential in 2010
	industrial roundwood	recovered and non-wood fibre	total	
Africa	84	2	86	81
Asia	421	222	643	729
Oceania	54	0	54	80
Europe	502	133	632	893
North and Central America	658	147	805	835
South America	153	2	155	225
World total	**1,872**	**506**	**2,375**	**2,843**

Note all volume figures are in million m^3 EQ (i.e. the figures for recovered and non-wood fibres have been converted to their industrial roundwood equivalents). The figures for potential production in Europe in this table are from ETTS V and include industrial roundwood, residue and recycled paper production, except for Russian Federation, where the official AAC for 2010 has been used. The potential production figures for North America are official estimates of future industrial roundwood production only and exclude the potential contribution of recovered fibre supplies. Consequently, total production potential in North America is far greater than shown here.

As *Table 11* shows, forecast production levels appear to be well within the forecast limit of forest, recovered paper and non-wood fibre production potential in all regions except Africa. However, three points are worth noting:

1. It must be stressed that the projections of future supply potential from the GFSM are incomplete, are not strictly comparable with the results from other studies such as ETTS V and NATTS and are based on what little data is currently available (which might be quite unreliable in many cases).

2. The projections from the GFSM in the above table present results which should probably be considered as an absolute maximum amount of potential supply. The cost of accessing increasingly marginal areas, which are included in the GFSM analysis, may prevent the total potential supply presented above from being utilised in the near future.

3. It should be remembered that, while supplies at a broad regional or country level may be plentiful, there may continue to be local scarcity which puts forestry policymakers under pressure to release areas of natural forest for timber harvesting in some areas.

In regions such as Africa and Asia, where supplies (particularly supplies of large logs) from forests are coming under pressure, consumers of wood and fibre may increasingly have to look to other sources of supply to meet demands (as they already are in some parts of Asia). This is particularly likely if increased scarcity is combined with more effective monitoring and control (i.e. to stop overharvesting). Alternatively, a perhaps more likely future, is that markets for forest products will continue to move in the direction of substitution of sawnwood and plywood by other wood-based panels and engineered wood products, which can be manufactured from small sized wood or non-wood substitutes.

3.7 Overall synthesis of the baseline projections

The above analysis suggests that supplies of wood and other types of fibre required to meet demand for the foreseeable future will be broadly within the productive capacity of the world's forests and other fibre sources. However, the situation will vary between countries and regions. For example, South Asia will continue to have to use a wide range of non-forest supply sources to meet their needs. Sawlog production will also approach the capacity of forests and plantations to provide the required higher qualities of logs in some regions, such as: Africa; Southeast Asia; and the Pacific Islands.

Given the above, it is also expected that product prices will not generally rise significantly over the projection period. Upward pressure on the prices of certain types of wood (typically the higher grades) may arise, but the price and availability of cheaper wood and non-wood substitutes will limit the potential for price increases. Such conditions will also encourage shifts in processing towards reconstituted panels at the expense of sawnwood and plywood.

Trading patterns are not expected to change significantly, except that the trend towards more in-country processing of wood raw materials is expected to continue in the future. This may lead to slower growth in trade in semi-processed and commodity grade wood products in the future compared with trade in higher value products.

4. MAIN GLOBAL MARKET POTENTIALS

The previous section of this analysis provided a broad indication of the potential markets and sources of supply for the main categories of forest product. This section increases the level of disaggregation to sharpen the focus of the analysis on the countries that account for most of the world's wood supply and demand and the most important countries in each of the main developing regions of the world.

The top ten consumer and producer countries across all forest product categories are mostly the same: the G5 countries, Sweden, Finland, Russian Federation, China and Indonesia. The United States of America is the largest producer and consumer of wood products across all product categories. Given the World Bank's focus on less developed countries therefore, this section has grouped OECD member countries together and included the most important producer and consumer countries in the developing regions in the analysis.

However, even outside the OECD country group, the same countries tend to appear as large producers or consumers across all product categories. Of the less developed countries, China, Russian Federation, Brazil and Indonesia are within the top six producers and consumers across all product categories. India, Malaysia and Chile are also important in many of the product categories. Countries which are not so important at a global scale but are important within their respective regions include: Thailand; Turkey; Nigeria; South Africa; and Argentina.

The analysis presented below has used the country groupings described earlier (i.e. three OECD regions and four non-OECD regions). Statistics for an alternative country grouping - World Bank client and non-client countries in each of their operational regions - is given in Annex 2.

4.1 Industrial roundwood production and consumption

Current and projected industrial roundwood production and consumption is shown in *Table 12*. In terms of production, OECD countries, led by the United States of America and Canada, currently produce 62% of the world's industrial roundwood. Other large OECD producers include: Sweden, Finland and Germany.

Of the non-OECD regions, Asia and Oceania has the greatest share of world industrial roundwood production (17%) and four producers of global significance (China, Indonesia, Malaysia and India). The only other globally significant producers in the non-OECD regions are Russian Federation, Brazil; Chile and South Africa.

Industrial roundwood production in non-OECD Europe is dominated by the Russian Federation (production in other countries in Eastern Europe is very small at the global scale). However, Russian production continues to be significantly lower than experienced in previous decades due to the economic circumstances facing the country. It is likely that, of all the non-OECD countries, the Russian Federation has the greatest potential to increase industrial roundwood production substantially.

The non-OECD South and Central America and Asia and Oceania regions both contain a number of large industrial roundwood producers. Production in these regions comes from a mixture of tropical natural forests, tropical plantations and temperate plantations. The plantations in these regions have tremendous potential to increase wood supplies in the future. However, there are uncertainties about the yields which might be achieved in some of these plantations. The other major supply uncertainty in these regions concerns the amounts and manner of harvesting which will be allowed in the regions' natural forests in the future.

Africa is a minor industrial roundwood producing region, despite containing most of the major remaining countries which will export tropical logs. One third of industrial roundwood production in Africa comes from South Africa (mostly from temperate plantations). However, industrial roundwood production in this country is small at the global scale.

In terms of current industrial roundwood consumption, the picture is only slightly different. OECD countries account for 65% of world industrial roundwood consumption, again led by the United States of America and Canada. Japan is the next major consumer and, as a result of relatively low domestic production, is a major importer (Japan accounts for a substantial share - about 40% - of the world's industrial roundwood imports). Other major consumers are: Sweden; Finland; and France.

Of the non-OECD countries, the same six countries (Russian Federation, China, Indonesia, Malaysia, India and Brazil) are the top industrial roundwood consumers and account for 24% of world consumption. All the other non-OECD countries added together only account for 11% of global industrial roundwood consumption. Non-OECD countries in Asia have the greatest share of consumption of the non-OECD regions (19%) and this region is a net importer of industrial roundwood.

By 2010, it is expected that non-OECD countries will have increased their share of global industrial roundwood production and consumption to 42% and 38% respectively. The United States of America and Canada will remain the world's largest industrial roundwood producers and consumers, but with a smaller share of the global market. Most other OECD countries are expected to increase production and consumption in line with the global trend. Japan will remain a significant log buyer, but will find it increasingly difficult to source logs from its traditional supplier countries. It is likely to look to the southern countries, particularly in Oceania and South America, for new sources of supply.

Table 12: Current and projected industrial roundwood production and consumption by region and country

Region	1996				2010 (projection)			
	Production		Consumption		Production		Consumption	
	(1,000 m^3)	%	(1,000 m^3)	%	(1,000 m^3)	%	(1,000 m^3)	%
OECD - Europe	256,327	17%	277,108	19%	326,616	17%	362,780	19%
OECD - Asia and Oceania	72,448	5%	115,960	8%	97,024	5%	156,812	8%
OECD - Americas	595,622	40%	581,326	39%	653,304	35%	637,086	34%
OECD total	**924,397**	**62%**	**974,394**	**65%**	**1,076,943**	**58%**	**1,156,678**	**62%**
Russian Federation	67,000	4%	51,652	3%	94,523	5%	83,542	4%
Romania	9,441	1%	9,516	1%	9,028	<1%	9,008	<1%
Belarus	9,206	1%	8,690	1%	14,221	1%	13,278	1%
Latvia	5,690	<1%	3,387	<1%	6,920	<1%	1,660	<1%
Slovakia	4,887	<1%	4,343	<1%	4,549	<1%	3,515	<1%
Others	17,091	1%	13,564	1%	46,201	2%	37,682	2%
Non-OECD Europe total	**113,315**	**8%**	**91,153**	**6%**	**175,442**	**9%**	**148,685**	**8%**
China	108,718	7%	112,407	8%	151,582	8%	154,770	8%
Indonesia	47,245	3%	46,739	3%	57,256	3%	56,960	3%
Malaysia	35,771	2%	28,843	2%	37,910	2%	24,883	1%
India[1]	24,989	2%	25,302	2%	46,936	3%	49,955	3%
Turkey	10,745	1%	11,501	1%	13,789	1%	13,806	1%
Others	21,698	1%	16,701	1%	70,707	4%	63,474	3%
Non-OECD Asia & Oceania total	**249,165**	**17%**	**241,493**	**16%**	**378,180**	**20%**	**363,849**	**19%**
Brazil	84,711	6%	82,504	6%	97,405	5%	88,114	5%
Chile	21,387	1%	14,938	1%	28,933	2%	21,971	1%
Argentina	6,220	<1%	5,258	<1%	10,752	1%	7,756	<1%
Ecuador	5,514	<1%	5,495	<1%	1,558	<1%	1,519	<1%
Paraguay	3,877	<1%	3,882	<1%	2,107	<1%	2,094	<1%
Others	13,007	1%	12,644	1%	16,725	1%	15,390	1%
Non-OECD Americas	**134,716**	**9%**	**124,721**	**8%**	**157,480**	**8%**	**136,844**	**7%**
South Africa	18,176	1%	15,780	1%	21,677	1%	18,214	1%
Nigeria	8,479	1%	8,470	1%	9,698	1%	9,796	1%
Congo, Democratic Republic of	3,433	<1%	3,255	<1%	4,694	<1%	4,580	<1%
Cameroon	3,364	<1%	2,057	<1%	3,455	<1%	1,806	<1%
Côte d'Ivoire	3,008	<1%	2,676	<1%	2,989	<1%	2,929	<1%
Others	31,471	2%	28,930	2%	41,016	2%	37,358	2%
Africa total	**67,931**	**5%**	**61,168**	**4%**	**83,529**	**4%**	**74,682**	**4%**
Non-OECD total	**565,127**	**38%**	**518,535**	**35%**	**794,631**	**42%**	**724,060**	**38%**
World total	**1,489,524**		**1,492,929**		**1,871,574**		**1,880,738**	

Note: 1. Based on production of wood products, it is suspected that current industrial roundwood production in India is substantially under-reported. A figure of closer to 40 million m^3 is probably the current level of industrial roundwood production and growth from 1996 to 2010 will, consequently, really be lower than appears here.

Of the non-OECD countries, industrial roundwood production is expected to increase in all the major producer countries. However, there are uncertainties about supply in some of the larger producers. China has announced a policy to restrict harvesting from the natural forest as has Malaysia. Several smaller countries (e.g. Sri Lanka; Thailand and the Philippines) already have production bans in the natural forest and others are examining this policy option (e.g. Vietnam).

Most industrial roundwood production growth in non-OECD countries is expected to come from the maturation of plantations in large producer countries such as: China; Brazil; and Indonesia. Other slightly smaller producer countries are also expected to increase their share

of world industrial roundwood production due to the maturation of their plantation resources (e.g. Chile and Argentina).

4.2 Sawnwood production and consumption

Current and projected sawnwood production and consumption is shown in *Table 13*. OECD countries currently have a 68% share of world production and a 69% share of world consumption. The United States of America and Canada again lead the sawnwood production table, although this time they are followed by: Japan; Sweden; Germany; and France. In terms of sawnwood consumption, major consumers in this group are: United States of America; Japan; Germany; Canada; France and Italy.

Canada is by far the largest sawnwood exporter in the world. Major sawnwood importers are the United States of America, Japan, the United Kingdom, Germany and Italy.

Of the non-OECD countries, the top four sawnwood producers (Russian Federation, China, India and Brazil) account for 19% of global production and consumption. The remaining developing countries added together account for about 13% of sawnwood production and 14% of sawnwood consumption.

Non-OECD Asia and Oceania again has the largest share of non-OECD sawnwood production (15%) and consumption (16%). In this region, Malaysia, Indonesia and Turkey are significant sawnwood producers and consumers at the regional level. Other countries of regional significance include: Chile in South America; and Nigeria and South Africa in Africa.

Out of all the non-OECD countries, only the Russian Federation and Malaysia are globally significant sawnwood exporters and China is the only major sawnwood importer. Brazil is of minor significance as a world exporter of sawnwood.

By 2010, the OECD share of world sawnwood production is expected to decline only slightly, but its share of global sawnwood consumption is expected to fall to 65%. This is due to slow growth in sawnwood consumption expected in the United States of America and Canada. Growth in the other OECD countries is expected match the global trend. Overall, the market for sawnwood in OECD countries is expected to grow by only 0.6% per annum or 9% in total over the period.

In contrast, relatively high rates of growth in consumption of sawnwood are expected in non-OECD countries, particularly in Asia and Eastern Europe, as their economies expand. Average annual growth of 2.2% or total growth of 35% over the period is expected in the non-OECD countries; this figure is roughly twice the rate of growth in OECD countries.

An important projection for non-OECD Asia and Oceania is that sawnwood consumption growth is expected to exceed production growth over the period to 2010. Most exporters in the region are expected to consume more of their domestic production and have less sawnwood left over for export and sawnwood imports are projected to increase in several countries. As a result, the region is projected to change from net exporter of sawnwood to net importer of sawnwood.

Table 13: Current and projected sawnwood production and consumption by region and country

Region	1996				2010 (projection)			
	Production		Consumption		Production		Consumption	
	(1,000 m^3)	%	(1,000 m^3)	%	(1,000 m^3)	%	(1,000 m^3)	%
OECD - Europe	79,763	19%	80,006	19%	90,515	18%	94,540	19%
OECD - Asia and Oceania	38,663	9%	51,206	12%	50,121	10%	60,325	12%
OECD - Americas[1]	175,026	41%	163,222	38%	193,442	39%	165,269	33%
OECD total	**293,452**	**68%**	**294,433**	**69%**	**334,077**	**67%**	**320,133**	**64%**
Russian Federation	21,600	5%	16,927	4%	30,586	6%	26,457	5%
Romania	1,693	<1%	808	<1%	1,527	<1%	1,217	<1%
Belarus	1,545	<1%	1,397	<1%	1,961	<1%	1,652	<1%
Latvia[2]	1,300	<1%	..	..	476	<1%	223	<1%
Lithuania	1,250	<1%	204	<1%	623	<1%	621	<1%
Others	3,134	1%	2,435	1%	9,485	2%	9,575	2%
Non-OECD Europe total	**30,522**	**7%**	**21,771**	**5%**	**44,658**	**9%**	**39,746**	**8%**
China	26,969	6%	28,901	7%	29,920	6%	37,202	7%
India	17,460	4%	17,450	4%	22,208	4%	22,207	4%
Malaysia	8,382	2%	4,985	1%	6,243	1%	5,948	1%
Indonesia	7,338	2%	6,941	2%	11,381	2%	10,553	2%
Turkey	4,331	1%	4,455	1%	4,848	1%	4,884	1%
Others	1,788	<1%	7,144	2%	9,980	2%	15,555	3%
Non-OECD Asia & Oceania total	**66,267**	**15%**	**69,875**	**16%**	**84,580**	**17%**	**96,349**	**19%**
Brazil	19,091	4%	17,563	4%	20,067	4%	20,453	4%
Chile	3,802	1%	2,739	1%	3,182	1%	3,155	1%
Ecuador	1,886	<1%	1,803	<1%	270	<1%	269	<1%
Argentina	1,000	<1%	1,121	<1%	1,356	<1%	1,296	<1%
Costa Rica	780	<1%	779	<1%	842	<1%	927	<1%
Others	3,699	1%	3,800	1%	3,617	1%	5,189	1%
Non-OECD Americas	**30,258**	**7%**	**27,805**	**7%**	**29,334**	**6%**	**31,289**	**6%**
Nigeria	2,723	1%	2,698	1%	3,135	1%	3,132	1%
South Africa	1,574	<1%	1,948	<1%	1,852	<1%	1,812	<1%
Cameroon	1,400	<1%	1,084	<1%	259	<1%	224	<1%
Côte d'Ivoire	706	<1%	206	<1%	730	<1%	110	<1%
Ghana	604	<1%	364	<1%	494	<1%	463	<1%
Others	2,140	<1%	6,111	1%	2,134	<1%	5,028	1%
Africa total	**9,147**	**2%**	**12,411**	**3%**	**8,604**	**2%**	**10,770**	**2%**
Non-OECD total	**136,193**	**32%**	**131,862**	**31%**	**167,177**	**33%**	**178,154**	**36%**
World total	**429,645**		**426,295**		**501,254**		**498,288**	

Notes: 1. *It is not really possible to compare actual consumption in 1996 with the projection for 2010, because the projection is a projection of the trend and consumption in 1996 was significantly above this trend. Consequently, the growth trend in consumption is higher than the appearance given here.*

2. *Net exports of sawnwood from Latvia were greater than officially recorded production in 1996, so consumption can not be accurately estimated.*

4.3 Wood-based panel production and consumption

Current and projected wood-based panel production and consumption is shown in *Table 14*. OECD countries have a 67% share of world wood-based panel production and 73% share of wood-based panel consumption. Again, the United States of America is the worlds largest producer and consumer. Germany, Canada, Japan, Italy and France are the next largest producers and the order of the next largest consumer countries is: Japan; Germany; the United Kingdom; Italy; Canada and France.

Canada is the largest OECD exporter of wood-based panels. However, in contrast to the market for sawnwood, it is not the world's largest exporter (Indonesia is). The high level of wood-based panels production in Japan is partly dependent on the import of industrial roundwood (the same is true of Japan's sawnwood production).

An interesting feature to note, is that European production of wood-based panels is globally much more significant compared with Europe's position in the global markets for industrial roundwood and sawnwood. Europe is particularly strong in markets for reconstituted panels, which form a much greater share of the market for solid wood products (sawnwood and wood-based panels) in Europe than elsewhere. For example, reconstituted panels account for about 30% of solid wood product consumption in Europe, compared with 15% in North America and just over 10% in Asia.

Non-OECD countries have a one-third share of world wood-based panel production and a slightly lower share of world consumption. The top three wood-based panel producers (China, Indonesia and Malaysia) have a 22% share of world production and Brazil and Russian Federation are the only other globally significant developing country producers with a 2% share of world production each.

Asia and Oceania is by far the largest non-OECD producer region and wood-based panel production in many Asian countries is currently concentrated in the plywood sector. Much of this current strength in plywood production is based on the natural advantage of a relatively abundant availability of large logs from the natural forest. The same is also true of Brazil to some extent.

Several of the non-OECD countries shown in *Table 14* are also globally significant wood-based panel exporters. For example, Indonesia is the world's largest exporter of wood-based panels, Malaysia is the world's third largest exporter and Brazil is the world's eighth largest exporter. Most of these exports are of commodity-grade plywood to markets in East Asia, including: China; Japan; and Republic of Korea.

The shares of wood-based panel production and consumption held by OECD countries and non-OECD countries is not expected to change by very much by 2010. The only major expected change is that, as with sawnwood, production growth in non-OECD countries is not expected to keep-up with consumption growth. Thus, net exports from non-OECD countries to OECD countries are expected to fall significantly as these countries consume more of their production in their domestic markets.

Table 14: Current and projected wood-based panel production and consumption by region and country

Region	1996				2010 (projection)			
	Production		Consumption		Production		Consumption	
	(1,000 m^3)	%	(1,000 m^3)	%	(1,000 m^3)	%	(1,000 m^3)	%
OECD - Europe	37,942	25%	38,808	26%	52,415	29%	49,514	28%
OECD - Asia and Oceania	12,389	8%	20,238	14%	17,370	10%	24,935	14%
OECD - Americas	49,605	33%	49,002	33%	53,394	30%	53,150	30%
OECD total	**99,936**	**67%**	**108,049**	**73%**	**123,180**	**69%**	**127,599**	**71%**
Russian Federation	3,036	2%	2,126	1%	6,305	4%	5,628	3%
Hungary	459	<1%	337	<1%	477	<1%	517	<1%
Romania	433	<1%	435	<1%	508	<1%	556	<1%
Belarus	374	<1%	348	<1%	570	<1%	485	<1%
Slovenia	361	<1%	303	<1%	168	<1%	499	<1%
Others	1,562	1%	1,305	1%	3,782	2%	3,966	2%
Non-OECD Europe total	**6,225**	**4%**	**4,853**	**3%**	**11,809**	**7%**	**11,651**	**7%**
China[1]	15,349	10%	19,479	13%	13,912	8%	16,014	9%
Indonesia	10,128	7%	1,873	1%	11,978	7%	3,376	2%
Malaysia	6,770	5%	1,760	1%	4,141	2%	2,183	1%
Turkey	1,078	1%	1,316	1%	835	<1%	1,126	1%
Philippines	596	<1%	833	1%	496	<1%	499	<1%
Others	1,140	1%	3,393	2%	3,953	2%	8,368	5%
Non-OECD Asia & Oceania total	**35,061**	**23%**	**28,653**	**19%**	**35,315**	**20%**	**31,567**	**18%**
Brazil	3,558	2%	2,617	2%	3,320	2%	1,849	1%
Chile	844	1%	446	<1%	782	<1%	786	<1%
Argentina	590	<1%	448	<1%	1,274	1%	1,208	1%
Ecuador	380	<1%	296	<1%	336	<1%	335	<1%
Venezuela	194	<1%	212	<1%	351	<1%	392	<1%
Others	776	1%	847	1%	1,081	1%	1,298	1%
Non-OECD Americas	**6,342**	**4%**	**4,866**	**3%**	**7,143**	**4%**	**5,867**	**3%**
South Africa	653	<1%	741	<1%	492	<1%	456	<1%
Côte d'Ivoire	272	<1%	199	<1%	72	<1%	56	<1%
Nigeria	115	<1%	135	<1%	113	<1%	153	<1%
Ghana	105	<1%	33	<1%	90	<1%	88	<1%
Tunisia	104	<1%	136	<1%	214	<1%	258	<1%
Others	573	<1%	774	1%	1,081	1%	1,347	1%
Africa total	**1,822**	**1%**	**2,019**	**1%**	**2,062**	**1%**	**2,357**	**1%**
Non-OECD total	**49,450**	**33%**	**40,391**	**27%**	**56,328**	**31%**	**51,441**	**29%**
World total	**149,385**		**148,440**		**179,508**		**179,040**	

Note: 1. The trend in wood-based panel production and consumption in China is broadly upwards over the projection period.. Sudden very high levels of production and consumption were reported for China in 1995 and 1996 and it is believed that these figures may be a statistical anomaly.

Given that such a large share of wood-based panel production in non-OECD countries in Asia is plywood production and, consequently, dependent on the supply of large logs from the natural forest, the uncertainties about this source of industrial roundwood supply raised earlier must also apply to the outlook for wood-based panel production. Much of the recent increase in plantation area in Asia is accounted for by short-rotation pulpwood species which will not supply the sorts of logs required to make plywood. Furthermore, the areas which have been planted with suitable species will require some considerable time to mature and are unlikely to make much of a difference within the timescale of this analysis. Therefore, the projected increases in wood-based panel production shown here may be difficult to achieve without continued harvesting in the natural forest (at possibly even greater levels) or some restructuring of the industry into reconstituted panel production.

Another alternative solution might be to source such logs from other countries and there are already signs that some producers are looking to countries in other developing regions in order to obtain large logs from natural forests and keep this industry going. It is questionable however, whether such moves can be sustained in the long-run.

4.4 Pulp production and consumption

Current and projected pulp production and consumption is shown in *Table 15*. OECD countries currently have a three-quarters share of world pulp consumption and production and are again dominated by United States of America and Canada. Non-OECD Asia and Oceania currently has a 17% share of global pulp production and a 19% share of global pulp consumption. The non-OECD regions are relatively insignificant. Broadly speaking, the non-OECD region as a whole is a very small net exporter to OECD countries.

Of the non-OECD countries, China is the only globally significant pulp producer and consumer. The Russian Federation, Brazil and South Africa are significant within their regions, but fairly small producers at a global scale. It should also be noted that non-wood fibre pulp accounts for a major share of the Chinese market (as it does in India).

Very little growth in production and consumption is expected over the period to 2010. Most growth is likely to occur in non-OECD countries, particularly Asia and Oceania but also, to some extent, South and Central America. Thus, the OECD share of future world production and consumption is expected to fall slightly to 70% and 72% respectively.

The forecast for pulp production and consumption growth is relatively low considering that, of all the product categories, paper consumption is expected to grow the fastest in the future. This is because the GFPM analysis presented here has assumed that the use of recovered fibre will increase in the total fibre furnish in line with historical trends.

The collection and utilisation of recovered fibre is largely policy driven, so the extent to which this material is used in the future is largely in the hands of government policymakers (not necessarily forestry policymakers, though). At the rates of recovery assumed in this analysis, there is still scope to increase recovery further, but much will depend upon the costs of collecting more material and the incentives or regulations requiring producers and consumers to do so.

Table 15: Current and projected pulp production and consumption by region and country

Region	1996				2010 (projection)			
	Production		Consumption		Production		Consumption	
	(1,000 MT)	%	(1,000 MT)	%	(1,000 MT)	%	(1,000 MT)	%
OECD - Europe	33,958	19%	39,859	22%	43,425	21%	44,035	21%
OECD - Asia and Oceania	14,367	8%	19,604	11%	17,714	9%	22,601	11%
OECD - Americas[1]	83,386	47%	73,577	41%	82,098	39%	80,049	39%
OECD total	**131,711**	**74%**	**133,039**	**75%**	**143,236**	**69%**	**146,686**	**71%**
Russian Federation	3,725	2%	2,758	2%	2,936	1%	2,734	1%
Romania	247	<1%	258	<1%	273	<1%	267	<1%
Slovakia	235	<1%	203	<1%	166	<1%	168	<1%
Bulgaria	107	<1%	77	<1%	157	<1%	91	<1%
Slovenia	101	<1%	192	<1%	95	<1%	202	<1%
Others	214	<1%	217	<1%	1,001	<1%	923	<1%
Non-OECD Europe total	**4,629**	**3%**	**3,703**	**2%**	**4,628**	**2%**	**4,385**	**2%**
China	24,751	14%	26,809	15%	35,330	17%	36,467	18%
Indonesia	2,635	1%	2,143	1%	2,753	1%	2,810	1%
India	1,870	1%	2,132	1%	2,375	1%	2,392	1%
Thailand	503	<1%	718	<1%	436	<1%	1,007	<1%
Turkey	354	<1%	500	<1%	203	<1%	621	<1%
Others	719	<1%	1,196	1%	3,327	2%	3,853	2%
Non-OECD Asia & Oceania total	**30,832**	**17%**	**33,498**	**19%**	**44,424**	**21%**	**47,150**	**23%**
Brazil	6,225	3%	4,258	2%	7,144	3%	4,363	2%
Chile	2,123	1%	479	<1%	4,056	2%	514	<1%
Argentina	822	<1%	768	<1%	1,005	<1%	535	<1%
Colombia	307	<1%	380	<1%	476	<1%	642	<1%
Venezuela	165	<1%	358	<1%	124	<1%	195	<1%
Others	139	<1%	227	<1%	498	<1%	718	<1%
Non-OECD Americas	**9,781**	**5%**	**6,470**	**4%**	**13,303**	**6%**	**6,966**	**3%**
South Africa	1,547	1%	1,177	1%	1,888	1%	1,693	1%
Swaziland[2]	200	<1%	..	..	99	<1%	..	..
Morocco	104	<1%	60	<1%	9	<1%	68	<1%
Kenya	66	<1%	71	<1%	143	<1%	143	<1%
Egypt	60	<1%	124	<1%	77	<1%	105	<1%
Others	154	<1%	276	<1%	204	<1%	344	<1%
Africa total	**2,131**	**1%**	**1,708**	**1%**	**2,419**	**1%**	**2,353**	**1%**
Non-OECD total	**47,373**	**26%**	**45,379**	**25%**	**64,774**	**31%**	**60,854**	**29%**
World total	**179,083**		**178,418**		**208,009**		**207,540**	

Notes: 1. *It is not really possible to compare actual consumption and production in 1996 with the projection for 2010, because the projection is a projection of the trend and consumption and production in 1996 was significantly above this trend. Consequently, the growth trend in consumption and production is higher than the appearance given here.*

2. *Net exports of sawnwood from Swaziland were greater than officially recorded production in 1996, so consumption can not be accurately estimated..*

4.5 Paper production and consumption

Current and projected paper and paperboard production and consumption is shown in *Table 16*. As with the market for pulp, OECD countries have a dominant share of the global market for paper, accounting for nearly 80% of global production and 75% of global consumption. However, OECD countries as a whole are net exporters to non-OECD countries.

Again, China is the only non-OECD country with a significant paper market and non-OECD Asia and Oceania holds the largest global share of paper production (15%) and consumption (18%) of all the non-OECD regions.

As with other product categories, the share of the global market held by OECD countries is expected to decline by 2010. Production share will fall back 3% to 76% as less developed countries expand their production capacity more rapidly than OECD countries. Consumption share will fall back only slightly, by 1% to 74%.

Paper consumption growth in most non-OECD countries is expected to exceed growth in the OECD countries by a wide margin. However, due to the currently extremely low levels of consumption in many of these countries, this is not expected to change the picture of global supply and demand by very much in the near future.

In terms of future paper (and pulp) production, the main uncertainty about the forecast presented here concerns the large area of pulpwood plantations which have been established in many tropical countries over the last decade or so. The potential volume of fibre which can be produced from these plantations is huge and this is shown in the projections of the GFSM. However, although these potential supply increases are incorporated in the GFPM, the latter is somewhat constrained to follow trends starting from existing patterns of production capacity. If large volumes of cheap available fibre in Asia and South America were to suddenly emerge over the next 10 years or so, this could change production costs and result in a shift in manufacturing capacity into these regions.

The extent to which this might occur will depend on several factors including: the ease with which the complex processing technology required for pulp and paper manufacturing can be introduced into many of these countries; the comparative cost of other factors of production; and the competition for this resource from the reconstituted panels sector (see above). If conditions are favourable, production could shift on a scale which is noticeable at the global level. If not, some of these countries could be left with a large resource without a market.

Table 16: Current and projected paper production and consumption by region and country

Region	1996				2010 (projection)			
	Production		Consumption		Production		Consumption	
	(1,000 MT)	%	(1,000 MT)	%	(1,000 MT)	%	(1,000 MT)	%
OECD - Europe	75,544	27%	68,652	25%	103,608	26%	95,186	24%
OECD - Asia and Oceania	41,581	15%	42,645	15%	61,676	16%	61,876	16%
OECD - Americas	106,634	37%	97,911	35%	133,247	34%	130,881	33%
OECD total	**223,759**	**79%**	**209,208**	**75%**	**298,531**	**76%**	**287,943**	**74%**
Russian Federation	3,212	1%	1,788	1%	4,252	1%	3,563	1%
Slovenia	460	<1%	368	<1%	1,013	<1%	910	<1%
Hungary	363	<1%	522	<1%	457	<1%	753	<1%
Romania	332	<1%	320	<1%	433	<1%	402	<1%
Slovakia	327	<1%	190	<1%	321	<1%	377	<1%
Others	698	<1%	1,049	<1%	1,788	<1%	2,031	1%
Non-OECD Europe total	**5,392**	**2%**	**4,238**	**2%**	**8,263**	**2%**	**8,036**	**2%**
China	30,253	11%	32,917	12%	50,980	13%	48,098	12%
Indonesia	4,386	2%	3,372	1%	5,014	1%	4,278	1%
India	3,025	1%	3,369	1%	4,338	1%	4,340	1%
Thailand	2,241	1%	2,506	1%	1,863	<1%	3,081	1%
Turkey	1,235	<1%	1,772	1%	1,128	<1%	1,366	<1%
Others	1,856	1%	6,414	2%	6,403	2%	14,610	4%
Non-OECD Asia & Oceania total	**42,996**	**15%**	**50,350**	**18%**	**69,728**	**18%**	**75,772**	**19%**
Brazil	5,885	2%	5,574	2%	7,714	2%	6,376	2%
Argentina	1,108	<1%	1,630	1%	947	<1%	2,006	1%
Venezuela	735	<1%	799	<1%	1,047	<1%	801	<1%
Colombia	676	<1%	961	<1%	1,194	<1%	1,236	<1%
Chile	597	<1%	606	<1%	910	<1%	873	<1%
Others	540	<1%	1,968	1%	2,005	1%	2,690	1%
Non-OECD Americas	**9,541**	**3%**	**11,538**	**4%**	**13,817**	**4%**	**13,982**	**4%**
South Africa	1,871	1%	1,708	1%	2,439	1%	2,616	1%
Egypt	221	<1%	483	<1%	232	<1%	824	<1%
Kenya	129	<1%	149	<1%	268	<1%	276	<1%
Morocco	106	<1%	239	<1%	189	<1%	356	<1%
Tunisia	90	<1%	154	<1%	66	<1%	219	<1%
Others	278	<1%	671	<1%	420	<1%	926	<1%
Africa total	**2,695**	**1%**	**3,405**	**1%**	**3,614**	**1%**	**5,217**	**1%**
Non-OECD total	**60,624**	**21%**	**69,531**	**25%**	**95,421**	**24%**	**103,007**	**26%**
World total	**284,383**		**278,740**		**393,952**		**390,950**	

4.6 Major bilateral trade flows

The last section of this report showed the broad inter-regional trade flows of wood and wood products and previous parts of this section have noted some of the world's major wood and wood product importers and exporters. Before concluding, this section will present a little more detail about some of the main trade flows of wood and wood products currently taking place.

Unfortunately, the GFPM in its current formulation, does not produce projections for country-to-country or region-to-region trade flows, but only produces projections for exports and imports (to the rest of the world) for each country. The model is also based on economic rationality and fails to capture some of the significant impacts of trading policies on trade

flows. However, an attempt will be made to describe some of the changes in trade flows which may occur over the period to 2010, based on a careful interpretation of the model's results and a general appraisal of current trends in wood and wood products trade.

4.6.1 Current trade flows by product and region

In terms of international wood and wood products trade, a handful of major exporting and importing countries appear at the top of the trade tables for nearly all products. To a large extent, major producers are also major exporters and major consumers are also major importers. The only exceptions to this rule are United States of America, Japan and China which are both major producers and importers of some wood products.

Of the OECD countries, major exporter countries include: United States of America (industrial roundwood and all products); Canada, Finland and Sweden (most products); and Australia and New Zealand (industrial roundwood). Of the non-OECD countries, major exporters are: Russian Federation; Chile and Malaysia (industrial roundwood and some products); Indonesia and Brazil (some products).

Major importers in the OECD include: Canada and Finland (industrial roundwood); Japan and Republic of Korea (industrial roundwood and most products); and United States of America, United Kingdom, Germany, Italy and France (some products). The only major non-OECD importer is China. The main trade flows by product are set-out below.

Industrial roundwood. The largest trade flow of industrial roundwood occurs between countries on the Pacific Rim. Six countries (United States of America, Russian Federation, Chile, Australia, Malaysia and New Zealand) export industrial roundwood to Japan, China and Republic of Korea. Together, these activities accounted for around 50 million m^3 of industrial roundwood trade in 1995 or 43% of the global total of 113 million m^3. The only other major industrial roundwood trade flow is from United States of America to Canada (4.5 million m^3).

Industrial roundwood (tropical). Despite the attention given to tropical roundwood trade, trade flows of tropical logs are actually very small (14% of total industrial roundwood trade). The only major exporter is Malaysia which, joined by Papua New Guinea and Solomon Isles, exports to Japan, Republic of Korea and China. African exports are also fairly low. The two largest exporters (Gabon and Cameroon) export to a range of European and Asian Countries.

Sawnwood. Total trade in sawnwood in 1995 was 107 million m^3. Exports from Canada to United States of America accounted for 40 million m^3 of this. Exports from Canada and United States of America to Japan and from Sweden and Finland to the rest of Europe accounted for much of the rest of world trade. The Russian Federation and Malaysia are the only significant non-OECD sawnwood exporters and exported to a broad range of countries.

Wood-based panels. Total trade in wood-based panels amounted to 41 million m^3 in 1995. Two trade flows are significant: Malaysia and Indonesia to China, Japan and Republic of Korea (8.7 million m^3 , mostly plywood); and Canada to United States of America (4.6 million m^3, mostly particleboard).

Pulp. Pulp trade is, perhaps, the most interesting of all because major countries involved in the total trade of 33 million MT in 1995 can be found on four continents. The trading patterns are also quite complex. The largest individual trade flow is from Canada to United States of America (4.5 million MT). Significant trade flows also occur between these two countries and Europe and Sweden and Finland and the rest of Europe. Canada and United States of America are joined by Brazil and Chile as major exporters to Japan, China and Republic of Korea. However, Brazil and Chile are also significant exporters to United States of America. Outside Asia, this is the only major trade flow from non-OECD countries to an OECD country.

Paper. The main trade flows in paper products are similar to the trade flows in sawnwood. Canada exported 11 million MT to United States of America in 1995 (out of total global trade of 69 million MT). The other main trade flows were from Canada, United States of America, Finland and Sweden to the rest of Europe. Interestingly, Asia is not a major trader in paper products. Only China is an importer of minor significance. Japan chooses to manufacture most of its own needs from recycled fibre and imports of industrial roundwood (much of which is imported in the form of chips).

4.6.1 Possible future trade flows in 2010.

As noted above, any forecast of trade flows in 2010 is likely to be highly speculative. However, the changes in supply and demand expected in the future might lead to the changes in trading patterns outlined below.

Industrial roundwood. Global industrial roundwood trade in the future will continue to be concentrated around the Pacific Rim. Japan, China and Republic of Korea will continue to have significant levels of demand for imported industrial roundwood, unless their trading policies change or current exporters can provide them with finished products at very competitive prices. However, the extent to which they manage to continue to import a significant proportion of their wood needs in the form of industrial roundwood, rather than products, will largely depend upon export policies and industrial developments in the countries currently supplying them.

There will be a significant increase in the availability of plantation-grown wood in some of their supplier countries. However, it seems likely that some of their current suppliers will develop significant wood processing industries of their own and may prefer to export products in the future. The most likely to do this are the developed supplier countries, such as Australia and New Zealand and, maybe, Malaysia. Consequently log export flows may shift somewhat towards countries which are some way behind these with the development of their domestic processing industries (e.g. in developing South America and Oceania).

A further potentially vast source of future supply in this area is Eastern Siberia. Expansion of harvesting into this area will depend upon the economics of production and, to some extent, diplomatic relations in the region. It is anticipated, however, that production from this region will expand to fill-in an expected reduction in temperate industrial roundwood exports from the United States of America.

In summary, the main centres of import demand are expected to remain the same, but the weight of the various exporting countries is expected to shift from United States of America to Russian Federation in the northern hemisphere and from Southeast Asia and developed Oceania to less developed Oceania and South America in the Southern Hemisphere.

Sawnwood. No major changes in the trade flows of sawnwood are expected in the future. As already noted, most international trade in sawnwood takes place between developed countries and this is expected to continue in the future. China will become a larger importer of sawnwood and is likely to have to rely on a wider range of countries to meet its import needs. A greater share of exports to China are also likely to come from outside Asia. Sawnwood exports from the few significant developing country exporters (Malaysia, Russian Federation and Brazil) are also likely to decline as their domestic demand growth exceeds production growth. Indeed, Russian Federation may remain the only large developing country exporter of sawnwood by the year 2010.

Wood-based panels. Trading patterns in wood-based panels are also expected to remain more or less the same in 2010. Of the three significant developing country exporters, exports from Brazil and Indonesia are expected to remain roughly the same as production growth keeps up with domestic consumption growth. In Malaysia, domestic consumption growth is expected to exceed production growth, leading to a decline in exports. China, Japan and Republic of Korea will therefore, have to look elsewhere for some of their future wood-based panel imports.

As already noted, the majority of wood-based panel exports from developing countries are in the plywood sector. Production in Malaysia is expected to decline somewhat over the period to 2010 due to increasing log scarcity. To the extent that this affects Brazil and Indonesia, these countries may also see a decline in exports in the future rather than the constant level of exports projected here. If this leads to upward price pressure in plywood markets, other countries with substantial remaining natural forest resources (e.g. Papua New Guinea, Suriname and Guyana) or more mature plantations (e.g. Chile and Argentina) may choose to develop greater export plywood markets. They would be unlikely however, to reach a globally significant scale within the time period of this analysis.

An alternative for many plywood exporting countries facing potential log shortages, would be to move into production of other types of wood-based panel. It is likely that this will eventually occur across the whole of Southeast Asia and some restructuring may take place during the period of this forecast. Again, it is unlikely however, that they would be able to reach a globally significant scale within the time period of this analysis.

Pulp and paper. The most interesting potential development in pulp and paper trade which is quite likely to occur over the period to 2010, is the continued increase in pulp exports from South America (Chile, Argentina and Brazil) to Asia and, possibly, United States of America. This region has already developed the nucleus of a globally significant centre of pulp production and exports and it should be relatively simple to build on this base and expand production and exports further. (In the case of Brazil, these comments apply equally to the paper industry). There will, however, be continued pressure (in terms of both production economies and government policies) to integrate pulp production with paper production, thus tending to limit expansion in the trade of pulp.

In contrast, two of the three largest Asian pulp and producers (China and India) produce mostly non-wood fibre pulp and the only other significant producer (Indonesia) is still relatively inexperienced in this area. The rate at which pulping and papermaking capacity is installed and effectively managed in these and other countries, will have a profound impact on whether Asia's vast pulpwood plantation resource is left in the ground, produced and exported as chips or roundwood, or produced and exported as pulp and paper.

4.7 Overall synthesis of the main global market potentials

The preceding discussion has shown in greater detail, the countries or groups of countries which are most significant at the global scale in terms of wood and wood product production, consumption and trade. The most important point this discussion has highlighted is that, in general, production, consumption and trade of all wood and wood products is overwhelmingly dominated by a small number of developed countries and that this situation is not likely to change by very much over the period to 2010.

Developing countries have a roughly 20% to 30% share of global production and consumption of all wood and wood product categories and their shares of the different product category markets are generally expected to increase marginally by 2010. Of the four developing regions identified in this analysis, Asia and Oceania is has by far the largest market for wood and wood products.

Developing countries which have been highlighted as globally significant in production, consumption and trade include: Russian Federation, China and Brazil (industrial roundwood and all products); and Indonesia and Malaysia (as producers and consumers of industrial roundwood and most products and exporters of some products). Of the above countries, all are major exporters with the exception of China. India is also a major producer and consumer but does not register as a major trading nation in wood and wood products markets.

Other developing countries of minor global significance or regional significance include: Chile and Argentina in South America; Turkey in Asia; and South Africa in Africa. It is interesting to note that none of the developing European countries, with the exception of Russian Federation, are of even minor significance in any of the wood and wood product categories. This is probably due to their small size. However, it must also be noted that they have tremendous marketing opportunities by being located so close to Western Europe. Just as Japan has acted as a catalyst for forest product market development in Asia, countries such as Germany, Finland, Sweden and Austria could (and indeed already are to some extent) do the same in Eastern Europe.

In terms of individual countrys' forest products markets, it would appear that the most interesting developments over the next decade or so are going to arise in the Pacific-Rim countries. This region is and will continue to be a major centre of production, consumption and trade, including a considerable amount of trade between developing and developed countries. Major developing country producers in the region face uncertainties regarding their future supply from the natural forest and the large area of plantations that they have developed. In turn, this will cause many of them to consider carefully the forest processing industry developments they will wish to pursue over the next few decades. Given the

timescale over which some of these changes might take place, they will have to examine such changes fairly soon.

Part 2: implications of the supply and demand projections

5. MAJOR DRIVING FORCES AND CHALLENGES FOR THE FUTURE

The first part of this report identified the main trends in wood and wood products markets which are likely to develop over the next decade or so. These trends are summarised below along with the major challenges facing the markets in the future.

5.1 Main market developments

Patterns of regional demand will not change by very much. The analysis has shown that developed countries currently account for 60-80% of forest product demand depending on the type of forest product. This situation is not likely to change very much over the next decade. Rapid economic growth in Asia will increase the importance of this region as a consumer, but much of the demand and demand growth in Asia will continue to be dominated by Japan. Despite relatively slower projected consumption growth in North America and Western Europe, the sheer size of these economies is likely to mean that they will also continue to consume a substantial share of the worlds forest product output.

Growth in consumption will continue to shift towards consumption of paper and reconstituted panels. For several decades now, growth in consumption of paper and reconstituted panels has consistently been 1-2 percentage points above growth in consumption of sawnwood and plywood in most countries and this trend is likely to continue. The only major exception to this is parts of Asia where demand for plywood is currently still very strong.

Importance of a few forest product suppliers at the global level. Despite the fact that forest resources are generally distributed more evenly than income across the world, more intensive use of forests and higher productivity rates in developed countries means that forest product supply is also quite concentrated in the hands of a few developed countries. Most of the world's wood production comes from temperate and boreal forests, which currently account for 80% of global supplies. Of the temperate and boreal countries, USA, Canada, Sweden and Finland account for 45% of global wood supplies. China and the Russian Federation are the next largest producers, with 7% and 4% shares of world production respectively. Of the tropical countries, Brazil is the largest producer with a 6% share of world output. Indonesia, India and Malaysia are the only other significant producers with shares of 2-3% each. This global dominance of a handful of countries is expected to continue in the future although, at the regional level, a few smaller producers may gain prominence (e.g. countries with large plantation resources such as South Africa, Chile and New Zealand).

Adequacy of wood supplies at the global level. The results of this analysis confirm the consensus among recent studies, that wood supplies at a global level will be adequate to meet demands for both industrial wood and wood fuel in the immediate future. However, the types of wood which will be available in the future will be very different from what has been produced in the past. The natural forest will generally produce less wood in smaller log sizes than previously except in the few countries where virgin natural forest will remain available for wood supply. Most growth in wood supply in the future is expected to come from forest

plantations and trees outside forests, which have the potential to play a much greater role in supply than they have in the past.

Forest products trade. A general trend towards trade in higher value-added products has been experienced in the past and is expected to continue in the future. This trend will be supported by the general thrust toward more liberal trade policies, through the World Trade Organisation (WTO) and regional associations such as the Asia-Pacific Economic Co-operation forum (APEC) and Association of Southeast Asian Nations (ASEAN). Several countries already have trade restrictions on unprocessed forest products such as logs and rough sawnwood and these policies are expected to continue in the future.

5.2 Main challenges for the future

In terms of the future markets for wood and wood products, the main challenges facing the forestry sector will be to secure adequate wood supplies while meeting the social and environmental demands increasingly being placed on forests. There are undoubtedly enough forest resources to meet future demand needs, but the crucial question which will be faced in the future will be: from what mixture of natural forest, plantation and non-forest resource should future demands be met? Given that supply sources are likely to diversify, another issue will be: how will the processing sector develop to accommodate these changes and what role will trade policies play in this transition? The main likely future challenges in each of these areas are summarised below.

Pressure on supplies from the natural forest. It is expected that moves to take greater areas of natural forest out of wood production and declining harvesting volumes in the remaining areas, will put some pressure on wood supplies from natural forests. At a global scale, such moves may not have a major impact, but they may have more of an impact at the regional level. For example, greater scarcity of large logs in Asia will put pressure on plywood production and encourage substitution by other types of panels in markets currently dominated by plywood.

An increased role for forest plantations and trees outside of forests. It is anticipated that forest plantations and trees outside of forests will play an increasing role in wood supplies in the future. These resources will produce smaller log sizes and, more generally, a very different type of wood than has been produced in the past. The main uncertainties with respect to these supply sources will be the growth rates which will be achieved (particularly in forest plantations) and the extent to which these supply sources will substitute for products coming from the natural forest. To a large extent, the degree of substitution achieved will depend upon the pricing policies (for industrial roundwood from the natural forest) which countries pursue.

Changes in the structure of industrial processing capacity. The changes noted above will be reinforced by the expected changes in forest product demand. The strongest levels of demand growth are anticipated in the reconstituted panels and pulp and paper sectors. In comparison, only relatively slow growth in the demand for sawnwood and plywood is expected in the future. This shift is important because the former can be produced from a range of fibre sources and do not require high quality, large logs for their production. The challenge facing the sector, will be to restructure the forest processing industry towards the

larger, more technologically complex processing plants required to produce these wood products. This challenge will be particularly acute in those developing countries which have developed large sawmilling and plymilling sectors (e.g. several countries in Southeast Asia).

The potential role for technology improvements. Another way in which the forest sector may choose to respond to the increasing wood product demand and changes in supply sources could be to strive for greater wood processing efficiency. Indeed, for the sawmilling and plymilling sectors, this may become of paramount importance. There is, as will be shown below, still tremendous scope to increase the efficiency of processing plants around the world and such moves could go a large way towards accommodating the expected changes in wood supply outlined above. As with the development of new sources of supply however, much will depend on pricing policies.

Globalisation and trading policies. The forestry sector will continue to rely on international trade for a major share of revenues and, given the desire to trade in higher value-added products, exporter countries will continue to seek access to high value markets in Europe and North America. Foreign investment will also continue to be important for the development of the sector in developing countries. Against this background, concerns about environmental issues are likely to continue to play a role in forest products trade and investment and measures such as certification may become more important in the future for some exporter countries.

The remainder of this part of the report discusses in more detail some of these challenges, then attempts to draw-out the main conclusions of this analysis and implications for World Bank involvement in the forestry sector.

6. THE FUTURE AVAILABILITY AND MANAGEMENT OF FOREST RESOURCES FOR WOOD PRODUCTION

This section of the report discusses some of the changes which might be expected in the future in the availability of forest resources and the way in which they are managed. It discusses the future potential availability for wood production of natural forest, plantations and trees outside of forests. It then discusses the likely impact of SFM on future wood supplies. It finishes by synthesising the main implications of these changes on forest products markets.

6.1 Deforestation and competing demands for forest land

Deforestation is a major force affecting the future availability of forest resources for wood supply both directly, through the total amount of forest in existence, and through the pressure it puts on forestry policy makers to take greater areas of forest out of wood production. After discussing deforestation in general terms, two specific demands on forest-land are discussed below: the conversion of forest land to agricultural uses and the placement of forests into legally protected areas.

6.1.1 Deforestation: a brief overview

Table 17 summarises the regional changes in forest cover estimated by FAO in 1995 on the basis of the 1990 Forest Resource Assessment. There is considerable variation between regions: South America has the highest level of deforestation in terms of area loss, while Africa has the greatest annual percentage loss of forest. In contrast, forest cover is actually increasing in Europe and the countries of the former USSR. Given that the forest area change is negative in all of the regions except one, deforestation can be expected to remain a prominent issue in the public policy debate over forests.

Table 17: Annual change in forest area by region estimated in 1995

Region	Forest area	Annual change (1990-95)	
	1,000 ha	1,000 ha	%
Africa	520,237	-3,748	-0.7
Asia	503,001	-2,901	-0.6
Oceania	90,695	-91	-0.1
Europe	933,326	+519	+0.0
North and Central America	536,529	-274	-0.1
South America	870,594	-4,774	-0.5
World	**3,454,382**	**-11,269**	**-0.3**

Source: FAO (1999c)

There is evidence that the rate of deforestation might be declining in some areas. For example, forest plantation programmes in a few countries (e.g. India and China) are slowing the overall rates of deforestation in some regions. Recent research by the Center for International Forestry Research (CIFOR) in Latin America has also suggested that the conversion of forest to agricultural land there may be declining as small-scale farmers switch

their attentions to secondary forest (or other wooded land) for the expansion of their agricultural holdings.

The complexity of land-use changes which are currently taking place around the world was highlighted in the recent APFSOS, where it was shown that a range of land-use changes have been taking place in the Asia-Pacific region over the last few decades. Overall, deforestation in the region appears to have been slowing somewhat due to afforestation programmes in some of the largest countries in the region (e.g. China, India and Indonesia). Furthermore, other more complex patters of change were found to be at work within the region. For example, Australia and New Zealand are expanding forest area at the expense of agricultural land, while China is expanding both agricultural land and forest area by cultivating previously unused land. Only some of the countries of Southeast Asia were found to be following the typically expected model of conversion of forest land to agriculture.

Perhaps the most revealing insight of the analysis was the finding that the process of gradual forest degradation is making it increasingly difficult to talk simply about deforestation. For example, in terms of natural forest, deforestation in Asia is still very high. However, with high rates of plantation establishment, total forest loss each year is much less. Furthermore, if forest is broadened to include other wooded land, the annual loss of forest and other wooded land each year is only about 20% of the figure for forest alone. This is because much of the forest lost each year still contains some trees and therefore, enters the other wooded land category.

Due to the complexity of the mechanisms encouraging deforestation and afforestation and the current uncertainty about the way in which they operate, it would probably be premature to suggest that, at the global scale, the rate of deforestation is increasing or declining. Therefore, the supply and demand projections presented earlier were made on the basis of an assumption that deforestation would continue in the future at roughly the same rates as in the past.

6.1.2 The demand for conversion of forests to agricultural land

Deforestation is driven by a range of factors including: deliberate conversion to other land uses; overgrazing; overharvesting of wood or non-timber forest products; wood fuel collection; fire; and outbreaks of pests and diseases. Most of the deliberate conversion of forest areas to other land uses is probably accounted for by the conversion of forest land to agricultural uses. This is sometimes planned by the government (e.g. as in some cases in Indonesia) but is more often the result of shifting agriculture or overgrazing. Conversion to other uses such as opencast mining and reservoirs is also important in a few locations (e.g. Malaysia; Papua New Guinea; Nauru and New Caledonia).

There is no clear consensus about the extent to which deforestation is caused, directly or indirectly, by forest harvesting. Certainly, the forestry literature cites many examples of poor harvesting and over harvesting leading to negative environmental impacts around the world. Also, in a number of countries, industrial harvesting is generally recognised as a major cause of forest degradation, but rarely does harvesting alone lead to total loss of tree cover. Probably more important in facilitating permanent deforestation is the provision of infrastructure (roads, supply lines and communication facilities) associated with forest

harvesting operations, which assists with the process of settling previously undisturbed forest areas and expanding the agricultural frontier.

Given that conversion of forest-land to agricultural uses is probably still the largest determinant of forest loss in tropical regions, it is useful to examine the likely pressures that demands for agricultural land will place on the world's forest resources in the future.

The last global appraisal of the future demand for agricultural land was completed by FAO in 1995 (Alexandratos, 1995). This showed that, in developing countries, future needs (to 2010) for greater agricultural production would be satisfied by two changes:

- increased cropping of existing agricultural areas, partly through an expansion of irrigation, which would bring into production an additional 120 million ha of land which is currently left fallow each year; and

- conversion of other types of land into agricultural land (about 90 million ha).

It was also predicted that the main areas of agricultural land expansion would be in Sub-Saharan Africa, Latin America and the Caribbean, with maybe a little expansion in East Asia.

Analysis of past land-use changes from the 1990 Tropical Forest Resource Assessment (FRA 90) suggested that about 85 million ha of forest in tropical countries might be converted to agriculture over the 20 years 1990 to 2010. This would suggest that conversion of forest land to agriculture might account for about 64 million ha over the period 1995 to 2010 or 70% of the requirement indicated by Alexandratos. However, it is also worth noting that this figure implies that the conversion of forest to agricultural land accounts for deforestation of about 4.3 million ha, or roughly 0.12%, per annum. This is only about one-third of the estimated total rate of global deforestation of 11 million ha/year, or 0.3% per annum.

Based on these observations, it could be assumed that the conversion of forest land to formal agriculture may account for about one third of future forest area losses in developing countries, much the same as in the past. However, conversion or degradation due to informal agriculture (i.e. shifting cultivation) may exert a greater pressure on forest resources than is implied here.

It should be noted that the above projections only apply to developing countries. Forest areas in North America and Japan have not changed by very much in recent years and have been increasing in many European countries, Australia and New Zealand. Increased agricultural productivity and measures to enhance the environment are likely to continue to encourage the afforestation of agricultural and other types of land in many of these countries.

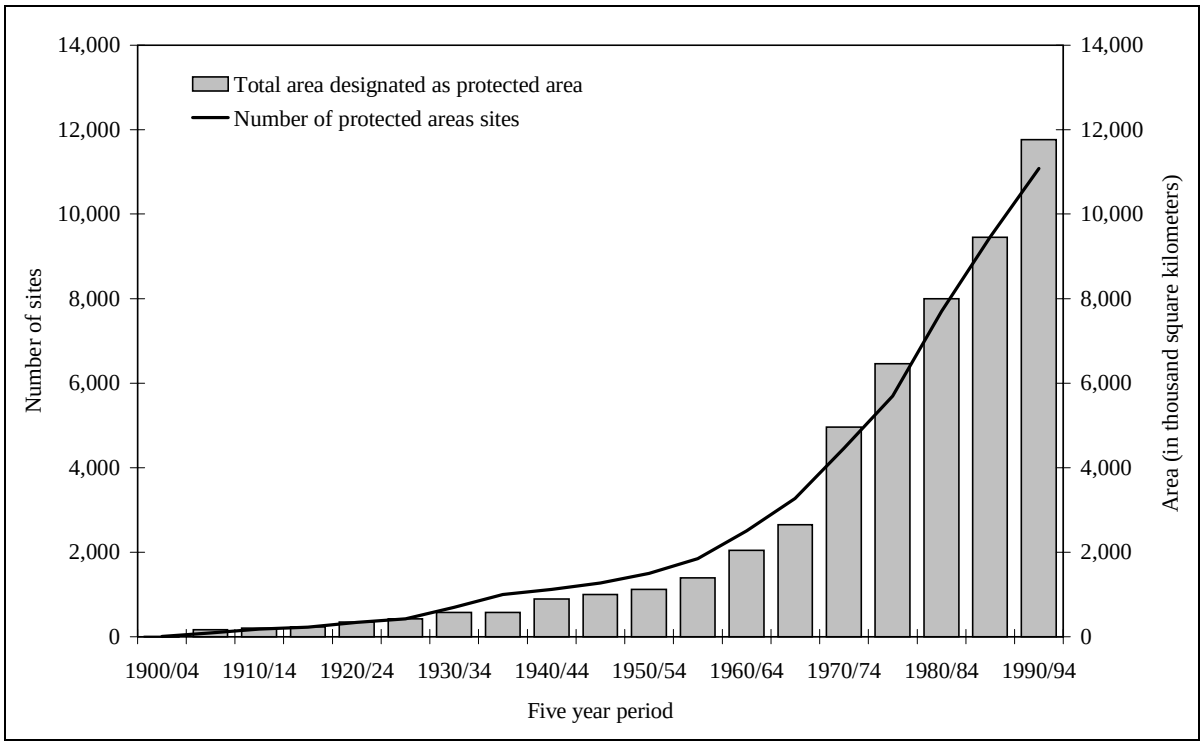
It should also be noted that conversion of forest to agriculture may not necessarily lead to great reductions in potential wood supply. In places where large areas of forest have been converted to agriculture, the reduced supply of timber for local needs often results in the planting of trees outside of forests in hedgerows, shelterbelts and small farm wood lots. This can increase potential wood supplies from these types of resource dramatically, particularly where population is high. These sorts of changes, plus the trend towards afforestation of

agricultural land in developed countries, could have the impact of increasing potential future wood supplies, although probably not for several decades.

6.1.3 The placement of forest into legally protected areas

Increased interest in environmental issues in the 1980's and 1990's is a global phenomenon which has affected nearly all countries in the world. Greater concern for the environment has affected the way in which forests are managed in many countries and has started to affect the markets for forest products as well. One of the ways in which it has started to affect the availability of forest resources for wood supply is by placing greater pressure on policymakers to take natural forest areas out of production.

Figure 5: Growth in the global area of legally protected areas 1900 - 1994



Source: WCMC

Figure 5 shows the growth in the number and total area of legally protected areas between 1900 and 1994.[16] Historically, the number and area of protected areas has increased by around 8% each year. This has slowed down somewhat in recent years and annual growth in the area of legally protected areas is currently a little over 4% while growth in their number is about 3%. This amounts to an increase in the global area of legally protected areas of around 150 million ha to 200 million ha every year.

The area of forest within legally protected areas has recently been estimated by the World Conservation Monitoring Centre (WCMC) and CIFOR and is shown in *Table 18*. By

[16] Legally protected areas for the purpose of this analysis have been defined as areas within national protected designations corresponding to IUCN Categories I-VI.

comparing *Figure 5* and *Table 18*, it can be seen that about one-quarter of the world's legally protected areas are forest areas. Furthermore, the total area of forest in legally protected areas is currently estimated to be just over 300 million ha or around 8% of the total forest area.

Table 18: Global area of forest[17] and forest in protected area estimated in 1996

Region	Forest area	Forest in protected area	
	1,000 ha	1,000 ha	% of total
Africa	568,313	49,693	8.7
Continental South and Southeast Asia	170,768	19,246	11.3
Insular Southeast Asia	146,836	24,750	16.9
Far East	145,603	7,740	5.3
Middle East	16,766	639	3.8
Australasia	149,323	12,582	8.4
Europe	181,400	14,483	8.0
Russian Federation	825,716	15,064	1.8
North America	845,399	69,996	8.3
Central America	90,198	8,810	9.8
Caribbean	5,385	790	14.7
South America	842,946	87,492	10.4
World	**3,988,792**	**311,284**	**7.8**

Source: WCMC/CIFOR (1998)

In addition to forests in formally protected area systems, many countries have also restricted or prohibited harvesting across parts or all of their forest estates (i.e. logging bans). Countries with complete bans on harvesting in their natural forests include: Thailand; Sri Lanka; Bangladesh; South Africa; El Salvador; and Uruguay; and China and Vietnam are believed to be considering implementing such a move.

The projections of supply and demand presented earlier were based on an assumption that the area of forest in legally protected areas or subject to other restrictions on harvesting would not change in the future. Clearly, this is almost certainly unlikely to be the case. However, in order to determine the effect that the future placement of forests into protected areas will have on the future availability of wood supplies, it is necessary to make an assumption about how much forest will be placed in legally protected areas in the future.

Past trends would suggest that maybe around 30 million ha to 50 million ha of forest might be put into protected areas globally every year, but this figure seems rather high (for example, by 2010, this would result in 20% of the world's forest area being placed in protected areas). Therefore, for the purpose of this analysis, it was assumed that an amount of forest would be put into protected areas such that 10% of forest area in every country would be in protected areas by the year 2010. This figure (10%), is a target which has been recommended by several environmental organisations working in this field.

The amount of forest which would have to be placed into protected areas to meet a 10% target is shown in *Table 19*. Globally, just under 110 million ha would have to be placed into protected areas to meet such a target. According to FAO statistics, the regions where most forest would have to be placed into protected areas to meet such a target would be: South

[17] Due to differences in definitions, the area figures presented here differ slightly from those presented from FAO sources.

America; North and Central America; and Africa. A considerable area of forest in Europe would also have to be put into protected areas, mostly in the Russian Federation.

Table 19: Forest area in protected areas in 1997 and amount required to meet a 10% target

Region	Forest area (1,000 ha)		Area in protected areas (1,000 ha)	
	Available for wood supply	Unavailable for wood supply	Current	Required to meet a 10% target
Africa	166,461	233,157	34,058	18,486
Asia	223,207	175,077	75,659	4,682
Oceania	26,274	61,593	13,850	2,271
Europe	645,651	187,503	78,806	8,853
North and Central America	332,168	288,700	33,637	31,629
South America	155,492	707,062	51,200	42,042
World	1,549,253	1,653,092	287,210	107,962

Source: FAO (1999a)

6.2 The development of forest plantation resources

Forest plantations[18] presently constitute only a very small proportion of the world's total forest area. The global area of forest plantations is currently estimated to be just over 120 million ha, or approximately 3.5% of total forest area (see *Table 20*). Forest plantations represent, however, an extreme of management intensity, usually focussing on wood-fibre production. Consequently, the importance of forest plantations in terms of both their actual and their potential contribution to meeting global demands for wood fibre is far greater than their share of total forest area would imply.

Table 20: The estimated global distribution of forest plantation resources in 1995

Country or region	Industrial forest plantation area (million ha)	Non-industrial forest plantation area (million ha)	Total forest plantation area (million ha)
Africa	3.6	2.2	5.7
Asia	41.8	15.1	56.9
China	*17.5*	*3.9*	*21.4*
India	*4.1*	*8.3*	*12.4*
Japan	*10.7*	*0*	*10.7*
Oceania	2.7	<0.1	2.7
Europe	8.7	0	8.7
Former-USSR	22.2	0	22.2
Russian Federation	*17.1*	*0*	*17.1*
North and Central America	18.9	0.3	19.2
United States	*18.4*	*0*	*18.4*
South America	5.4	2.8	8.2
World	**103.3**	**20.4**	**123.7**

Sources: FAO, UNECE, Pandey (1997).

[18] The UN-ECE/FAO Temperate and Boreal Forest Resources Assessment 2000 defines plantation(s) as: "Forest stands established by planting or/and seeding in the process of afforestation or reforestation. They are either: forests 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; and regular spacing". This is the definition that has been used for this analysis.

There is considerable variation in the global distribution of forest plantations. The largest proportion of the world's forest plantations can be found in Asia (just under 50%). However, as *Table 20* shows, the five countries with the largest plantation areas collectively account for two-thirds of the global plantation resource.

Many countries around the world support forest plantation establishment in one way or another and the level of incentives available to establish forest plantations partly accounts for why some countries have much greater forest plantation resources than others. Other factors that can partly explain differences between countries include: agricultural subsidy regimes and the availability and price of land; expected growth rates; and local market conditions for roundwood (see Brown (1999) for a further discussion of some of these issues).

6.2.1 Estimated current wood supply from forest plantations

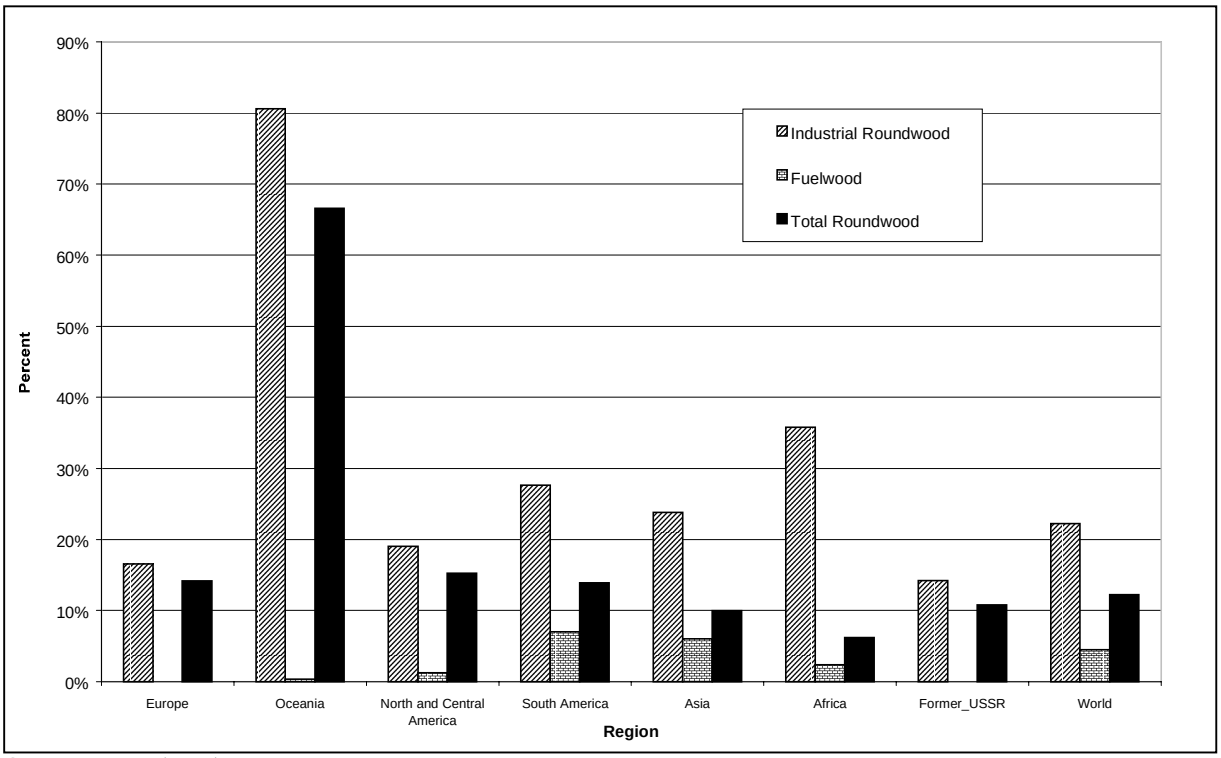
Information about the source of roundwood production is not currently collected at the global level. Therefore, it has been necessary to estimate the level and proportion of current production which might come from forest plantations, based on the area and age-structure of existing plantation resources, potential yields and harvesting losses and the availability of other sources of supply in individual countries. The utilisation of plantation-grown wood has also been split according to the type of plantation, with an assumption that industrial forest plantations are used for industrial roundwood supply, while non-industrial forest plantations are primarily used for wood fuel supply[19].

Based on this information, the forest plantation supply model suggests that industrial forest plantations account for a relatively high proportion of industrial roundwood production (around 331 million m^3 per year, which is equal to about 22% of global industrial roundwood production), but only a modest share of wood fuel production (around 86 million m^3 per year or about 4% of global production). This is not surprising, given that trees outside of forests, such as woodlots and individual trees on agricultural land are often more convenient sources of wood fuel (see *Section: 3.5.2 Sources of wood* fuel supply for further information). The "bottom-line" is that current forest plantation production could be supplying around 12% of the world's total roundwood harvest.

It should also be noted that this varies considerably between geographical regions. *Figure 6*, for example, shows the estimated current industrial and non-industrial forest plantation harvests as a percentage of the total harvest of natural forest and plantation-grown industrial roundwood, wood fuel and total roundwood, in different regions. Plantation production for industrial roundwood is particularly important in the Oceania region, where 80 percent of industrial roundwood is plantation-grown. Africa (35 percent), South America (27 percent) and Asia (23 percent) also have above average proportions of industrial roundwood production in plantations. Production from plantations in a handful of countries in each of these regions – Australia, New Zealand, Chile, China, Japan and South Africa – is sufficiently large to put these regions ahead of the global average.

[19] Plantations for wood fuel production are a major component of the non-industrial forest plantation area.

Figure 6: Estimated production of wood from forest plantations as a percentage of total wood production in 1995



Source: Brown (1999)

6.2.2 Factors affecting the future supply of wood from forest plantations

The extent to which wood from forest plantations is accepted in the market is determined by both quantitative and qualitative dimensions. At a very broad level it is feasible to estimate approximate aggregate yields from a given plantation resource base and thus, develop simple wood production forecasts (as was done above and is done regularly in the UK and New Zealand, for example). An equally important but far more difficult proposition however, is to determine the *degree* to which future plantation production will be substituted for wood from other sources. This is particularly important in countries that have large areas of natural forest, but can also be important in countries where plantations are the major domestic forest resource. For example, Japan has a large domestic plantation resource but still chooses to import a large proportion of its domestic industrial roundwood requirements each year as naturally-grown industrial roundwood from other countries.

This point is exemplified by noting that a predominant strategy in evaluating plantation establishment uses financial criteria as the key decision variable. Under current log price structures, plantation investment models based on internal rate of return (IRR) analysis, have encouraged a weighting in establishment towards short rotation lengths and high-yield, fast-growing, industrial-grade species. For example, around 50% of identified tropical plantations are either eucalyptus or fast-growing pine species. The likely trend, therefore, is that plantation-grown wood will increasingly substitute for small-sized naturally grown wood, in the markets for wood pulp and for the production of composite wood panels. The products least likely to be supplied to great extent by plantations in the future are consequently likely

to be slow-growing, high-value "luxury" timbers and large peeler logs used in producing veneer and plywood.

Another issue affecting the role plantations might play in future wood supply concerns their acceptability from an environmental viewpoint. Despite the apparently key role plantations may play in meeting future wood demands, plantation programmes have been increasingly surrounded by controversy. A number of criticisms have been levelled at plantations, the prominently that they: promote the loss of biodiversity; degrade soils and reduce soil fertility; deplete groundwater reserves; are susceptible to catastrophic loss through pests or disease; and destabilise the often fragile social fabric of rural communities, by reducing the amount of land available to the poorest sections of society.

Examples can be found of all these faults. Equally, in almost every instance the major difficulties can be overcome or countered through careful planning. Biodiversity (if it is lost) can be promoted through mixed species planting and silviculture that promotes the development of understorey species; soil degradation can be avoided by better land preparation techniques; pest risks can be reduced by targeted research and development; social problems can be ameliorated by careful consideration of community-based issues in project planning. The key to ensuring the future acceptability of forest plantation establishment, is to ensure that they are established within the broad context of sustainability.

6.2.3 Future likely rates of plantation establishment

The future potential supply of industrial roundwood from forest plantations will depend upon a number of factors. The most crucial factor will be the rate at which new planting is sustained, although improvements in fields such as plant breeding, silvicultural techniques, plant survival and harvesting techniques, are all likely to contribute to greater productivity. This analysis has assumed that the latter variables will all remain unchanged and has concentrated on producing three future scenarios for new planting, in order to forecast potential industrial roundwood supply from forest plantations through to the year 2050.

Scenario 1 provides a baseline forecast, by assuming that forest plantations are not expanded beyond their current area and that all areas are replanted after harvesting.

Scenario 2 assumes that new planting will increase the forest plantation area at a constant rate of 1.2 million ha per annum in total (equal to 1% of the current area of forest plantations).

Scenario 3 assumes that the annual rate of new planting estimated in 1995 (4.71 million ha in total) is maintained until the year 2010, after which it is reduced by 940,000 ha at the start of each of the following decades (i.e. until it declines to zero in 2050).

All three of these scenarios assume that the geographical distribution of the global forest plantation estate will not change (in other words, that any new planting will take place in proportion to the current share of forest plantations located in each country). However, the age-class structure (and hence the annual volume harvested) in each country will change over time, in response to harvesting, replanting and new planting. The implications of these

scenarios, in terms of plantation establishment by region and for the countries with most forest plantations, are shown in *Table 21*.

Table 21: Industrial forest plantation areas in 2050 under three new planting scenarios

Country or region	Scenario 1 (million ha)	Scenario 2 (million ha)	Scenario 3 (million ha)
Africa	3.6	5.6	8.9
Asia	41.8	64.8	119.5
China	*17.5*	*27.1*	*68.3*
India	*4.1*	*6.4*	*11.7*
Japan	*10.7*	*16.6*	*12.4*
Oceania	2.7	4.2	5.7
Europe	8.7	13.5	15.3
Former-USSR	22.2	34.4	28.0
Russian Federation	*17.1*	*26.5*	*21.1*
North and Central America	18.9	29.3	43.2
United States	*18.4*	*28.5*	*41.2*
South America	5.4	8.4	13.6
World	**103.3**	**160.2**	**234.2**

Source: Brown (1999).

Scenario 2 is notable for requiring only relatively modest, and seemingly plausible, increases in plantation areas (+55%). For example, the 27.1 million ha proposed for China in 2050 under Scenario 2 is markedly less than the 40.4 million ha currently planned in China to 2050. Plantation development is, however, unlikely to be uniform across countries. Countries such as Chile and New Zealand have, for example, achieved isolated increases in plantation areas of 5% to 10% in a single year. Other countries have gone for extended periods with little or no plantation establishment. South Africa, for example, is not encouraging further afforestation because of water scarcity. Conversely, Australia has targeted the development of a 3 million-hectare plantation estate (a trebling of the current estate) by 2020.

The areas implicit in Scenario 3 also seem to be generally achievable in physical terms. Institutional and policy constraints may, however, play a highly significant role in limiting planting below the indicated levels. Two notable cases are China and the United States, both of which would be required to maintain rates of plantation establishment higher (or for longer) than seems likely at present. Some of this "excess" planting could, however, be spread across other countries without markedly affecting the results of Scenario 3. It is believed that these three scenarios cover the most pessimistic and optimistic likely futures for global rates of forest plantation establishment and their impacts on future potential wood supply from plantations will be discussed at the end of this section.

6.3 The potential for increasing future wood supplies from trees outside of forests

Increases in the demand for wood products are often simplistically portrayed as leading directly to increases in forest harvesting. While this may be true in a number of countries, it overlooks the wide mixture of land-based and non-land-based resources which are currently used to meet wood and fibre demands. One such non-forest resource is trees outside of forests. As more information is collected about this resource, the important role that trees outside of forests play in current wood supply and the potential they have for increasing supplies in the future is gaining increasing recognition.

Trees outside of forests play important economic, social and environmental roles and nowhere are these roles more critical than in developing countries. They act as the primary source of industrial roundwood, wood fuel and non-wood forest products in many countries, they often perform vital environmental function such as soil and water conservation and they can provide multiple social benefits to both rural and urban populations.

This section describes what the resource encompasses, presents information about the extent of the resource in some countries and discusses some of the key issues related to the potential wood supply from the resource.

6.3.1 What are trees outside of forests?

By definition, trees outside of forests include all areas of trees and woody crops not identified as forests. However, although there is a commonly accepted international definition of forests, there is not yet a definition of what should be counted as trees outside of forests. Therefore, definitions vary widely between countries, which makes it difficult to estimate and analyse the extent of this resource at the global scale[20].

Trees outside of forests undoubtedly encompasses a wide variety of situations, from individual trees to areas of woodland considered too small to count as forest under the agreed international definition. This analysis has not attempted to clarify exactly what trees outside of forests should include. Rather, the analysis has accepted that definitions vary and has included the wide range of resource types identified as trees outside of forests in various countries, including: agricultural tree crops; agro-forestry plantations; individual trees on agricultural and other land trees; home gardens; roadside trees; wood-lots; and other wooded land.

6.3.2 What is the extent of the resource?

Information about the area of trees outside of forests is not collected globally, so it is difficult to get an idea of the total global extent of the resource. Furthermore, because of the diversity of the resource, any statistics which are available are only likely to be partial. However, there are some statistics on certain types of trees outside forests and a few countries (particularly where the resource is significant) have detailed statistics which give an idea of the diversity and importance of the resource in particular circumstances.

[20] The exception to this is "other wooded land", for which there is an internationally agreed definition. Other wooded land is not included as forest in international forestry statistics and is, thus, a component of trees outside of forests.

Table 22: Forest, other wooded land and agricultural tree crop area

Region	Forest area (1,000 ha)	Other wooded land (1,000 ha)	Area of agricultural tree crops harvested in 1998 (1,000 ha)
Africa	545,085	591,591	5,150
Asia	497,359	162,911	19,813
Oceania	71,467	106,336	616
Europe	904,253	212,220	0
North America	456,737	292,552	0
Latin America & Caribbean	967,469	292,249	1,282
World	**3,443,370**	**1,658,859**	**26,861**

Note: Agricultural tree crops defined as including: oil palm; rubber; and coconuts. Other significant agricultural tree crops include fruit and nut trees, but these are not included here.

Two components of the trees outside of forests resource about which global statistics are available are other wooded land and agricultural tree crops. *Table 22* summarises the areas of these two resources. As the table indicates, the area of these two resources is, in some cases, significant. For example, Africa has a greater area of other wooded land than it does of forest. Overall, the global area of other wooded land is about half the area of forest.

The area of agricultural tree crops shown in the table is less significant. In total, the area of agricultural tree crops is only equal to about 1% of the area of forests, but in some regions they are relatively more important (e.g. Asia, where the area equals roughly 4% of the area of forests in the region). However, it should be noted that the area of agricultural tree crops shown in the table does not include the area of fruit trees in each region. These are known to total several million hectares in Asia and may equal several hundred thousand hectares in each of the other regions. Furthermore, the table shows the area harvested and does not include the area of immature crops not yet ready for harvesting in each region. Recent work in the APFSOS showed that if fruit trees and immature crops were also to be counted, the area of agricultural tree crops in Asia could equal the area of forest plantations.

Table 23: Area of forest and trees from homesteads contributing to wood supply in Bangladesh

Year	Forest area (1,000 ha)	Area of trees outside of forests from homesteads (1,000 ha)	Total area used for wood supply (1,000 ha)	Share of productive area from homesteads (%)
1966	719	360	1,079	33
1970	532	360	892	40
1975	214	400	614	65
1976	217	360	577	62
1977	290	360	650	55
Since 1980				60

Sources: FAO (1981)

Most of the countries where statistics about trees outside of forests are readily available are in South Asia, where the resource contributes significantly to wood supply. For example, *Table 23* shows the contribution of homesteads (i.e. small farm woodlots) to wood supply in Bangladesh. With the gradual loss of forest cover experienced in Bangladesh since the 1960's, homesteads have increased in prominence in the country's wood supply and now provide approximately 60% of the total wood supply. Other examples of the contribution of this resource to wood supplies are given at the end of this section.

6.3.3 The potential to increase wood supplies from trees outside of forests

In order to estimate the potential for wood supplies from trees outside of forests, it is necessary to have information about both the area of the resource and the level of stocking or growth of utilisable wood. As noted above, only partial information is available about area and, unfortunately, even less is known about stocking and the growth potential of trees outside of forests. Furthermore, as with forest plantations, the social and economic conditions which lead owners of the resource to turn potential yields into actual timber supply have to be better understood before forecasts can be made. However, from experiences gained in the APFSOS, it is possible to make some general statements about the nature of wood supplies from the resource and these are summarised below.

Ownership. In contrast to much of the worlds forest resources, trees outside forests are largely in the hands of private owners and, to some extent, outside the control and regulation of forestry authorities. Therefore, the supply of wood from trees outside of forests is likely to be more strongly influenced by social and economic factors and less influenced by forestry policy decisions than is, say, supply from natural forests and plantations.

Motivation to use for commercial wood supply. Following on from the above, experience suggests that in many countries at the moment, trees outside of forests are seen by large commercial wood producers as a resource to be used as a last resort, when forests have been depleted or placed under harvesting restrictions. This is largely as a result of pricing policies, where it is often cheaper to access forest resources (particularly if they are controlled by the government) rather than purchase wood from smallholders, farmers and others, at something closer to a competitive market price.

Motivation to plant. Similarly to the point raised above, trees outside of forests are often initially planted by individuals to provide a wide range of goods and services, when natural forests have been depleted in the areas in which they live. However, systems of land tenure can complicate the picture (for example, in some countries, areas of natural forest are cleared and planted with crops and trees to establish a right to use the area). There are also now some schemes (e.g. outgrower schemes in India) whereby commercial forestry interests are paying farmers and other landowners to plant trees to secure future wood supplies. Planting for multi-purpose benefits is a prominent feature of trees outside of forests in both developed and developing countries.

Potential yields. Although areas containing trees outside of forests often have low stocking (a few trees per hectare), the lack of competition and the fact that these areas of land are often more fertile (and may be improved with additional nutrient inputs) can lead to very high yields. Thus, for example, one hectare of agricultural land containing 5% tree cover growing at 20 m^3/ha/year, can sustainably supply the same amount of wood as a natural forest with 100% stocking but only growing at 1 m^3/ha/year. High yields are often also common because, due to the fact that much of the resource is privately owned, the resource is often well managed and maintained.

Management for multiple-use benefits. Given that trees outside of forests are often managed as part of an agricultural enterprise and for a range of expected benefits, decisions to

cut them for timber supply can be influenced by a range of factors other than wood prices. For example, in many developed and developing countries around the world, farm woodlots are managed as a store of value and are only cut to cover large irregular expenses. Woodlot owners in Asia appear to have started to take greater interest in the commercial timber value of their timber resources and manage them for timber production. However, it may be more difficult to persuade such owners to supply timber in Africa, where the non-timber benefits of trees (e.g. food security) generally vastly outweigh their potential commercial value.

Many of the points raised above have interesting implications both for the future for wood supplies and the achievement of other policy objectives, such as the development of small and medium-sized enterprises, alleviation of rural poverty and sustainable development. These will be discussed in the concluding chapter of this report.

6.4 The impact of Sustainable Forest Management on future wood supply

The concept of Sustainable Forest Management (SFM) has increased in prominence in the public policy debate about forest management over the last decade. Policymakers are slowly reaching a consensus as to what the concept means exactly and how it can be implemented and the implementation of SFM could have a significant impact on future wood supplies.

6.4.1 A brief explanation of Sustainable Forest Management

SFM is primarily a systematic approach to sustaining each component of the forest ecosystem and sustaining interactions between the components. In natural forests, this usually means combining wood production with other management objectives and, above all, maintaining ecological capacity through the conservation of plant and animal biological diversity and soil and water conservation.

Similar intentions are 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. *Box 5* presents a summary of major differences in management approaches between the two concepts of SFM and traditional sustained yield forestry.

Measures to encourage the implementation of SFM have started to be introduced at the international and national level. At the international level, several groupings of countries are working on mechanisms to measure and report criteria and indicators for SFM. At the national level, countries are revising legislation and introducing policies such as new codes of forest practice to incorporate wider objectives, such as those outlined in *Box 5*, into forest management. The extent to which SFM is implemented will primarily depend upon the cost of such measures and the extent to which forestry administrations monitor and enforce compliance with the policies to encourage SFM they are currently introducing.

Box 5: Typical contrasts between Sustainable Forest Management and sustained yield

Sustainable Forest Management	Sustained yield forestry
Maintain the productivity of the forest, by avoiding erosion, soil degradation, and impoverishment of the soil ecosystem.	Emphasises productivity but tends to use intensive techniques to replant 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 the silvicultural characteristics of species and economic considerations. Where feasible, stands of low value species tend to be converted 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 utilisation and reducing costs are the primary motivations to change harvesting practices. Such motivations often have to be constrained by regulation (e.g. 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)

6.4.2 The implications of Sustainable Forest Management for future wood supply

Two components of SFM which have the potential to affect future wood supplies are the increased placement of forest areas into legally protected areas and changes in the way in which harvesting is carried-out in remaining forest areas. The former has already been discussed above, so the latter will be discussed here.

The largest potential impact of SFM on future wood supply will probably be through changes in harvesting regulations that are likely to be introduced. Most countries around the world have regulations the amount of wood which can be harvested from public (and sometimes also private) forest lands and many also lay down rules about how, when and when the wood may be cut. The achievement of SFM will, in many cases, require a revision of these rules (and, of course, stricter implementation of these rules - in many cases, implementation is currently very weak).

There is currently considerable debate and disagreement about exactly what measures would be required so that a forest manager could then say that they are managing their forests sustainably. However, most current interpretations of SFM have resulted in a general trend

towards a reduction in the amount of timber that can be harvested each year from areas of natural forest and plantations.

Measures that might be introduced in forest plantations include:

1. requirements to plant more native species and a greater diversity of species;

2. requirements to leave greater areas of open space around watercourses and other sensitive sites; and

3. measures to reduce the amount of artificial inputs (i.e. fertilisers and pesticides) added to forest crops.

Such measures will all generally tend to reduce the growth potential of plantations (although better silvicultural practices, the selection of faster growing trees and other technology developments may offset this effect to some extent).

In terms of harvesting, in plantations and areas of natural forest where clear-cutting harvesting systems are the norm, measures which might be introduced include:

1. alteration of rotation ages away from economically optimum rotation ages towards ages which are more aesthetically pleasing and better for the environment (generally longer rotation ages);

2. changes in the size of areas which may be clear-cut as one contiguous area, probably reducing the average clear-cut area (and, consequently increasing operating costs) in most cases; and

3. retention of areas of forest to grow to biological rotation age in order to provide seed, maintain wildlife habitats and reduce soil erosion (e.g. the variable retention silvicultural system recently accepted for adoption by one major forestry company in British Columbia).

In plantations and natural forest where selection felling is more commonly applied, SFM may involve increasing the minimum size of trees which may be felled, reducing the number or type of species which may be felled in a given area (to conserve biodiversity) and extending the cutting cycle.[21]

All of these possible changes to harvesting regulations are likely to have the effect of reducing the volume of timber which can be taken from a forest area in any one year. They will therefore, tend to reduce potential harvesting volumes in the short-run. However, in the long-run, they may support a sustainable level of production that will exceed what would be possible in later years if current harvesting systems were to be continued. It should also be noted that they will also generally tend to increase roundwood production costs (see below).

[21] Similar to the rotation age in a plantation, the cutting cycle is the period of time which must elapse before a forest manager is permitted back into an area which has been selectively logged in order to take a subsequent volume of timber.

6.5 Synthesis: implications of future changes in forest resource availability and management for future wood production

The above sections described the main ways in which changes in future forest resource availability and management might affect potential wood supplies. This final section tries to summarise and quantify these changes.

6.5.1 The effect of forest land-use changes on future potential supply

Two possible land-use changes were examined above as probably having the greatest potential effect on future wood supplies: changes in the demand for agricultural land and changes in the area of forest in protected areas or subject to other forms of harvesting restrictions.

As has already been noted, the expected future demand for agricultural land is only about one third of the expected future rate of deforestation, which has been built into the calculation of the baseline supply projections presented earlier. If a greater share of the world's future food production requirements were to be satisfied by a higher rate of conversion of forest land to agricultural uses, there is a considerable additional area of forest conversion to other land uses already built into the estimates of future deforestation to believe that such an increase could be accommodated without significantly increasing the deforestation estimates used here. Thus, it is believed that any such changes are unlikely to have a significant impact on future potential wood supplies. This view is reinforced by the fact that, as will be shown below, agricultural land can also be a significant source of future wood supply from trees outside of forests.

The amount of forest which would have to be placed into protected areas to meet a global target of 10% was shown in *Table 19*. If such a target were to be achieved, the impact on future supply potential would depend upon the type of forest areas taken out of production.

As *Table 19* showed, the amount of forest which would have to be removed from production to meet such a target is far less than the amount of forest already assumed in the GFSM, to be unavailable for future wood supply at the broad regional level. Even at the individual country level, there are only a handful of very small countries which are already harvesting in or have access to such a large extent of their forest estate that such a move would necessarily reduce the area available for wood supply.

Therefore, given that currently inaccessible areas are more likely to be chosen for placing into protected areas (because they have been less disturbed) than areas currently available for wood supply, it seems likely that the achievement of a 10% forest protected area target could be achieved with minimal impact on future timber markets. However, to test a range of future possibilities, three scenarios for the future placement of forest areas into legally protected areas have been constructed for this analysis and are shown in *Table 24*.

Table 24: The effect on potential future wood supply of achieving a minimum of 10% forest in protected areas by the year 2010

Region	Area removed from area available for wood supply to meet the target (1,000 ha)			Potential future wood and fibre supply in 2010 with areas removed (million m^3)			GFPM projection for 2010 (million m^3)
	Low	Medium	High	Low	Medium	High	
Africa	0	7,700	18,486	81	77	72	86
Asia	32	2,628	4,682	729	720	714	643
Oceania	0	679	2,271	80	78	73	54
Europe	14	6,864	8,853	893	884	881	632
North and Central America	0	16,922	31,629	835	792	755	805
South America	0	7,579	42,042	225	214	164	155
World	47	52,231	107,962	2,843	2,766	2,659	2,375

Note: The potential future production estimate for North and Central America is a vast underestimate because potential future recovery of recycled fibre has not been included in the official estimate for North America.

The low impact scenario assumes that all forest required to be taken out of production to meet a 10% protected area target (at the individual country level) has to come first from forest currently unavailable for wood supply. The high impact scenario assumes the opposite and that forest available for wood supply will be placed into protected areas first. The central scenario assumes that forest areas placed into legally protected areas will come from each of the two types of forest in proportion to their present relative sizes.

The areas remaining in production in each scenario are then simply multiplied in the table, by the baseline estimate of future potential supply originally shown in *Table 11* to give the revised estimates of future production potential shown in the right-hand half of *Table 24*. (For ease of reference, the baseline forecasts of total actual production from the GFPM are also shown on the far right-hand side of the table).

This simplistic calculation of the effect on potential supply of moving areas of forest into protected areas probably overestimates the impact of such moves. For example, the original estimates of supply potential for all regions except North America, included supply from recycled and non-wood fibre which will not be affected by such changes. However, the results shown in *Table 19* illustrate the generally minor impact such moves would have on future supply potential, in most regions and under most future scenarios.

Under the low impact scenario, only a tiny amount of forest available for wood supply would have to be moved into protected areas, so the 10% target could be achieved with practically no impact on future wood supplies. Under the medium impact scenario, potential production would fall in each of the regions by between 1% in Asia and 5% in South America and would also be likely to have little impact. Under the high impact scenario, production would fall in each of the regions by between 2% in Asia and 27% in South America. This might start to have an impact on future wood supplies in some regions.

Africa is the only region where transferring forest areas into protected areas might cause reductions in production potential to lead to cuts in actual production. The figures for North and Central America in *Table 24* also show production potential dropping below the actual production forecast for 2010 under the high and medium impact scenario. However, it must be remembered that the enormous potential production of recycled fibre is not included in the figures presented for this region.

Production potential in all of the other regions should be likely to remain high enough to cover industrial roundwood needs under almost all circumstances and even in Africa, the abundance of trees outside of forests may make it possible to achieve the 10% forest in protected area target with minimal impact on timber markets.

6.5.2 Future supply from plantations and trees outside of forests

Based on the three scenarios of future industrial forest plantation establishment rates given in *Section 6.2.3 Future likely rates of* plantation establishment, the forecasts of future potential industrial roundwood production from forest plantations shown in *Figure 7* were constructed. These scenarios illustrate several features relating to potential future industrial roundwood production from forest plantations:

1. they show that the recent historically high rates of plantation establishment will ensure that potential wood production from forest plantations will significantly increase over the period to 2010 (to around 600 million m^3/year);

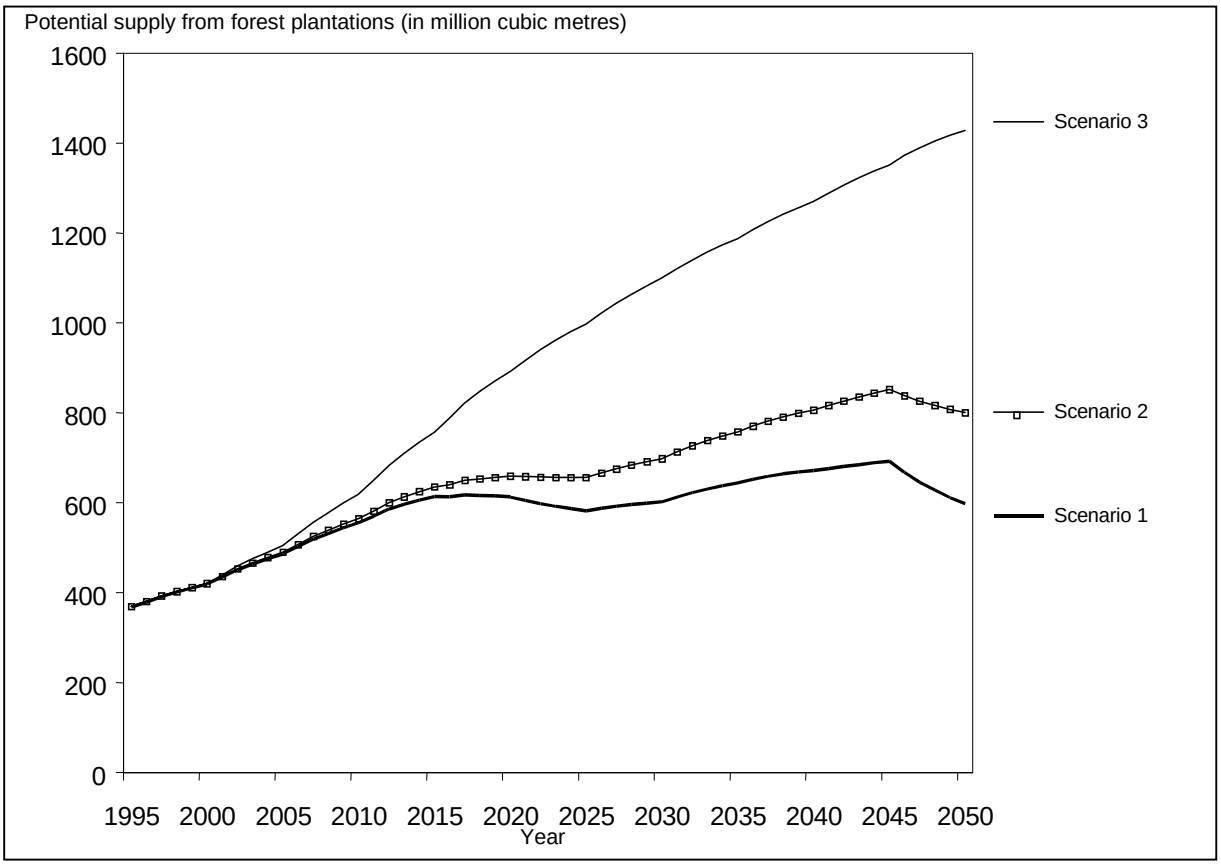
2. they show that the current rate of forest plantation establishment will have little effect on potential production within the period to 2010; but

3. they also show that the current rate of forest plantation establishment will have a major impact on potential wood production over the longer term (a difference of about 700 million m^3/year between the high and low forecasts by the year 2020).

The forecast of total industrial roundwood supply and demand can not be reliably extended to 2050, so it is difficult to assess the likely importance of forest plantations for future industrial roundwood supply in the very long-term. However, it is possible to make some tentative statements based on a continuation of current trends in supply and demand. For example, scenario 1 (no new planting) is likely to be insufficient to keep pace with growth in industrial roundwood consumption in the long-term and additional new sources of wood or fibre (or new technologies) would probably have to be found to satisfy future demands. Something close to scenario 2 would probably roughly keep pace with increasing demand for industrial roundwood in the long-term and would result in current levels of harvesting in natural forests and the use of non-forest fibre sources being maintained (unless other new fibre sources are found or new technologies are introduced). Only under scenario 3, with its relatively large implications for land-use change, would forest plantations be likely to substitute for industrial roundwood production from natural forests. Scenario 3 suggests an expansion in forest plantation production to 1.5 billion m^3/year (a level that is approximately equal to current levels of global industrial roundwood consumption).

As this analysis shows, the long-term production forecast from forest plantations is very sensitive to the assumptions made about future forest plantation establishment rates. Consequently, much is likely to be determined by the future availability of land for new planting.

Figure 7: Three forecasts of future potential industrial roundwood production from forest plantations



Source: Brown (1999)

In the case of potential future wood supply from trees outside of forests, it was already noted above that a current lack of data makes it extremely difficult to make any projections at a global scale. However, at a regional and country scale and for certain components of the trees outside of forests resource, it is possible to make some rough estimates. This is particularly the case for countries and regions where such resources might be most important. So, for example, the Government of Sri Lanka has collected information about current sources of supply and some projections of potential wood production from trees outside of forests, as illustrated in *Table 25*.

Table 25: Current and projected wood production from homesteads and other non-forest tree resources in Sri Lanka (in thousand m^3)

Product and source	Year			
	1995	2000	2010	2020
Rubberwood peeler logs	**7.8**	**7.9**	**8.4**	**8.2**
Sawlogs				
Home gardens	551.3	570.0	641.8	702.4
Rubber plantations	253.1	256.3	270.0	265.8
Coconut and Palmyra	168.0	202.4	210.9	154.3
Trees on tea land	75.9	75.9	75.9	75.9
Other perennials	65.6	68.6	74.9	81.9
Roadsides and settlements	4.7	4.8	5.1	5.2
Poles				
Home gardens	786.6	813.2	822.6	831.7
Other perennials	45.6	47.7	52.1	57.0
Total	**1,958.6**	**2,046.8**	**2,161.7**	**2,182.4**

Source: Government of Sri Lanka (1995)

As the above table shows, homesteads and non-forest trees generally are expected to supply more sawlogs and more poles for local consumption over the next 20 years. Because harvesting is currently not allowed in forest areas and Sri Lanka is not a wealthy country, this supply is vital to meet future domestic wood demands.

Table 26: Current and projected wood production from trees outside of forests in the Asia-Pacific region (in million m^3)

Region	Source				
	Other wooded land	Agricultural land		Other land	Total
		Agricultural tree crops	Other crops and pasture		
1995					
Advanced Industrial Economies	6.4	2.0	16.5	1.6	26.5
Newly Industrialising Economies	0.1	1.7	0.5	0.1	2.4
North Asia	19.2	60.4	317.9	44.7	442.2
Southeast Asia	17.2	115.6	60.4	8.7	201.9
South Asia	9.7	44.6	133.3	12.4	200.0
Pacific Islands	0.5	0.3	0.9	0.5	2.2
Asia-Pacific	**53.1**	**224.6**	**529.5**	**68**	875.2
2010					
Advanced Industrial Economies	6.4	1.8	16.3	1.6	26.1
Newly Industrialising Economies	0.1	1.6	0.5	0.1	2.3
North Asia	19.0	143.1	308.9	43.3	514.3
Southeast Asia	15.6	146.2	81.2	9.7	252.7
South Asia	7.3	48.7	134.7	11.8	202.5
Pacific Islands	0.4	0.4	1.7	0.5	3.0
Asia-Pacific	**48.8**	**341.8**	**543.3**	**67**	1000.9

Source: FAO (1998)

The only region where detailed research into the future potential supply from trees outside of forests has been conducted is the Asia-Pacific region (FAO, 1998; Blanchez, 1998). A summary of the current and future projected potential wood supply from trees outside of forests presented in the APFSOS is shown in *Table 26*. It should be pointed-out that some of these estimates are based on sparse data and that there is much uncertainty attached to these forecasts. However, they can serve as a rough guide to the importance of this resource within

the region. For example, they show that the recent and future projected increase in the establishment of agricultural tree crops in the region (fruit orchards and plantations of oil palm, coconuts and rubber) could have a significant impact on future wood supplies, particularly in North and Southeast Asia. Already some countries in the region (e.g. Thailand and Malaysia) are developing industries to take advantage of this resource.

It seems likely that Asia and Africa are the two developing regions where there is most scope for increasing wood supply from trees outside of forests.

6.5.3 Changes in wood supply with the implementation of SFM

The main ways in which implementation of SFM may lead to a reduction in future harvesting volumes were described above. Some quantitative estimates of future volume reductions and production cost changes are shown in *Table 27*. This table was constructed from a review of the forestry literature carried-out as part of the GFSM analysis. In many cases, the impacts shown in the table are based on a single study of a small area. Therefore, the results of these studies must be interpreted cautiously and not be seen as representative of whole countries, regions or the world.

Table 27: Summary of the findings of recent studies into the production cost and volume implications of implementing SFM around the world

Region	Country	Case study	Short-term volume reductions	Cost implications
North America	Canada	Clayoquot Sound	30-40%	8-25% cost increase
North America	Canada	White River	10-25%	Increase
North America	Canada	Seine River	24%	n.a.
Europe	Sweden	A Barklund	6-8%	n.a.
Asia	Malaysia	Sarawak	50%	Increase
Asia	Malaysia	Innoprise Corp.	6-8%	5% cost increase
Asia	Malaysia	Dermakot	up to 100%	n.a.
Asia	Indonesia	Indonesian Plan	18.4%	n.a.
Asia	Indonesia	STREK Project	9 - 15%	Increase
Latin America	Bolivia	Chimanes	24 - 57%	35-67% loss in profits to logging contractors
Latin America	Brazil	Paragominas	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		n.a.	Increase

Source: FAO (1999a)

Most of the studies reviewed here suggest that the implementation of SFM is likely to result in reductions in future harvesting volumes (per unit area), particularly in the short-term. In the tropical regions, they suggest reductions may be between 20% and 60%, but sometimes as high as 100%, depending upon circumstances. In the few studies of temperate and boreal

forests, they suggest generally lower volume impacts of between 10% and 40%. In the longer-term however, the literature also suggests that SFM will result in higher production than a continuation of current harvesting practices through the maintenance of site productivity and the retention and prevention of damage to immature trees (in selectively logged areas).

Less information is available about the impact of SFM on production costs, but what information is available suggests that costs may rise by up to 25% in temperate and boreal countries. In tropical countries, the cost impact of implementing SFM could be much lower, say up to 5%. This is partly because current poor harvesting practices in many tropical countries are not only bad for the environment, but are also not very cost-effective. Therefore, the improved practices required to implement SFM may actually result in cost savings in some cases[22].

Losses of harvesting volumes such as those suggested above would have profound implications for future wood and wood product supply and demand. The regions most likely to be affected would be Africa and Asia, although some major temperate and boreal producers would also face significant challenges. Such losses could be replaced by supplies from plantations and trees outside of forests, but again, this would require a significant restructuring of the wood processing industry. However, the greatest uncertainty about the future impact of the implementation of SFM on harvesting volumes is likely to concern the total area where radical changes in current forest practices will be required. The above table has shown the possible impacts of changes in a few specific examples from around the world. It seems likely that there are large areas of forest where the impacts of the implementation of SFM would be less than suggested above.

[22] For example, there is a wealth of studies in the forestry literature to show how the implementation of SFM techniques such as proper planning, road and skid-trail layout and reduced impact felling have little impact on costs and can actually reduce costs or increase the value of output in some cases.

7. THE FUTURE FOR FOREST PRODUCT PROCESSING, MARKETING AND TRADE

The previous section of this report examined, in greater detail, the supply-side of the baseline wood and wood product supply and demand forecasts presented earlier. In particular, it examined possible future changes in forest resources and the effect they might have on the availability of future wood supplies. This section of the report discusses possible future changes which might take place on the other side of timber markets; in other words, changes in the demand for wood products and, through technology changes, the derived demand for industrial roundwood.

With the exception of wood fuel and a few minor uses for round poles, all roundwood is processed to some extent before it reaches the final consumer. Sometimes this processing is fairly simple, such as sawing the wood; other processes such as pulping and the manufacture of reconstituted panels are considerably more complex. There have been considerable changes in the efficiency of all of these processes in the past and it is expected that there will continue to be changes in technology in the future.

On top of technology changes, there are also changes in consumer preferences for final products (e.g. sawnwood and paper) which can have an impact on the derived demand for wood and wood products. In particular, recent debate has focused on environmental concerns about the production of wood and wood products. This has led to a number of initiatives which may affect the marketing of and demand for wood and wood products.

One final issue which will also be examined here is the impact which the increasing globalisation of the world economy might have on the production and trade in wood and wood products. To a certain extent, the forest industry has always been a global industry. A large proportion of wood and wood product production is traded in international markets and foreign capital, skills and technology support production in many of the largest producing countries in developing regions. However, both the potential changes in technology and changes in consumer preferences referred to above are largely driven by developed countries, so increased globalisation may have an influence on how they affect developing country producers.

This section of the report is organised as follows: first, it describes current trends under each of the above topics and the impact they might have on future wood and wood product supply and demand. It then finishes by roughly quantifying the possible impact some of these changes might have on the markets for wood and wood products.

7.1 The impact of technology changes on the derived demand for wood and fibre

As in any other industry, the forest processing industry is constantly improving technology in response to changes in resource availability and in the pursuit of new markets and higher profitability. There are three main ways in which technology changes affect the industry and, consequently, the balance of forest products supply and demand:

1. in terms of raw material availability, new processes increase the types and quality of wood and fibre which can be processed into useful products and increase the volume and variety raw material resources which can be considered as available for future wood supply;

2. in terms of end-uses, technological changes alter the patterns of demand for wood products, many of which have very different wood raw material requirements; and

3. in terms of the production process, new processes and improvements to existing processes can increase the amount of product which can be manufactured from a given amount of wood and fibre input, effectively utilising another source of supply - forest processing residues.

There are many examples of how such changes have affected wood and wood product supply and demand in the past. The development of a wide variety of different types of reconstituted panels have allowed the forest industry to manufacture products out of wood from vast areas of forest which were previously identified as containing mostly non-commercial species. Examples include the aspen forests of North America and birch woodlands across much of Northern Europe. In Southeast Asia, research into processing and effective marketing have supported the development of a significant rubberwood processing industry.

The development of the reconstituted panel industry has also started to change patterns of solid wood consumption in end-uses such as furniture manufacturing and construction. Not only do reconstituted panels tend to have higher product recovery rates than the sawnwood that they have started to replace in some markets, but they have also increased the recovery of utilisable product from sawmilling itself by increasing the market for sawmilling residues.

The analysis presented below has investigated the likely future developments in each of these areas for three main sectors: the paper and paperboard manufacturing sector; solid wood product production in developed countries and solid wood product production in developing countries[23].

7.1.1 Technology changes in paper and paperboard production

In terms of fibre supply and demand, the most noticeable changes in pulp and papermaking technology which have occurred in recent years have been changes in the acceptability of new fibre sources and in the end-uses of different types of paper. In contrast, fibre recovery in the actual pulp and paper production process has not changed by very much. For example, many of the recent advances in waste recovery, such as better screening and recovery of effluents, have had beneficial environmental impacts, but have probably not increased fibre recovery dramatically for any particular pulping process.

The greatest technological change in the sector over the last three decades has been the move towards the increasing use of recycled paper in the fibre furnish for papermaking. This has

[23] The latter two parts of this investigation were carried-out with the assistance of the US Forest Service Forest Products Laboratory in Madison, Wisconsin and Forest Research Institute of Malaysia.

been encouraged by the increasing costs of disposing of such waste material and environmental legislation.

Statistics showing historical trends in the use of recovered fibre in the overall fibre furnish have been collected by FAO. Therefore, it has been possible to analyse these trends and incorporate an expected change in the future use of recycled fibre into the supply and demand projections presented earlier. Currently, wastepaper recovery rates (the proportion of paper consumption which is collected each year for recycling) vary from 10-15% in countries with abundant forest resources and low population densities to 65-70% in countries with high population densities and limited forest resources. The baseline projections presented earlier have assumed that the proportion of paper consumption collected and turned into recycled paper will increase in line with historical trends, subject to an overall limit that the proportion of recovered fibre used in papermaking will not exceed 70%.

The historical trend in the use of recovered paper in the total fibre furnish can be inferred from *Figure 1*, which shows the proportion of pulp used in paper manufacturing falling from 80% in 1970 to around 60% in 1996. Recovered paper and a small amount of fillers (e.g. china clay and bonding agents) account for the remaining volume of raw materials used in paper production. It is expected that the trend shown in *Figure 1* will continue and that, by 2010, pulp will only account for about 50% of the inputs required to make paper. This trend is incorporated into the baseline projections presented earlier.

Even greater growth in the future use of recovered paper is technically feasible, but would depend upon two major factors: the economics of collection and recovery (i.e. the costs of collection and the value of recovered paper) and policy measures requiring or encouraging papermakers to use such material.

Relatively high recovery rates are currently achieved in some developing countries where population is high and labour is inexpensive (e.g. India and China). However, the value of recovered paper is often low in developing countries where there is an abundance of cheap pulpwood. Thus, in countries such as Russia and Indonesia recovery rates are somewhat lower than could be achieved given their relatively low labour costs and high levels of urbanisation. However, it is unlikely that, without specific government intervention to encourage greater recycling (e.g. recycling laws or changes in pulpwood pricing policies), developing countries will increase their use of recovered paper beyond the levels incorporated into the forecasts presented earlier.

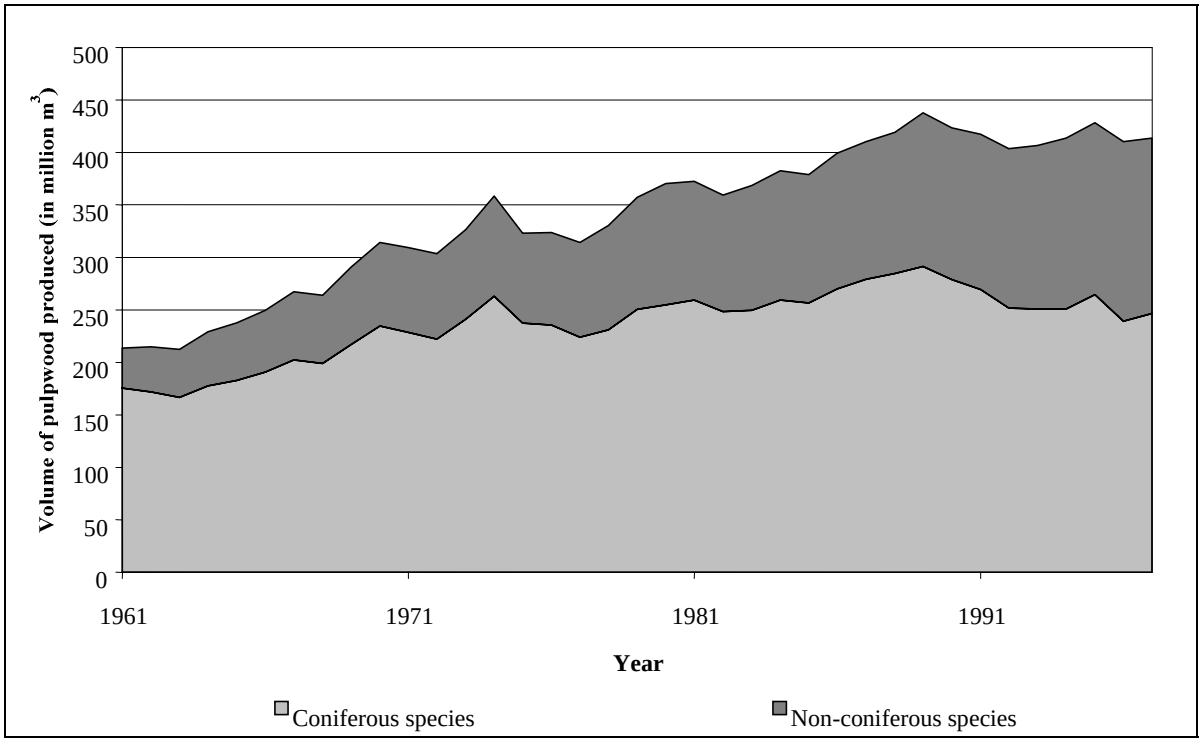
OECD countries (particularly those in Western Europe) have passed most of the major changes in legislation to encourage paper recovery. For example, the European Parliament passed a directive in 1994 requiring that member states must recover a minimum of 50% of all packaging materials within five years of the implementation of the directive into national laws[24]. Some member states have individual initiatives which go beyond this (e.g. Germany). In the United States of America, the American Forest and Paper Association has established a voluntary target of 50% wastepaper recovery by the year 2000. Other highly urbanised countries such as Australia and Japan are also already major wastepaper recyclers, without the need for much government intervention. Again, these developments have already been

[24] EC Directive 94/62 on Packaging and Packaging Waste (EC, 1996).

incorporated into the forecasts presented earlier and it is doubtful whether the use of recovered paper could be increased beyond these levels within the timescale of this analysis.

The other major raw material change which has occurred in the last few decades is the growing acceptability of hardwood species for pulp production. Traditionally, softwood species have always been preferred for pulp production due to their long fibre length and strength. However, improvements in the pulping process have enabled hardwoods to take a greater share of this market in recent years. For example, *Figure 8* shows that the proportion of non-coniferous pulpwood production in total pulpwood production has increased from less than 20% in 1961 to 40% in 1997.

Figure 8: Production of coniferous and non-coniferous pulpwood 1961 - 1997



Source: FAO (1999b)

This development has encouraged the establishment of fast-growing plantations of hardwood species across the world. For example, in the Southern United States of America, large fast-growing poplar plantations have been established for the production of pulpwood and a large proportion of the vast areas of plantations in tropical countries have been planted with eucalypti and acacia for pulp production.

The move towards greater acceptability of hardwoods for pulping has, in part, also been encouraged by changing end-use demands in the paper sector. The fastest growing sector of the paper market is the market for printing and writing paper. Such papers require high density, opacity and porosity. These are characteristics in which hardwood pulps excel compared with their softwood alternatives. The trend towards demand for these types of paper will also reduce fibre requirements because such paper has a higher content of non-fibre raw materials (e.g. bonding agents and fillers such as kaolin).

The above changes have already been built-in to the forecasts presented earlier in that the different product recovery rates (for each of the paper products) have been incorporated into the projections for derived pulpwood demand.

The only other major technological shift which may improve recovery in the near future is if the mixture of mechanical and chemical pulp in the overall fibre furnish changes. Due to the differences in the pulping process, it generally takes less raw fibre (roughly one cubic metre) to produce one metric tonne of mechanical pulp than it does to produce one tonne of chemical pulp. However, chemical pulping is often a cheaper process due to lower energy costs and is the preferred process for species with short fibre lengths such as hardwoods. Therefore, chemical pulp currently accounts for the vast majority of pulp consumption in most countries of the world.

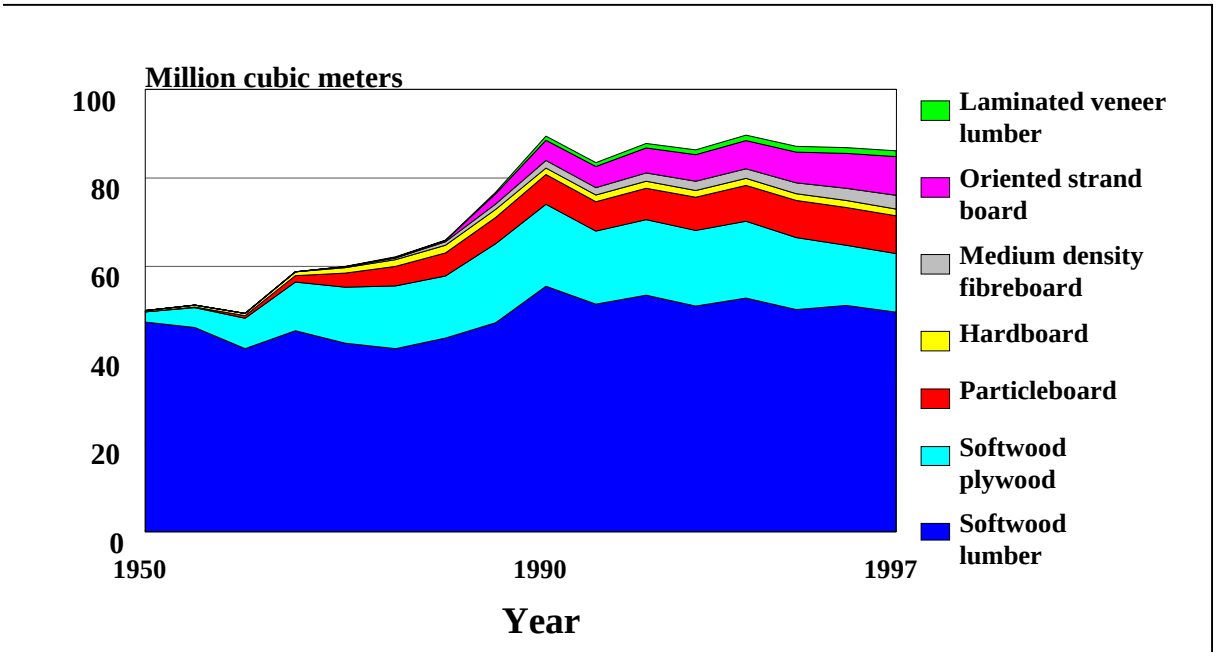
As mechanical pulping processes improve, it is expected that pulp consumption will shift more towards mechanical pulp. The model currently assumes that a gradual shift towards greater use of mechanical pulp will occur on the grounds of increased cost-effectiveness. Thus, for example, the proportion of total wood pulp consumption held by mechanical pulp increases from 22% in 1996 to 27% in 2010 in the baseline projections presented earlier. If technology allows mechanical pulp to substitute for chemical pulp even faster than is currently projected, this would have the impact of reducing future wood and fibre requirements for pulping even further.

7.1.2 Solid wood product production in developed countries

Technological innovation has brought several new solid wood products to the market in recent decades. Each time this has happened, these products have tended to help to extend the use of forest resources. Particleboard (chipboard) production started on a commercial scale in the 1950's, followed by oriented strand board production in the late 1970's and medium density fibreboard production in the early 1980's. New products currently beginning to enter the market in a major way include laminated veneer lumber, I-joists and strand lumber.

Figure 9 shows the increasing role that engineered wood products have played in the markets for solid wood products in the United States from 1950 to 1997. As the figure shows, a considerable amount of the growth in production of solid wood products over the last four decades has been met by development of these new products. In contrast, sawnwood production has remained relatively static and plywood production, while growing at first, has declined in recent years.

Figure 9: New product developments in the markets for solidwood products in the United States of America since 1950



Source: Ince et al (1997)

This situation has been mirrored in most developed European economies except that, in many cases, the market share taken by reconstituted wood products[25] has been even greater than in the United States of America and Canada. Only in Japan has the market for solid wood products not experienced these sorts of changes to a significant extent.

The technology to produce such products and utilise them in situations where previously sawnwood and plywood would have been used, has had a profound impact on the extent and type of forest resources which can now be used for solid wood processing. The most important impact has been that such products have enabled smaller sized trees and residues from sawmilling and plywood manufacturing to be used to manufacture these products. This has greatly increased the supply of wood and fibre from sources that would have previously been considered as non-commercial.

A similar impact has been that such changes have greatly increased the number of species which can be used to manufacture solid wood products. Wood, because it is a natural product, can be very variable in terms of its strength, durability and workability. Consequently, all over the world, a few species have become the preferred species for manufacturing sawnwood and plywood, because their properties have been researched, are generally predictable and are well documented and well known.

[25] Reconstituted or engineered wood products are solidwood products or panels other than sawnwood and plywood. They include products such as: chipboard; hardboard; insulating board; oriented strandboard; glue laminated lumber; and medium density fibreboard.

Trying to introduce a new, less well known species to manufacturers of sawnwood and plywood is a slow and difficult task. However, with engineered wood products, it has been possible to take a wide variety of species and, through the manufacturing process, turn them into an acceptable and predictable product. Thus, for example, species such as birch in Europe and Alder in North America were once regarded as non-commercial because they were generally too small to peel or saw and didn't have many of the other properties desired for sawnwood or plywood. Now they can be chipped and turned into reconstituted panels which can be used in a variety of end-uses and are generally cheaper to produce than the sawnwood and plywood they have replaced.

The third impact on raw material demands has been that reconstituted panels generally require less wood input per cubic metre of output. Thus, for example, sawnwood and plywood typically require 1.75 to 2.0 cubic metres of input to produce one cubic metre of output in developed countries (and even more in developing countries because technology levels tend to be lower). However, conversion rates for reconstituted products are generally lower than this and may be in the range of 1.2 to 1.6 cubic metres of input to one cubic metre of output.

In part these technological changes have been driven by increased scarcity of large logs in temperate and boreal forests as harvesting has moved from old-growth to secondary-growth natural forests. Another major factor has been the availability of cheap wood residues, which were previously either used for pulp production or simply discarded if no local pulpwood market existed. It is not uncommon now to find sawmills in Europe and North America with near-100% product recovery rates when the residues from sawmilling are chipped and used in the manufacture of pulp and reconstituted panels.

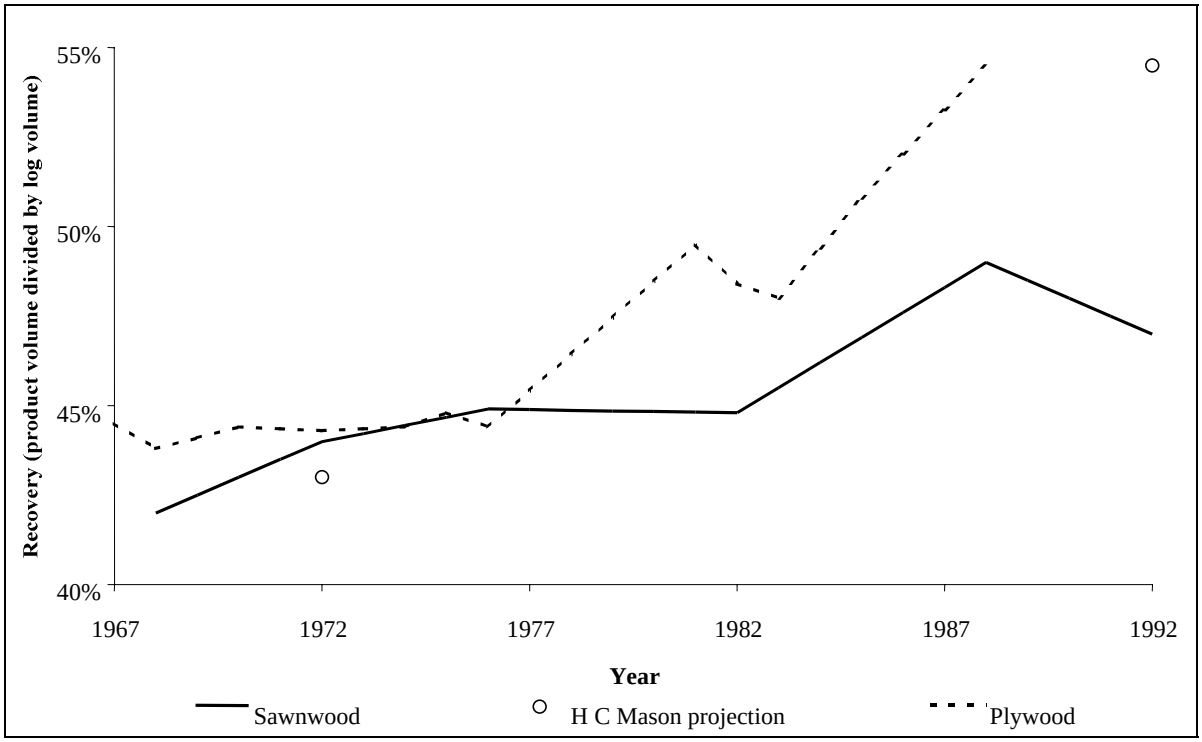
In terms of end-uses, technological improvements have also reduced the volume of product required to meet end-use needs or demands. Thus, for example, I-joists and laminated veneer lumber can be substituted for sawnwood in many end-uses such as roofing joists and beams. These products require a lower volume of wood than an equivalent piece of sawnwood to meet a certain structural requirement. They can also be produced in longer lengths which reduces the need for overlaps at seams, which further reduces wood requirements.

In contrast to paper and paperboard production, processing technology in the sawmilling and wood-based panels manufacturing industries has also improved dramatically over the last few decades. Spelter (1999), lists a whole range of ways in which sawmills in North America are increasing the amount of product they can recover from each cubic metre of log input, including: better operator training; optimised sawing; curve sawing; and varying feed rates into the sawblade.

These improvements have helped to push product recovery rates (i.e. the volume of sawnwood produced from a given volume of roundwood) up in the North American sawmilling industry over the last 30 years. For example, *Figure 10* shows that product recovery rates in the Western United States of America increased from 42% in 1968 to 47% in 1992. This was slightly below projections made in 1973 (H C Mason and Associates, 1973), but these improvements have been made against a background of slowly deteriorating log size and quality in the region. However, it does mean that, for each cubic metre of wood input, mills in this region managed to produce 0.5% more sawnwood output on average each year over this period. This rate of growth in recovery (0.5% per annum) may not seem like

much, but it must be remembered that the projected growth to 2010 of sawnwood production in North America shown earlier is also only a small figure (0.7% per annum).

Figure 10: Projected and actual product recovery in sawmills and plywood mills in the Western United States of America 1968 - 1992



Source: Spelter (1999)

The wood-based panel industry in North America has similarly developed some improvements in processing technology which have increased recovery rates. Plywood mills now use scanners to reduce waste at the start of peeling and improve clipping. Modern peeling machinery can also peel down to a smaller core with retractable or telescopic spindles. This has pushed plywood recovery rates up from 45% to 55% over the last 30 years in some regions (see *Figure 10* above).

In the manufacture of reconstituted wood panels, a range of technological improvements have increased product recovery. Larger logs can now be fed into the chippers or flakers and modern machinery can make larger panels. Both of these improvements reduce trimming losses. Heat conditioning the logs before they enter the process also reduces the production of fines (small particles - e.g. sawdust - which can not be used in the final product) and better gluing technology has reduced the amount of wood needed to make a board of a given strength. Reconstituted panels already have the best recovery rates of all solidwood products (up to 60% in the most technologically advanced mills), but many mills are somewhat behind in their adoption of new technology. There is therefore, still some scope for improvement in product recovery rates across the industry overall.

7.1.3 Solid wood product production in developing countries

Very little information is available about product recovery in developing countries. However, it is generally believed that many developing countries, particularly those with large forest resources, have much lower rates of product recovery than are typically found in developed countries. It is also believed that there have not been any significant trends towards greater efficiency in forest products processing in developing countries over the last 30 years.

To a large extent though, many of the opportunities for technological improvement outlined above are, if anything, even greater in developing countries than they are in developed countries. There are two reasons for this. Firstly, at least in the case of tropical countries, the average size and quality of industrial roundwood harvested from the forest is generally higher than would be found in most developed countries. Secondly, the required quality of products in developing countrys' domestic markets are generally lower than would be found in developed country markets. Therefore, many of the conversion losses associated with producing a high-quality finished product might not apply to many developing countries where a slightly lower quality of product is generally acceptable.

There are however, a few examples where new products have been developed in response to changes in resource availability. One of the most notable developments over the last few years has been the increased use of agricultural tree crops in Southeast Asia. Rubberwood utilisation has been pioneered by Malaysia in response to diminishing industrial roundwood supply in Peninsular Malaysia and the large area of rubber plantations present in the country. A similar development has also occurred in Thailand, where there is now a complete ban on logging in the natural forest and both countries have developed significant rubberwood processing industries.

Rubberwood sawnwood is unlikely to substitute for other types of sawnwood in many applications, but it has been found to work well in applications such as furniture making. There are also now several medium-density fibreboard plants either operating or planned in Southeast Asia which will use rubberwood as their main raw material source. The next likely development will be the use of oil palm husks and trees for the manufacturing of medium-density fibreboard. One such plant was proposed in Malaysia last year, although it is unclear whether, given current financial circumstances, this plant will still be built in the near future.

In terms of end-uses, one of the most notable aspects of forest products markets in developing countries is the size of the share of solidwood products markets in these countries held by sawnwood and, to a lesser extent, plywood. Only a tiny proportion of the world's reconstituted panel production takes place in developing countries and, similarly, such products have only a negligible share of their domestic markets. As noted above, reconstituted panel production offers tremendous opportunities for utilising new sources of fibre from forest industry residues to less-well known forest species and non-forest trees. It is likely that a significant proportion of the high growth in demand for forest product expected in developing countries over the next decade, could be met without significantly greater forest harvesting if reconstituted panel products were to be more frequently utilised.

7.2 The impact of globalisation on future supply and demand

The trend toward increased globalisation has accelerated during the past decade. Most countries have adopted trade, investment, and even environmental policies, which have reduced national insularity and promoted a greater level of standardisation in market prices, production processes, product quality, and regulatory environments. As noted above, the forestry sector has always, to a certain extent, been a global industry and it has not, therefore, been immune to these developments.

It is likely that three aspects of globalisation have the most potential to significantly affect the future development of forestry and forest products markets. These are:

1. trade liberalisation in forest products markets;

2. the increasing role foreign investment and multinational corporations operating in the forestry sector; and

3. the globalisation of environmental advocacy and concern.

The possible future developments in each of these areas and the potential impacts they might have on markets for wood and wood products are briefly described below.

7.2.1 Trade liberalisation

In 1994 the Uruguay Round of negotiations over trade, tariffs and non-tariff barriers to trade concluded with a series of commitments to lower tariff and non-tariff barriers and overhaul the world's trade policy and dispute negotiation mechanisms. The commitments made during the Uruguay Round provided both promises of tangible reductions in global trade restrictions and a new impetus to trade liberalisation efforts.

In addition to the major negotiations such as the Uruguay Round, which have been taking place over the last 50 years, more recent history has also seen an expansion in the number and scope of regional trade agreements and trading blocs. Associations which have developed or expanded over the last 30 years include: the North-American Free Trade Agreement (NAFTA); the European Union (EU); APEC; ASEAN; the Mercado Comun del Sur (MERCOSUR); and the Caribbean Community (CARICOM). These have offered further potential for reducing trade restrictions at the regional level.

However, trade policies in the forestry sector are already currently relatively liberal in comparison to say, for example, agriculture. The highest rates of import tariffs on wood products in developed countries are for wood-based panels (especially plywood) and furniture, at around 15% (see: Bourke and Leitch, 1998). Tariffs on most other wood products are in the 5-10% range and many wood products have no import tariff at all. Import tariffs on all wood products in developing countries are generally higher than in developed countries and are mostly in the region of 20-40%, with tariffs as high as 50-80% on some finished wood products.

Probably the most significant trade measures that have had an impact on markets for wood products in the past are non-tariff barriers. Non-tariff barriers include a wide range of measures such as: export or import quotas; licensing requirements; phytosanitary, technical and environmental requirements or standards; and overcomplicated import or export procedures. Of these, export restrictions (usually put in place to develop domestic industries) have probably had more of a detrimental effect on forests than import restrictions (usually implemented to protect markets).

An example of a non-tariff barrier commonly encountered in the forestry sector is restrictions placed on the export of unprocessed wood products. A large number of countries have implemented such measures, both as a means of reducing demands on limited forest resources and as a means of promoting domestic processing industries. Some have restricted only log exports while others have gone further and have also placed restrictions on exports of wood chips or sawnwood. This is one of the few areas where the forestry sector has been tending to go in the opposite way to the global trend towards more liberal trade.

As with most trade restrictions, the net effect of export restrictions on global efficiency is likely to be negative. Such measures will encourage the development of a local industry, but they won't necessarily encourage the development of an efficient and internationally competitive industry. For example, export restrictions reduce domestic raw material prices (i.e. industrial roundwood prices), which then tends to reduce the incentive to use such materials efficiently. Also, as a significant industry develops, which is dependent upon the supply of cheap raw materials, it becomes increasingly difficult to remove the trade restriction. In other ways, export restrictions may be detrimental to forest resources since they tend to lower the revenues available to forest owners and hence reduce the incentive to invest in better forest management.[26]

A concise review of the outlook for future trade measures is given in Bourke and Leitch (1998), which presents a synopsis of the major commitments made during the Uruguay round to reduce import tariffs and non-tariff barriers to trade over the next 10 to 15 years. Generally, import tariffs in developed countries will fall by 43% for solidwood products and 99% for pulp and paper products. In many cases, import tariffs on pulp and paper products will fall to zero and import tariffs on furniture will also fall to zero in some countries. The only sector where import tariffs are expected to remain high is wood-based panels, especially plywood. Developing countries have also agreed to cut import tariffs to a certain extent, but import tariffs in developing countries will remain somewhat higher than those in developed countries. The impact of these tariff reductions on future supply and demand will be to further reinforce the expected trend towards greater trade in higher value-added products expected in the future.

[26] The statements presented here are based on the overall results of a number of studies into the impacts of export restrictions in the forestry sector. It must be borne in mind however, that such studies often have to make a number of assumptions and use estimates that are very approximate and that many studies have only analysed part of the situation. Export restrictions are sometimes ineffective, they can lead to other positive benefits that are difficult to measure and analyse and it is often difficult to assess what would have happened in the absence of such restrictions. Therefore, although the weight of theory and evidence suggests that they are certainly not a first-best solution, it is still debatable whether a more effective way could be found to achieve the goals of most export restrictions.

It is not possible to project what might happen to non-tariff barriers to trade and other trade impediments. Some agreements were reached on phytosanitary measures and technical barriers to trade in the Uruguay Round, but the impacts of such measures (and, consequently, reductions in them) are difficult to quantify. Furthermore, discussions tended to focus mainly on barriers to imports rather than export trade barriers (such as log export bans). It would seem therefore, likely that bans or high tariffs on exports of unprocessed wood products are likely to be a feature of the future, unless countries can be persuaded to remove them. The continuance of export restrictions for certain types of wood product and in certain countries was built into the baseline projections presented earlier and there are no grounds to suggest that these measures will change significantly in the future.

However, one new feature of trade which has become more prominent in recent years and has the potential to grow significantly in importance in the future, is the number of informal barriers or impediments to trade which have arisen in developed countries. Informal barriers to trade include: the formation of buyers groups; local and national government policies to only purchase certain types of products or products from certain countries; and voluntary bans and boycotts promoted by environmental non-governmental organisations (NGOs). In part, these impediments are intimately associated with moves to create green labels and certify forests. To the extent that these measures can be pushed forwards outside the mechanisms for control and negotiation of the World Trade Organisation, they have the potential to have a significant impact on exporters of wood and wood products in the future and their impact on future supply and demand patterns will be discussed in a separate section on certification below.

7.2.2 Foreign investment in the forestry sector

Recent strong moves toward the development of a Multilateral Agreement on Investment (MAI) are similarly indicative of the move towards globalisation in the investment and capital markets. Within the forestry sector there is significant and often longstanding foreign direct investment in forest and forest processing operations and some of the world's largest forestry companies have operations in many countries. Cross-border investments in the forestry sector have been controversial in some cases, particularly in the harvesting sector, but there are few signs that such investments are likely to decline in the long-term future.

Historically, there has been significant resistance to foreign ownership of forests in a number of countries. Forests have often been regarded as strategic national assets and foreign ownership has been regulated against in some countries and popularly opposed in most others. Nonetheless, there is evidence of a trend towards a more liberal future, with several countries advancing significantly down the path of forest privatisation, including selling forests to overseas interests.

Foreign ownership of processing facilities is much more common than foreign ownership of forests and tends to be less controversial. Such investments are often seen as a means of developing national economies through the generation of income and employment, provision of training and transfers of technology, marketing and management skills. To the extent that such investments do supply such benefits to host countries, they are a desirable component of national development which should be encouraged.

The main problems which have arisen with foreign investment in the past have been in cases where such investments have not supplied many of the above benefits. Perhaps the best examples of this have been where multinational companies have obtained licences to harvest outside their home countries, particularly (but not exclusively), in tropical forests. For example, several Asian companies have recently obtained harvesting licences in Africa and South America. In cases where they have imported capital and labour to manage these areas, they have provided few benefits to the countries where they are working. These arrangements have provoked some controversy in the companies home countries, the countries they are working with and within the international community.

In terms of the outlook for globalisation and forestry investment and the impact such moves might have on future timber markets, the future is uncertain and difficult to quantify. However, a few points are probably worth noting.

Firstly, the privatisation of forest resources is likely to continue, although probably at a slower rate and more so in developed countries than developing countries. A possible exception to this may be Eastern Europe, where efforts to return formerly centrally-controlled forest assets into private-hands can be seen as a form of privatisation. This continuing trend in privatisation will offer more scope for cross-border investment in forest management and harvesting in the future.

Secondly, in terms of processing facilities, most developing countries will continue to need strong inflows of foreign capital and expertise if they are to fully develop the economic potential of their forest resource base. However, from the point of view of national development, it will be important to ensure that such inflows involve more than just capital, but also involve flows of technological, marketing and management expertise.

The last point to note is that these developments, if carefully planned and monitored, are not to be feared. Many of the controversies surrounding forest harvesting by multinationals are not the fault of the multinationals themselves, but rather due to the weakness of forestry institutions in some countries. Often, the multinationals are merely following the same low standards set for domestic forest operators in host countries but, due to the sheer size of their operations, are having a much more noticeable impact. On the positive side, foreign investment in the forestry sector in developing countries, has the potential to bring in improved technology and management practices. This, in turn, could help to balance future supply and demand without requiring more harvesting in new areas of forest, in the same way as was suggested above under efficiency gains. The key to achieving this will be to ensure that there is the right policy and institutional framework in place in countries to encourage such moves.

7.2.3 Globalisation of environmental advocacy and concern

The 1990 Rio Summit highlighted awareness of the need for a global approach to environmental issues including forestry. The development of the new vision for forestry - "Sustainable Forest Management" - has effectively paralleled a broader drive toward global sustainable development, which has gathered momentum throughout the 1990s. To a large extent this has been a result of heightened awareness that environmental issues, such as those facing the forestry sector, will generally have cross-border implications. Evidence of such

awareness is provided by recent international initiatives such as: the development of criteria and indicators for sustainable forest management; moves towards forest certification; agreements on carbon emissions (including sinks such as forests); and agreements to jointly monitor and manage international watersheds.

This heightened international awareness of forests and the environment is, perhaps, the last major example of where increased globalisation has had an impact on forestry. Where formerly, powerful commercial forestry interests could manipulate developing country governments and poorly educated landholders, far greater balance has been achieved through the interventions of environmental NGOs, development agencies and the development of more stringent environmental regulations within developing countries themselves.

The trend toward increased globalisation in environmental advocacy and concern has also resulted in a recognition that, in the future, national forest policies are likely to receive greater international scrutiny and that forestry development and the ability to produce and trade in forest products may be contingent on meeting specific international standards. For example, market opportunities or access to foreign capital may be denied to companies that cannot prove that they have a good environmental record or provide a credible promise that they will do so in the future.

The outlook for this aspect of globalisation is that, with continually increased access to new communication media, the trend towards the internationalisation of environmental concern will continue. Furthermore, there is evidence to suggest that this globalisation will also result in stronger grass-roots NGO capacity in developing countries. The impact of this on future timber markets is most likely to be in the areas of trade and investment already discussed above.

7.3 The outlook for forest certification

One market development that has increased in importance since the early 1990's has been the issue of forest certification or ecolabelling. In many respects, forest certification represents a serious attempt by consumer countries to try to influence forest management through demand-side responses to environmental concerns as opposed to the more traditional route of pressure to change supply-side practices through international agreements, political pressure and lobbying and more gentle persuasion through the development assistance programmes of developed countries.

It is still uncertain as to what impact forest certification will have in the long-run and whether the interest in certification (both political and in terms of market preferences) will be sustained. However, this section will attempt to describe some of the basic issues that have developed to date and present some views on the future.

7.3.1 The growth of certification

A range of forest certification schemes have been developed or are currently being developed around the world at the moment. Certification schemes can be divided into two basic types: systems-based schemes and performance-based schemes, which can be implemented by one of three different types of agents: first; second; and third-party certifiers (see *Box 6* for a description of the different types of certification scheme).

Box 6: The difference between different types of forest certification scheme

Distinctions between different arrangements for certifying forests are usually made in two areas. Firstly, various schemes are differentiated according to who is doing the certification and secondly, there is a difference between schemes which actually measure performance as opposed to those which report on systems for identifying and measuring environmental performance. These differences are explained below.

First, second and third party assessment

The difference between first, second and third party assessment is the independence of the organisation carrying-out the assessment for the purpose of certifying the forest or forest product. A first-party assessment occurs when a company assesses, measures and reports its own performance against a set of environmental standards. Second-party assessment occurs where this is done by a slightly more independent body such as a customer or a trade association. Third-party assessment involves an assessment by a neutral third-party, based on a standardised and commonly accepted set of standards applying across the whole of the sector.

Performance and systems-based certification schemes

To pass a systems-based certification scheme, a company must demonstrate that it has a management system in place to identify, measure and monitor the company's impact on the environment and encourage improved environmental performance. It does not, however, have to pass any particular standard in any of the areas in which it is monitoring performance. Rather, the collection of the monitoring information itself is seen as a desirable first-step to improving performance.

A performance-based scheme goes a stage further than a systems-based scheme and requires that the company must meet certain standards or at least report achievement in a quantitative way in each of the environmental areas which it is monitoring. Typically, this information is then passed on to the consumer in the form of a "green label" or "ecolabel" on the final product.

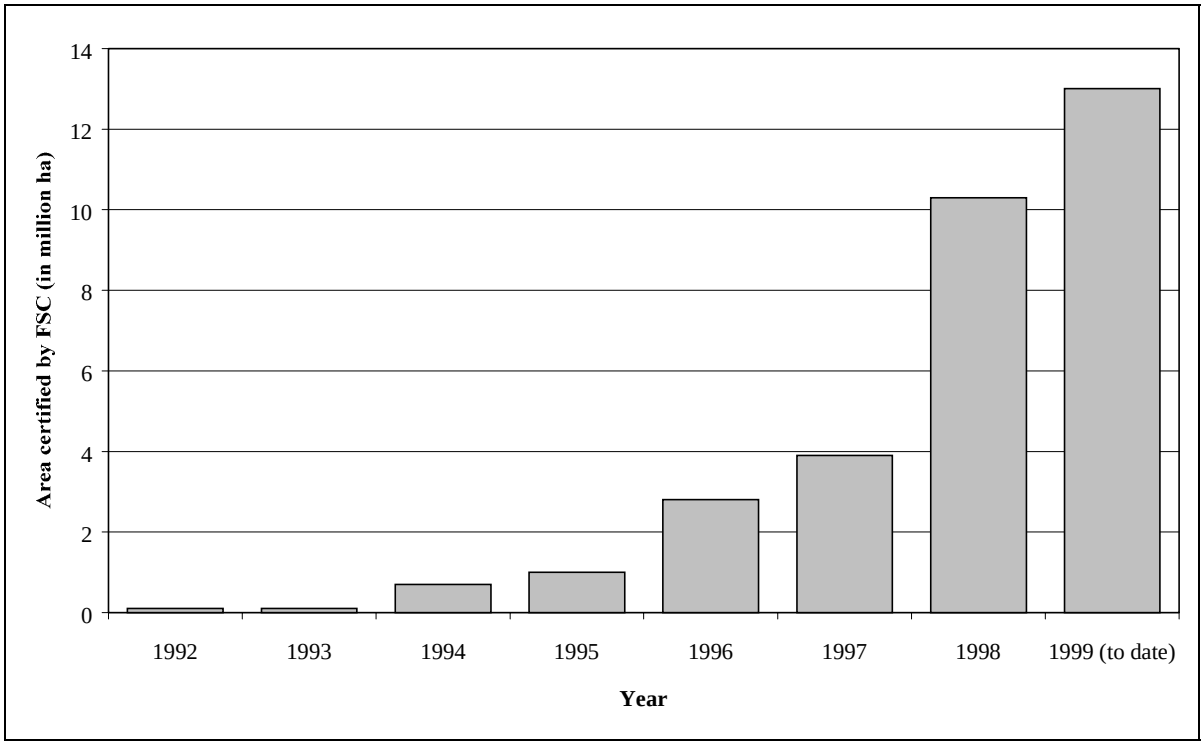
Source: Adapted from Hansen (1998)

A range of national and international certification schemes have developed over the last decade in response to varying market and forest conditions around the world. Probably the two largest national certification schemes at the moment are: the American Forest and Paper Association's Sustainable Forestry Initiative (which is a second-party, performance based scheme); and the Canadian Standards Association's Sustainable Forest Management System Standards (a third-party, system based scheme). Some other countries are also developing national certification schemes. Those countries which are furthest down the route of developing their own schemes include: Finland; Sweden; Norway; Indonesia and the United Kingdom.

Two major international certification schemes have been developed. The first is the International Organisation for Standardisation's ISO Standards 14001 and 14061. These standards are both systems-based certification schemes, with optional third-party auditing. The second major international certification scheme is the set of standards developed under

the auspices of the Forest Stewardship Council (FSC). The FSC certification scheme is a third-party performance-based scheme, monitored by independent certifiers accredited by the FSC. The standards which have to be met to obtain an FSC certificate vary in accordance with the local conditions facing the forestry sector in each country, but this is only reasonable considering the wide range of forest types which the FSC have attempted to cover in their certification scheme.

Figure 11: Area of forest certified by FSC-accredited certification bodies



Source: Forest Stewardship Council (1999)

Of all the forest certification schemes, the FSC certification scheme is probably the most well-known. The area now (January 1999) certified by the six independent companies working to FSC guidelines has just reached 13 million ha (see *Figure 11*). This is still, however, only a tiny fraction of the total area of forest used globally for wood production each year (several hundreds of millions of hectares). The World Wildlife Fund (WWF) and World Bank have, as part of their strategic alliance announced in 1998, agreed to pursue a goal that 200 million ha of forest will be certified by the year 2005. This will present a major challenge, particularly if they want to include a significant proportion of certified tropical forests in this total (see, for example, *Box 7*, which presents a much less optimistic view of the future for certification).

In parallel (and often in association) with the development of certification schemes, has been the development of demand for such products. The organisations promoting certification have tended to stimulate demand for certified products in two ways. Firstly, they have lobbied local authorities (and sometimes parts of national government) to use only certain types of timber. Secondly, they have encouraged local retailers (sometimes with the threat of environmental protest) to stock certified products. They have had some success in both of these sectors, but it should be remembered that the vast majority of wood products are used in industrial applications, where forest certification has yet to make any significant impact.

Box 7: Seven nails in the coffin of certification?

Forest certification represents a serious attempt by environmental NGOs to try to influence forestry policy and management by altering market signals. In as much as market signals have a powerful effect on the way that companies and individuals act, this is to be commended. However, there remain a number of questions about the viability of forest certification in the long-run and, perhaps more importantly, whether it is likely to have any real impact on the forests that are most under threat from unsustainable practices.

- Forest certification will be most attractive (i.e. present the least additional costs) to forest owners and mangers that already manage their forests reasonably well either due to strong national regulatory frameworks or because the owners already place high importance on environmental or multi-purpose management objectives. This is partly reflected by the fact that most of the area that has currently been certified by the FSC is in the western developed countries.

- By concentrating on how forests are managed for the production of marketed forest products, forest certification will do little to stop deforestation and have little impact on forests that are unsustainably managed to meet local needs.

- Increasing globalisation in forest products markets means that end products often mix wood and fibre inputs from a number of sources that are increasingly difficult to verify. Wood is also only a small part of the end product in some of its most important applications (e.g. in construction and furniture manufacturing) and the distance between the forest and end-user is becoming increasingly long.

- The benefits from purchasing certified wood to the end-user are mostly non-use benefits as opposed to use benefits (in comparison to some other environmentally friendly products such as energy efficient appliances and organic food).

- The benefits are poorly understood and difficult to market (in comparison to, say, dolphin friendly tuna).

- Studies have shown that the markets for certified forest products in developed countries are relatively limited and the prospects for price premia are poor.

- The majority (80 percent) of marketed wood and wood products produced in developing countries is also consumed in developing countries, where willingness to pay for environmentally friendly forest products will be constrained by ability to pay.

Taking these points into consideration, it is difficult to assess exactly how useful forest certification will be in the long-run as a measure to promote and encourage sustainable forest management. It is also very unclear as to whether it represents a cost-effective policy tool. The major benefit of forest certification may be that it has raised awareness of some important forestry issues amongst both consumers and producers and may lead to greater support for more effective policy changes in the future.

Actions by local authorities (and parts of national government) to ban the use of certain types of timber in their offices and public projects have been especially prevalent to date in Germany, Netherlands, United Kingdom and United States of America. These actions have mostly tried to ban the use of timber from sources which do not meet some definition of sustainability (which has often been defined as having an FSC-backed certificate). However, they have also either implicitly or explicitly tended to focus on banning the use of tropical timber. It is generally accepted that such bans are of limited value or, at worst, counterproductive (Bourke and Leitch, 1998) and some authorities are starting to back-down from such actions. It is also questionable whether such actions would stand-up to scrutiny under international trade law if tropical countries were to push for their removal in bodies such as the WTO.

Moves to encourage local retailers to take certified products (or even better still, to only take certified products), started in 1991 with the foundation of the 1995 Group of timber retailers in the UK. This line of action has been pushed forward in particular by the WWF and buyers groups (groups of retailers committed to only selling certified products in the future) can now be found in eight countries (see *Table 28*).

Table 28: Timber buyers groups operating in 1998

Country	Group name	Founded	Number of members	Total annual sales (US$ millions)
United Kingdom	1995+ Group	1991	87	69,000
Netherlands	Hart Voor Hout	1995	11	n.a.
Netherlands	Organisations committed to FSC	1992	473	n.a.
Belgium	Club 1997	1994	79	270
Austria	Gruppe 1998	1996	26	960
Germany	Gruppe 1998	1997	31	12,000
Switzerland	WWF Wood Group	1997	10	170
USA and Canada	Certified Forest Products Council	1997	640	n.a.

Source: Hansen (1998). Note: total annual sales is much greater than total annual sales of wood products for most of these companies. Taking this into account, these companies represent only a small share of forest products markets.

The establishment of buyers groups is a crucial component to the success of the forest certification movement in that they strengthen the demand for certified products without requiring a prolonged, widespread and, consequently, expensive promotional campaign, which environmental non-governmental organisations (NGOs) would be hard-pressed to keep-up. However, it is also worth noting that, as with the total area of forests certified to date, the actual market share held by companies which are members of buyers groups (and, therefore, committed to certification) is tiny compared with the total size of the market for forest products. Only in Belgium, does the buyers group supporting forest certification hold anything near to a significant proportion of the timber market (around 50% of the timber trade - Source: Rametsteiner *et al*, 1998).

7.3.2 The costs and benefits of certification

As with the costs of implementing Sustainable Forest Management (discussed in *Section 6.5.3 Changes in wood supply with the implementation* of SFM), the cost of meeting FSC certification standards is currently unknown and uncertain. Therefore, all figures presented here should be considered as highly speculative.

Table 27 showed that the cost of implementing SFM could increase roundwood production costs by up to 25% in temperate and boreal countries and 5% in tropical countries.[27] Many of the management interventions which would be desirable from the SFM point of view are also likely to be required to meet most certification standards, so it is anticipated that the cost of certification should be roughly the same as the cost of implementing SFM, plus a small allowance for the cost of auditing or monitoring to check that a forest meets the standards required to be certified.

[27] Other organisations, for example industry associations and the ITTO, have suggested much higher figures.

However, there is considerable evidence to suggest that forest owners and consumers of forest products, between them, will not be prepared to pay very much for certified products. For example, in a survey of willingness-to-pay (WTP) by Rametsteiner *et al* (1998), forest owners in United Kingdom and Finland were mostly only prepared to pay up to 2% of their timber income to obtain certification and almost none were prepared to pay over 5%. Furthermore, consumers in these countries were at most only prepared to pay an additional 5% for certified wood products and only then for certain types of wood product. Similar market research studies in the Netherlands (Stolp, 1997) have shown that consumers there are not prepared to pay any additional price premiums at all for certified products (and the Netherlands is a country where environmental issues tend to be considered as fairly important compared with most other West European countries!).

Clearly, if the average cost of meeting the higher management standards required to obtain an FSC certificate is considerably higher than producers and consumers are willing to pay, then this suggests that certified forest products will never account for more than a small share of the timber market and that the only forests which will become certified will be those where the costs of certification are very low (i.e. those which are already well-managed from an environmental viewpoint). This, to a certain extent, will reduce the impact of forest certification on the average forest management standards achieved in any particular country.

As the above discussion has shown, it is generally accepted that certified products are unlikely to attract price premiums in any but the most limited and specialised markets. This will severely limit the extent to which producers can pass on the costs of certification to customers and it looks increasingly likely that these costs will have to be borne mostly by the producers. The question then for the future of certification is: are there any other benefits to producers of certified wood products which can justify the additional cost of producing them?

At the moment, the answer to the above question seems to be yes and the main reason put forward by most companies which have shown an interest in producing or selling certified products seems to be a perception that certified products give the companies a marketing edge over their rivals. There is little hard evidence to suggest that certified products have allowed companies to increase their market shares, but this is a perception which is strongly felt by many companies selling certified products and has been reported in several studies (e.g. Hansen, 1998; Rametsteiner *et al*, 1998). How long this can last is unknown, but there will come a time when this perception of "marketing edge" will diminish and this may not be very far away unless NGOs can continue to keep publicising the availability and desirability of certified forest products.

7.3.3 Future challenges for forest certification

From the experiences with forest certification and the marketing of certified forest products to date, some major challenges for certification appear to be taking shape for the future. These are as follows:

Limited market demand. As noted above, several studies have shown that the demand for certified products currently appears to be quite limited. Some very large consumer countries (e.g. China and Japan) appear to have practically no interest in certified products at all. Even

in countries where certified products have been marketed more strongly (e.g. United Kingdom and Netherlands) there still appears to be only a small amount of demand for such products and next to no inclination to pay any more for them.

Lack of supply. Ironically, there have also been several instances recently of companies wanting to sell certified forest products, but being unable to obtain sufficient supplies of certified products. This has occurred in some of the large consumer markets where supply has been unable to keep-up with demand (e.g. the recent experience of Homebase in the United States of America) and in smaller markets where retailers have made strong commitments to sell certified products (e.g. the United Kingdom).

Fragmentation. There are now two separate international forest product certification schemes and a range of national schemes are also being developed. These schemes are all competing with each other for greater recognition and the amount of fragmentation amongst the various schemes is causing some concern and confusion within the industry. The amount of international trade in wood products also confuses the issue further (e.g. if a plywood producer in Canada intends to export a lot of plywood to the United Kingdom, should the producer apply for a certificate based on a national standard drawn-up in Canada or one for the United Kingdom?). Larger suppliers and retailers are overcoming some of this confusion by applying for certification under several different certification schemes. However, many can not afford this option and are choosing not to enter the market for certified products until things have become clearer.

Credibility. The last major challenge which has become more important in recent years is the credibility of some of the agencies offering certification. There have been several well-publicised controversies over forests which have been certified recently and this has done little to help the cause of certification. Rametsteiner *et al* (1998) shows that both producers and consumers in Europe believe that a government or scientific agency would best fulfil the role of certifying forests in their own countries. This study also showed quite clearly that NGOs and private independent companies are placed low on the list of organisations most people would like to have certifying their forests. The question of what role independent bodies such as the FSC should play in the long-term future therefore, remains unanswered, but it seems as though the role of such organisations might have to change in the future.

Until these challenges are effectively addressed, it seems likely that certification of forest products will continue to attract a lot of attention in forestry policy discussion but, in reality, have very little impact on forest products markets.

7.4 Synthesis: the impact of future technology changes, globalisation and certification on the markets for forest products

Out of all the topics discussed in this section, it seems likely that technology changes are likely to have the most impact and have the potential to have the most impact on forest products markets in the future. In contrast, globalisation and certification are expected to have only minor impacts on the future markets for forest products.

7.4.1 The effect of technology changes on future supply and demand

The baseline projections of supply and demand presented earlier were made with only one assumption about future technological change: that the proportion of recycled fibre in the total fibre furnish would increase in the future in line with past trends. The future roundwood supply projections assumed that supply would change in line with changes in the current commercially viable forest area and biological growth, but did not consider the possibility of greater areas of forest becoming commercially viable as production processes adapt to utilise new species. The projection model also used the same conversion factors to estimate derived roundwood demand from product demand for every year of the forecasts (with the exception of the greater use of recycled fibre noted above). Consequently, possible improvements in product recovery rates have not been built into the projection forecasts.

With respect to the first point, it is very difficult to project or forecast in any way, the area of forest resources which has been currently excluded from the model of timber supply, but might become viable as a source of supply in the future. For example, the development of whole industries based on the processing of aspen, birch and rubberwood, could not have been predicted 20 years ago. All that can be said is that the development of newer and better processing technologies will reinforce the trend towards the utilisation of smaller sized pieces of roundwood from a greater diversity of areas including agricultural tree crops, other trees outside of forests, harvesting and mill residues and wood from fast-growing pulpwood plantations. In this way, technological change is expected to support the changes in future supply already discussed in the last section of this report.

In terms of processing efficiency however, some quantitative information is available about the potential impact future improvements in technology might have on the supply and demand balance. Spelter (1999) for example, notes that there is a technical limit to the sawnwood recovery rate which can be achieved in the future, due simply to the geometrical problem of cutting square shaped objects from round shaped ones. His paper suggests that this might be in the range of 45% to 55% depending on log size (larger logs should have better recovery rates). He also suggests that recovery in reconstituted panel mills such as oriented strandboard (OSB) mills might level-off at around 60%.

Given that most sawmills and reconstituted panel mills in developed countries are currently achieving recovery rates somewhat below these figures, this would suggest that the improvements in efficiency experienced in the past could continue into the future for the next decade or so. If past efficiency trends continued, the figures quoted by Spelter would suggest that maybe 70% of future sawnwood production growth could be achieved by sawmill processing efficiency gains, leaving only 30% requiring gains in other areas or additional sources of industrial roundwood. A similar proportion of future expected growth in the production of reconstituted panels could be satisfied by increased efficiency in reconstituted panel mills.

In developing countries, the potential for efficiency gains is even greater. The current level of product recovery in many developing countries is unknown, but believed to be so low that it would not be unreasonable to state that all production growth expected over the next decade or so could be met by improvements in processing efficiency, without any need to increase the harvesting of industrial roundwood.

The extent to which new technologies are introduced to make more efficient use of wood resources, will depend upon the pricing of industrial roundwood and whether it becomes expensive enough to encourage such changes. In part, the currently low levels of technology in many developing countries can be explained by low roundwood prices set by governments for harvesting roundwood from the natural forest. As long as industrial roundwood continues to be made available at low prices, there will be little incentive to invest in capital which utilises the resource more efficiently. Therefore, the extent to which future technological changes help to balance future supply and demand essentially comes down to a question of roundwood pricing.

7.4.2 The effect of globalisation and certification on future forest products markets

As the world economy continues to become increasingly global, consumers will continue to look for low-cost suppliers and producers will continue to establish and transfer operations to low-cost locations. If forest products markets are further liberalised, this should reduce the artificial advantages enjoyed by producers in some markets, where either bans on the export of unprocessed forest products or high tariffs on the import of finished products support the domestic production of wood products. In as much as some protected industries may have to reduce output or increase competitiveness, this should stimulate greater efficiency and support some of the expected trends in increased efficiency already referred to above.

With respect to certification, there are two key questions for the future:

- what proportion of the world's timber trade is likely to be affected by the demand for certified products; and

- will certification actually lead to significantly improved forest management.

As noted above, less than 0.3% of the world's forest area has been certified to date and the proportion of the world's wood and wood products markets held by certified products is unknown, but may be at a similarly low level. Even if the WWF/World Bank target of 200 million ha of certified forest by 2005 were to be achieved, this would still only account for 6% of the world's forest area (but possibly a greater share of the area used for wood production).

The only anecdotal evidence on the future market penetration of certified products is given in Stolp (1997). This report indicates that some organisations supporting certification in the Netherlands believe that, as an absolute maximum, certified products might at some time in the future account for 25% of the timber market. However, in the light of the WTP survey results reported above, even this figure seems very optimistic. It seems likely therefore, that a somewhat lower figure than this might be achieved over the next decade or so.

Ten percent market penetration would seem like the most that could be expected by the year 2010 and only then in countries, such as those in Western Europe and North America, where certification has been actively supported by some forest product suppliers and retailers. Given that the most interest in forest certification, amongst both producers and consumers, has been shown in developed countries, the prospect of forest certification leading to significantly better forest management in developing countries seems most unlikely.

8. CONCLUSIONS

The supply and demand analysis presented in this report has suggested that, broadly speaking, global forest resources will produce sufficient supplies of roundwood to meet future demands for forest products, without significant upward pressure on prices. This is not to say however, that there will not be scarcity in some regions or for some types of wood in the future. For example the analysis has shown that the trend towards increasing scarcity of high-quality large logs (typically taken from the natural forest) is likely to continue in the future. Rather, the analysis has shown that the mixture of resources that will have to be used for wood supply will change somewhat in the future.

The changing pattern of resource availability expected in the future will have profound implications for the forest processing industry and for forestry administrations in many countries. A major concern for the industry will be the changes in technology, processing capacity and location, which will be required to accommodate the expected changes in resource availability. Forestry administrations will also have to take note of these expected changes in supply and demand patterns as they continue to support the development of the sector while, at the same time, attempt to encourage a change in emphasis in forest management towards SFM.

The important question for the future therefore, will not be: is there enough wood? But rather: where should it come from and who will produce it? Whatever course is chosen will have social, economic and environmental implications and forestry policymakers have, to some extent, the power to influence these outcomes. This concluding section of the supply and demand analysis will examine the implications of the outlook for the World Bank's three priority areas of: poverty alleviation; sustainable development and private-sector development.

8.1 Poverty alleviation

The production of wood and wood products makes a significant contribution to GDP and export earnings in some of the world's poorest countries. For example, *Table 29* shows that forest products exports accounted for more than 10% of total merchandise exports in 19 developing countries in 1995 (and in a further four developed countries as well).

What is particularly noticeable in this table is how important forest products exports are to many African countries. This is in stark contrast to the fact that Africa is an insignificant producer of wood and wood products on a global scale, accounting for generally less than 5% of total world output in all forest product categories. Therefore, although Africa is not a significant region in terms of world forest products markets, the reverse is not true and world forest products markets can be said to have a significant effect on many African economies.

In addition to the production of industrial roundwood, forests are often also important sources of food, forage, fuel, medicines and building materials for rural communities. The value of these outputs are often not captured in national accounts statistics, but may be as great, if not greater, than the value of industrial forest product outputs in many poor countries.

Table 29: Countries where forest products exports had a share of total merchandise exports greater than 10% in 1995

Country	Total value of merchandise exports (US$ million)	Total value of forest products exports (US$ million)	Forest products exports as a percentage of total merchandise exports (%)
OECD countries			
Canada	192,607	27,787	14.4
New Zealand	13,769	1,634	11.9
Finland	40,489	11,968	29.6
Sweden	79,878	10,850	13.4
Non-OECD countries			
Cameroon	1,654	329	19.9
Central African Republic	193	29	15.2
Congo, Rep of	1,136	127	11.2
Congo, Democratic Republic of	461	55	11.9
Equatorial Guinea	84	36	42.9
Gabon	2,650	388	14.6
Ghana	1,431	276	19.3
Guinea Bissau	31	4	12.9
Liberia	300	68	22.7
Chile	16,447	2,060	12.5
Paraguay	819	98	12.0
Cambodia	342	171	50.0
Indonesia	45,418	4,728	10.4
Laos	348	70	20.2
Myanmar	846	307	36.3
Papua New Guinea	2,681	536	20.0
Solomon Islands	182	115	63.2
Estonia	1,838	192	10.4
Latvia	1,306	277	21.2

Source: FAO (1997c)

From the point of view of poverty alleviation, the most important aspect of the future supply and demand projections presented earlier is that different sources of wood and fibre supply have different potentials to generate local income and employment and, hence, help to alleviate poverty. For example, harvesting natural forests generally does less to reduce poverty (and may actually increase it by encroaching on forest areas already used for subsistence purposes) than would say, obtaining future wood supplies from trees outside of forests. In as much as future supply patterns in most developing countries are expected to diversify away from exploitation of the natural forest towards supply from a broad range of sources, this could have a beneficial effect on some of the poorest citizens in developing countries.

A very rough appraisal of the potential ability of different sources of supply to alleviate poverty is given in *Table 30*. Harvesting of the natural forest is believed to provide generally little benefit in terms of poverty alleviation because of the high capital intensities and low level of labour inputs generally used in such operations. Plantations are a little better because they tend to employ more people during harvesting and replanting. However, plantations will not help alleviate poverty if they use land which local people were already using for something else. Greater use of harvesting and mill residues could have significant environmental benefits but would generally do little to improve poverty. Indeed, the use of better technology in forest harvesting and processing often means substituting capital for

labour, which might increase unemployment and, consequently, have a negative effect on poverty.

The potential sources of future wood and fibre supply which are believed to have the greatest potential benefits in terms of reducing poverty are trees outside forests and recycling and non-wood fibre supplies. The utilisation of such supplies generally involves the generation of a considerable amount of employment and can benefit both rural areas (trees outside forests and non-wood fibres) and urban areas (recovered paper).

Table 30: Current probable levels of wood and fibre production from various sources and the potential for alleviating poverty by increasing supply from these sources

Variable/region	Wood and fibre supply source				
	Natural forests	**Plantations**	**Trees outside of forests**	**Harvesting and mill residues**	**Recycled and non-wood fibre**
Potential of each source to help alleviate poverty	low	moderate	high	low	high
Current estimated level of production from each of these sources (non-OECD countries)					
Europe	moderate	moderate	low	moderate	moderate
Asia and Oceania	high	moderate	moderate	low	moderate
Americas	high	moderate	low	low	low
Africa	high	low	moderate	low	low
Potential to use each of the sources to alleviate poverty by including them in the future supply mix					
Europe	low	moderate	low	low	high
Asia and Oceania	low	moderate	high	low	high
Americas	low	moderate	moderate	low	moderate
Africa	low	moderate	high	low	low

The middle section of *Table 30* shows an estimate of the current level of importance of each of these supply sources for each of the four non-OECD regions identified earlier. Current supply in non-OECD Europe is believed to come from a fairly even mixture of natural forest, plantations, residues and recycled materials. Supply in the three other developing regions is believed to be currently much more heavily weighted towards production from natural forests.

The bottom section of *Table 30* shows the potential for supply from each source in each region to be increased and help to alleviate poverty. This section is, in a way, a function of the two sections above it. It shows that, from the point of view of alleviating poverty, it might be most effective to encourage greater use of trees outside of forests in Africa; trees outside of forests and recycled and non-wood fibre supplies in Asia and Oceania; and recycled and non-wood fibre supplies in Europe.

Another way in which forest resources can be used to alleviate poverty is more generally through the development of domestic processing industries. Several developed countries have used their abundant endowments of forest resources as an engine of economic growth including: Canada; Finland and Sweden. Some developing countries have also built substantial forest processing industries on the strength of their forest resources, including: Malaysia; Indonesia; Brazil; and Chile.

The success of development strategies which have used forest resources to develop substantial processing industries has been mixed. All the countries that have pursued such strategies have managed to create large industries generating a significant amount of income and employment for their local economies. However, their successes have not been without problems. For example, a common way in which domestic processing has been encouraged in the past is through a combination of trade restrictions (e.g. log export bans or very high tariffs on unprocessed forest products) and government policies for pricing roundwood from the natural forest, which allow processors access to very cheap sources of wood raw materials. This has led to distortions in investment and overuse of forest resources and an eventual loss of confidence in some of these countries (e.g. as in Malaysia and Indonesia at the moment).

Perhaps the key to the success of such strategies in the future lies in ensuring that the processing industries are not encouraged to develop beyond the capacity of the forest resources to support them in the long-run. This requires information about long-run supply potential which is generally better than is available in most developing countries today.

The countries which have the greatest potential to follow this model of economic development are perhaps those which currently have large log production and export sectors (e.g. many West African countries and the larger producers in the Asia-Pacific region such as: Cambodia; Papua New Guinea; and Solomon Islands). Others with significant plantation resources (e.g. China; India; and South Africa) could be expected to follow this model of development also, although, at least in the case of the latter two countries, they have significant domestic markets which can absorb a large amount of forest product production.

A more general observation from the supply and demand analysis is that all countries are expected to continue to their attempts to move into higher value-added products such as furniture, doors, windows and joinery products. The production of such higher value-added products can substantially increase income and employment but, as noted above, the policies introduced to stimulate such activities have to be designed with care. However increasing the production of higher value-added wood products is very challenging for many developing countries because of the higher levels of technology that are required. Such moves also require improvements in skills, both technical skills and management skills, in order to compete effectively in the increasingly global and highly competitive international forest products marketplace.

8.2 Sustainable development

The main component of sustainable development in the forestry context is the concept of Sustainable Forest Management (SFM). Political discussion and pressure to implement SFM has grown over the last decade and will continue to do so in the future. To a limited extent, this pressure will be supported by increasing globalisation in the forestry sector and greater demands for the certification of forest products and both of these moves will further encourage countries to implement policies in support of SFM.

However, it also seems likely that the implementation of SFM will develop at a much faster pace in developed countries than in developing countries. Institutional weaknesses in many developing countries makes it difficult for them to implement SFM and, at least in the case of

the countries that still have vast forest areas, unsustainable options appear to be more profitable in the short-run (these issues are discussed further in Contreras, 1999).

Implementation of SFM will involve a range of measures which will alter the way forests are managed in the future and, consequently, affect future wood supply. The two major components of SFM are likely to be

1. moves to increase the area of forest within legally protected areas; and

2. moves to alter the way in which forest harvesting and management are carried-out in the future, in order to increase the social and environmental acceptability of production forestry.

As the supply and demand analysis has shown, increasing the area of forest in legally protected areas should be feasible without too much impact on future wood supplies. A more important aspect of any policy moves in this direction will be to ensure that there is adequate funding to properly manage and protect such areas. For example, there are already vast expanses of legally protected areas in many developing countries, but many of these countries spend very little on the protection of these areas (see, for example, Paine (1997) for a discussion of protected area funding in the Asia-Pacific region).

Altering the way in which wood is harvested in the production forest is likely to have a much greater impact on future wood supplies. The supply and demand analysis has shown that potential wood supply could be reduced quite significantly, but should still generally be sufficient to cover future needs in most areas. Regions and product sectors where there might be problems are those which have already been identified as facing potential scarcity in the future, e.g. Southeast Asia and parts of Africa and the plywood production sector.

What is potentially more important to the success of any policies to encourage the implementation of SFM, will be the increased cost of SFM practices. Historically, wood product prices have generally remained constant or fallen in real terms in the past. It is unlikely therefore, that any increased production costs (as a result of following SFM practices) can be passed on to consumers. Nor is there yet any strong evidence to suggest that consumers will pay more for products from sustainably managed forests (i.e. certified products).

A major future challenge therefore, will be to identify how SFM can be financed given these limits. Not only will SFM cost forest managers more (in terms of increased expenditures and possibly lower timber incomes), but the higher standards of monitoring and control, which SFM is likely to entail, will also cost forestry administrations more. Certification, while appearing attractive on the surface, is unlikely to solve this problem and is only likely to be an attractive option for forest managers that are already managing their forests well and will, consequently, have lower compliance costs. In other words, in terms of cost-effectiveness, there may be a substantial amount of "deadweight" associated with this process.

It is possible that there is already considerable scope to pay for SFM out of the slack in many countries forest revenue collection systems. However, if countries are not currently very good at increasing their own government revenues from higher forest levies, it is questionable

whether they would be any better at persuading forest concessionaires to spend their excess profits on SFM.

One solution to this problem, which countries might take however, is to take part or all of their natural forests out of production completely. This model has been pursued to some extent in New Zealand, Chile and South Africa and several tropical countries in Asia, which have mostly replaced production from their natural forests with production from forest plantations. China, which is a huge consumer of wood and wood products, is also currently temporarily phasing-out production from some of its natural forests, in response to concerns about flooding. Even in the United States of America, the perennial battles over production from the National Forest can be interpreted as a struggle to take all of this area out of commercial wood production.

If more countries were to decide that SFM is just too expensive and that it would be easier just to simply take some or all areas of natural forest out of wood production, then this would have a severe and profound impact on future wood supplies. This is, of course, unlikely to happen on a dramatic scale in the countries that have little alternative but to harvest the natural forest (e.g. some of the Pacific Islands). It is also likely to occur very gradually and, thus, have little impact within the period of this analysis. However, moves in this direction are gradually gaining ground and this situation should be carefully monitored and appraised.

Another aspect of the supply and demand outlook which is of relevance to sustainable development, is the potential for better technology to enable residues, recycled material and less well known species to be used in the wood raw material supply mix. Past trends in efficiency gains and the greater use of residues and recycled materials are expected to continue in the future. In as much as these trends will reduce forest processing waste, they will have environmental benefits and can be considered as another contribution towards sustainable development. However, the extent to which these trends continue will depend upon the measures introduced to support such moves by forestry policymakers and environmental agencies.

There is still scope to improve efficiency across the whole forestry sector in developed countries and the scope for improvement in developing countries is tremendous. In as much policies and programmes to encourage such developments are often easier to plan and implement, they may present an opportunity to improve the sustainability of the forestry sector that is as great, if not greater, than the traditional approach of devising rules and regulations about what can and can't be done in the forest.

8.3 Private-sector development

On the roundwood supply side, the outlook for private-sector development in the forestry sector is positive. Changes in the relative strength of different sources of potential wood availability and in forest products markets should encourage the development of future supplies from plantations, trees outside of forests and recovered paper. These sources of supply all tend to be mostly in private ownership, therefore the expected changes in supply sources will offer tremendous scope for private-sector development.

Forestry policymakers can encourage supply from these sources by incentives (e.g. for plantations) or technical assistance (e.g. research and development and extension activities). However, an even stronger mechanism to encourage supply from these sources may be to adjust policies for wood supply from the natural forest (in countries where natural forests are important). Examples of policies which might be re-examined include stumpage pricing and forest land-use planning policies.

In the past, decisions to restrict supply from the natural forest have tended to be taken in response to serious concerns about environmental degradation (e.g. the bans on harvesting in the natural forest introduced in the Philippines and Thailand in response to concerns about deforestation in these countries). However, some countries, such as China, are now starting to consider such changes in their land-use policies before the condition of their natural forest areas has deteriorated significantly. A careful balance between restricting supply from the natural forest and developing alternative sources of wood supply is likely to be the best approach to implementing such changes. Forestry policy in Malaysia is a good example of where such an approach has been pursued, where gradual reductions in the availability of wood from the natural forest have been introduced and compensated for by extensive research into the utilisation of lesser-known forest species and agricultural tree crops such as rubberwood and oil palm husks.

In terms of forest product processing, the outlook for private-sector development is equally bright, but less so for the development of small and medium-sized enterprises (SME). The expected move towards greater production of reconstituted panels and pulp and paper in many developing countries will require large infusions of capital which only the private-sector will generally be able to afford. These developments should also involve the transfer of technology and skills to many developing countries.

These investments will tend to be large-scale and will generally strengthen the concentration of forest industries in many countries into a small handful of large corporations. However, on a positive note, the general increase the production of high value-added products such as furniture expected in the future, should offer some scope for SME development.

8.4 Common themes

Five common themes for potential World Bank support and encouragement emerge from the above analysis. These can be broadly described under each of the following headings: information; pricing; human resource development; industrial restructuring; and institutional development.

8.4.1 Information

The preceding analysis has shown that there is a continuing need for better information about the forestry sector in many developing countries. As a first step, better information about forest areas and potential yields are required to enable countries to more effectively plan and monitor the development of their forest industries. For example, few developing countries produce supply forecasts or reliable estimates of annual allowable cut and many don't even know with any great degree of accuracy what current production really is.

If serious attempts are really going to be made to introduce SFM in many developing countries, this is going to require a significant upgrading of their capacities to collect and interpret information about forest resources and production. The World Bank and others should consider what role they should play in supporting this process as part of their strategies to support sustainable development more generally.

8.4.2 Pricing

With increased demand for other forest services from natural forests and the introduction of policies to support SFM, it is believed that the pattern of wood supply in the future will have to move away from its current heavy dependence on the natural forest towards a broader range of supply sources. However, the extent to which future supply is taken from plantations, trees outside of forests and recycled fibre sources will be strongly influenced by pricing policies in the natural forest.

There is a wealth of literature to suggest that many countries are setting stumpage rates at levels well below forest concessionaires ability to pay (see, for example, Repetto and Gillis (1988) for an early review of some of these issues). Not only does this discourage the use of other supply sources, but it also tends to distort investment decisions, discourage investment in more efficient production processes and encourage unsustainable forest practices.

The World Bank and others should continue to encourage countries to improve their forest revenue collection systems on the grounds of greater economic efficiency and in order to improve the sustainability of their forest industry developments. To some extent, countries could also be encouraged to use some of this money to improve the effectiveness of their forestry administrations to monitor and control forest operations.

8.4.3 Human resource development

A third and often neglected implication of the outlook for future forest product supply and demand is that many of the issues discussed in this report have tremendous implications for human resource development (HRD). Policies to implement SFM and develop SMEs (say, by encouraging greater supply from trees outside forests); and the general level of industry restructuring towards more technologically complex production processes expected in the future, will all have to be supported by a significant and prolonged programme of HRD in many developing countries.

Some countries have already begun to upgrade the skills of their forestry staff. For example, India has a superb forest surveying section and a considerable number of well trained forestry extension workers. Similarly, Malaysia has a well developed forest research and development community. However, many countries have nowhere near the number of skilled staff necessary to make SFM a viable proposition in the near future. This is particularly the case at the lowest levels of forest operations, where forest workers often receive little training in anything but the most basic forestry skills.

The upgrading of human resources in the forestry sector in many countries will require a substantial amount of funding and technical assistance. The World Bank and others should consider the best way in which these investment needs can be met on a sustainable basis in the long-run.

8.4.4 Industrial restructuring

The supply and demand outlook has suggested that there will be a significant need for industrial restructuring. At a policy level, the World Bank, FAO and others should consider how they can best help countries to re-align their industrial policies to take into account the expected future changes in wood availability and forest products markets. This is particularly the case in countries where past industrial policy has been designed to support industries which may start to come under pressure (e.g. those relying on increasingly scarce large logs, such as the sawmilling and plywood industries). At a project level, there will also be some need for sector reviews to help countries anticipate and adjust to the changes noted above.

Some of the future challenges in terms of required industrial restructuring will have cross-sectoral implications and touch on other government policies outside the forestry sector. The World Bank can also play a useful role therefore, by trying to influence the relevant parts of government administrations outside of the forestry sector (e.g. industry, energy and planning ministries) where appropriate.

8.4.5 Institutional development

Many forestry administrations in developing countries have evolved to fulfil fairly limited roles. Mostly they have largely taken on the tasks of planning, encouraging or developing, then monitoring, roundwood production from the natural forest. The changing pattern of future wood supply and developments such as SFM and greater needs for HRD, research and better management of protected areas, will all require forestry administrations to broaden their activities.

As noted above, some have already started to do this (e.g. India and Malaysia), others will need encouragement and technical assistance with the restructuring of their institutional capacities. The World Bank and others should support this at the policy level in their regular dialogues with countries and consider how technical assistance can best be provided to facilitate this process.

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ANNEX 1: PROJECTIONS OF WOOD FUEL CONSUMPTION

More detailed estimates of current and future wood fuel consumption are given in the table below.

Table 31: Estimated wood fuel consumption in 1996 and projections for 2010, by World Bank operational region

Region	Estimated consumption in 1996	Estimated consumption in 2010	Countries included in the region
Africa			
Non-client countries	35	46	Reunion
Client countries	435,793	539,833	All Africa except Reunion, Libya, Algeria, Egypt, Morocco and Tunisia
Middle East and North Africa			
Non-client countries	683	711	Libya, Bahrain, Iraq, Israel, Kuwait, Oman, Qatar, Saudi Arabia, UAE
Client countries	10,942	13,388	Algeria, Egypt, Morocco, Tunisia, Iran, Jordan, Lebanon, Syria, Yemen
South Asia			
Non-client countries	0	0	None
Client countries	363,347	480,793	Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka, Afghanistan
East Asia and Pacific			
Non-client countries	7,311	6,278	Brunei, Singapore, DPR Korea, Japan, Macau, Cook Is, New Cal, Aus, NZ
Client countries	519,707	722,578	All others in Asia except Turkey
Europe and Central Asia			
Non-client countries	42,623	25,355	Yugoslavia, Uzbekistan, Cyprus, Western Europe
Client countries	61,466	37,160	Turkey, Former USSR and East European States except Yugoslavia and Uzbekistan
Latin America and Caribbean			
Non-client countries	2,248	2,601	Bermuda, Bahamas, Barbados, Caymans, Cuba, Martinique, Neth Ant, Fr Guyana
Client countries	271,041	328,304	All other Americas except Canada and USA
Other countries	87,624	52,552	Other developed countries
World Total	1,802,819	2,209,598	

Note: all figures are in million m^3.

ANNEX 2: SUPPLY AND DEMAND PROJECTIONS BY WORLD BANK OPERATIONAL REGIONS

Table 32: Industrial roundwood - current and projected supply and demand by World Bank operational region

Industrial roundwood	1996				2010			
	Production		Consumption		Production		Consumption	
	(1,000 m3)	%	(1,000 m3)	%	(1,000 m3)	%	(1,000 m3)	%
Africa (non-client countries)	**122**	**0.0%**	**126**	**0.0%**	**119**	**0.0%**	**116**	**0.0%**
South Africa	18,176	1.2%	15,780	1.1%	21,677	1.2%	18,214	1.0%
Nigeria	8,479	0.6%	8,470	0.6%	9,698	0.5%	9,796	0.5%
Congo, Democratic Republic of	3,433	0.2%	3,255	0.2%	4,694	0.3%	4,580	0.2%
Cameroon	3,364	0.2%	2,057	0.1%	3,455	0.2%	1,806	0.1%
Côte d'Ivoire	3,008	0.2%	2,676	0.2%	2,989	0.2%	2,929	0.2%
Others	29,675	2.0%	26,598	1.8%	38,637	2.1%	34,430	1.8%
Africa (client countries)	**66,135**	**4.4%**	**58,835**	**3.9%**	**81,150**	**4.3%**	**71,755**	**3.8%**
Africa (total)	**66,257**	**4.4%**	**58,962**	**3.9%**	**81,269**	**4.3%**	**71,870**	**3.8%**
E Asia and Pacific (non-client countries)	**60,535**	**4.1%**	**93,908**	**6.3%**	**82,436**	**4.4%**	**130,297**	**6.9%**
China	108,718	7.3%	112,407	7.5%	151,582	8.1%	154,770	8.2%
Indonesia	47,245	3.2%	46,739	3.1%	57,256	3.1%	56,960	3.0%
Malaysia	35,771	2.4%	28,843	1.9%	37,910	2.0%	24,883	1.3%
Viet Nam	4,487	0.3%	4,139	0.3%	6,106	0.3%	6,096	0.3%
Philippines	3,394	0.2%	4,017	0.3%	6,064	0.3%	6,072	0.3%
Others	43,844	2.9%	48,852	3.3%	79,448	4.2%	87,164	4.6%
E Asia and Pacific (client countries)	**243,459**	**16.3%**	**244,996**	**16.4%**	**338,366**	**18.1%**	**335,945**	**17.9%**
E Asia and Pacific (total)	**303,994**	**20.4%**	**338,904**	**22.7%**	**420,803**	**22.5%**	**466,242**	**24.8%**
Europe and C Asia (non-client countries)	**227,541**	**15.3%**	**251,493**	**16.8%**	**306,913**	**16.4%**	**343,992**	**18.3%**
Russian Federation	67,000	4.5%	51,652	3.5%	94,523	5.1%	83,542	4.4%
Poland	17,783	1.2%	17,785	1.2%	17,854	1.0%	17,539	0.9%
Turkey	10,745	0.7%	11,501	0.8%	13,789	0.7%	13,806	0.7%
Romania	9,441	0.6%	9,516	0.6%	9,028	0.5%	9,008	0.5%
Belarus	9,206	0.6%	8,690	0.6%	14,221	0.8%	13,278	0.7%
Others	38,715	2.6%	29,184	2.0%	90,389	4.8%	74,975	4.0%
Europe and C Asia (client countries)	**152,890**	**10.3%**	**128,328**	**8.6%**	**239,803**	**12.8%**	**212,148**	**11.3%**
Europe and C Asia (total)	**380,431**	**25.5%**	**379,821**	**25.4%**	**546,716**	**29.2%**	**556,140**	**29.6%**
L A and Caribbean (non-client countries)	**795**	**0.1%**	**827**	**0.1%**	**1,084**	**0.1%**	**1,043**	**0.1%**
Brazil	84,711	5.7%	82,504	5.5%	97,405	5.2%	88,114	4.7%
Chile	21,387	1.4%	14,938	1.0%	28,933	1.5%	21,971	1.2%
Argentina	6,220	0.4%	5,258	0.4%	10,752	0.6%	7,756	0.4%
Mexico	5,914	0.4%	5,914	0.4%	6,222	0.3%	5,677	0.3%
Ecuador	5,514	0.4%	5,495	0.4%	1,558	0.1%	1,519	0.1%
Others	16,089	1.1%	15,698	1.1%	17,748	0.9%	16,441	0.9%
L A and Caribbean (client countries)	**139,834**	**9.4%**	**129,806**	**8.7%**	**162,617**	**8.7%**	**141,479**	**7.5%**
L A and Caribbean (total)	**140,630**	**9.4%**	**130,633**	**8.8%**	**163,701**	**8.7%**	**142,522**	**7.6%**
Mid East and N Africa (non-client countries)	**267**	**0.0%**	**401**	**0.0%**	**571**	**0.0%**	**569**	**0.0%**
Iran (Islamic Republic of)	4,902	0.3%	4,894	0.3%	6,676	0.4%	6,676	0.4%
Morocco	941	0.1%	1,275	0.1%	1,184	0.1%	1,283	0.1%
Algeria	395	0.0%	442	0.0%	454	0.0%	507	0.0%
Tunisia	210	0.0%	248	0.0%	432	0.0%	554	0.0%
Egypt	128	0.0%	241	0.0%	191	0.0%	467	0.0%
Others	46	0.0%	97	0.0%	645	0.0%	647	0.0%
Mid East and N Africa (client countries)	**6,621**	**0.4%**	**7,197**	**0.5%**	**9,581**	**0.5%**	**10,134**	**0.5%**
Mid East and N Africa (total)	**6,888**	**0.5%**	**7,597**	**0.5%**	**10,152**	**0.5%**	**10,704**	**0.6%**
South Asia (non-client countries)	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**
India	24,989	1.7%	25,302	1.7%	46,936	2.5%	49,955	2.7%
Pakistan	2,062	0.1%	2,192	0.1%	3,462	0.2%	3,463	0.2%
Afghanistan	1,742	0.1%	1,740	0.1%	1,877	0.1%	1,877	0.1%
Sri Lanka	710	0.0%	710	0.0%	1,014	0.1%	1,014	0.1%
Nepal	620	0.0%	620	0.0%	1,264	0.1%	1,266	0.1%
Others	657	0.0%	666	0.0%	1,194	0.1%	1,196	0.1%
South Asia (client countries)	**30,780**	**2.1%**	**31,230**	**2.1%**	**55,746**	**3.0%**	**58,771**	**3.1%**
South Asia (total)	**30,780**	**2.1%**	**31,230**	**2.1%**	**55,746**	**3.0%**	**58,771**	**3.1%**
Other countries	**560,544**	**37.6%**	**545,781**	**36.6%**	**593,188**	**31.7%**	**574,490**	**30.5%**
World total	**1,489,524**	**100.0%**	**1,492,929**	**100.0%**	**1,871,574**	**100.0%**	**1,880,738**	**100.0%**

Table 33: Sawnwood - current and projected supply and demand by World Bank operational region

Sawnwood	1996				2010			
	Production		Consumption		Production		Consumption	
	(1,000 m3)	%	(1,000 m3)	%	(1,000 m3)	%	(1,000 m3)	%
Africa (non-client countries)	**33**	**0.0%**	**301**	**0.1%**	**10**	**0.0%**	**155**	**0.0%**
South Africa	1,574	0.4%	1,948	0.5%	1,852	0.4%	1,812	0.4%
Nigeria	2,723	0.6%	2,698	0.6%	3,135	0.6%	3,132	0.6%
Congo, Democratic Republic of	100	0.0%	56	0.0%	88	0.0%	85	0.0%
Cameroon	1,400	0.3%	1,084	0.3%	259	0.1%	224	0.0%
Côte d'Ivoire	706	0.2%	206	0.0%	730	0.1%	110	0.0%
Others	2,495	0.6%	2,261	0.5%	2,394	0.5%	2,444	0.5%
Africa (client countries)	**8,998**	**2.1%**	**8,252**	**1.9%**	**8,458**	**1.7%**	**7,807**	**1.6%**
Africa (total)	**9,031**	**2.1%**	**8,554**	**2.0%**	**8,468**	**1.7%**	**7,962**	**1.6%**
E Asia and Pacific (non-client countries)	**31,290**	**7.3%**	**43,114**	**10.1%**	**42,024**	**8.4%**	**50,530**	**10.1%**
China	26,969	6.3%	28,901	6.8%	29,920	6.0%	37,202	7.5%
Indonesia	7,338	1.7%	6,941	1.6%	11,381	2.3%	10,553	2.1%
Malaysia	8,382	2.0%	4,985	1.2%	6,243	1.2%	5,948	1.2%
Viet Nam	721	0.2%	698	0.2%	873	0.2%	873	0.2%
Philippines	313	0.1%	735	0.2%	347	0.1%	859	0.2%
Others	24,986	5.8%	28,043	6.6%	31,995	6.4%	36,354	7.3%
E Asia and Pacific (client countries)	**68,708**	**16.0%**	**70,303**	**16.5%**	**80,759**	**16.1%**	**91,789**	**18.4%**
E Asia and Pacific (total)	**99,998**	**23.3%**	**113,417**	**26.6%**	**122,783**	**24.5%**	**142,319**	**28.6%**
Europe and C Asia (non-client countries)	**71,639**	**16.7%**	**74,191**	**17.4%**	**83,585**	**16.7%**	**91,268**	**18.3%**
Russian Federation	21,600	5.0%	16,927	4.0%	30,586	6.1%	26,457	5.3%
Poland	5,060	1.2%	4,190	1.0%	4,576	0.9%	4,290	0.9%
Turkey	4,331	1.0%	4,455	1.0%	4,848	1.0%	4,884	1.0%
Romania	1,693	0.4%	808	0.2%	1,527	0.3%	1,217	0.2%
Belarus	1,545	0.4%	1,397	0.3%	1,961	0.4%	1,652	0.3%
Others	8,764	2.0%	4,432	1.0%	19,202	3.8%	15,927	3.2%
Europe and C Asia (client countries)	**42,993**	**10.0%**	**32,209**	**7.6%**	**62,700**	**12.5%**	**54,428**	**10.9%**
Europe and C Asia (total)	**114,631**	**26.7%**	**106,400**	**25.0%**	**146,285**	**29.2%**	**145,696**	**29.2%**
L A and Caribbean (non-client countries)	**149**	**0.0%**	**426**	**0.1%**	**104**	**0.0%**	**449**	**0.1%**
Brazil	19,091	4.4%	17,563	4.1%	20,067	4.0%	20,453	4.1%
Chile	3,802	0.9%	2,739	0.6%	3,182	0.6%	3,155	0.6%
Argentina	1,000	0.2%	1,121	0.3%	1,356	0.3%	1,296	0.3%
Mexico	2,543	0.6%	2,816	0.7%	1,228	0.2%	3,711	0.7%
Ecuador	1,886	0.4%	1,803	0.4%	270	0.1%	269	0.1%
Others	4,330	1.0%	4,144	1.0%	4,356	0.9%	5,667	1.1%
L A and Caribbean (client countries)	**32,652**	**7.6%**	**30,186**	**7.1%**	**30,458**	**6.1%**	**34,551**	**6.9%**
L A and Caribbean (total)	**32,801**	**7.6%**	**30,612**	**7.2%**	**30,562**	**6.1%**	**35,000**	**7.0%**
Mid East and N Africa (non-client countries)	**39**	**0.0%**	**2,091**	**0.5%**	**25**	**0.0%**	**1,912**	**0.4%**
Iran (Islamic Republic of)	159	0.0%	160	0.0%	203	0.0%	203	0.0%
Morocco	83	0.0%	622	0.1%	136	0.0%	794	0.2%
Algeria	13	0.0%	384	0.1%	0	0.0%	324	0.1%
Tunisia	20	0.0%	319	0.1%	0	0.0%	500	0.1%
Egypt	0	0.0%	2,532	0.6%	0	0.0%	1,190	0.2%
Others	18	0.0%	565	0.1%	101	0.0%	422	0.1%
Mid East and N Africa (client countries)	**293**	**0.1%**	**4,582**	**1.1%**	**440**	**0.1%**	**3,433**	**0.7%**
Mid East and N Africa (total)	**332**	**0.1%**	**6,673**	**1.6%**	**465**	**0.1%**	**5,345**	**1.1%**
South Asia (non-client countries)	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**
India	17,460	4.1%	17,450	4.1%	22,208	4.4%	22,207	4.5%
Pakistan	1,280	0.3%	1,342	0.3%	1,421	0.3%	1,421	0.3%
Afghanistan	400	0.1%	400	0.1%	443	0.1%	443	0.1%
Sri Lanka	5	0.0%	20	0.0%	0	0.0%	29	0.0%
Nepal	620	0.1%	620	0.1%	772	0.2%	772	0.2%
Others	88	0.0%	88	0.0%	124	0.0%	124	0.0%
South Asia (client countries)	**19,853**	**4.6%**	**19,921**	**4.7%**	**24,968**	**5.0%**	**24,996**	**5.0%**
South Asia (total)	**19,853**	**4.6%**	**19,921**	**4.7%**	**24,968**	**5.0%**	**24,996**	**5.0%**
Other countries	**152,999**	**35.6%**	**140,719**	**33.0%**	**167,723**	**33.5%**	**136,970**	**27.5%**
World total	**429,645**	**100.0%**	**426,295**	**100.0%**	**501,254**	**100.0%**	**498,288**	**100.0%**

Table 34: Wood based panel - current and projected supply and demand by World Bank operational region

Wood based panels	1996				2010			
	Production		Consumption		Production		Consumption	
	(1,000 m3)	%	(1,000 m3)	%	(1,000 m3)	%	(1,000 m3)	%
Africa (non-client countries)	**0**	**0.0%**	**54**	**0.0%**	**0**	**0.0%**	**47**	**0.0%**
South Africa	653	0.4%	741	0.5%	492	0.3%	456	0.3%
Nigeria	115	0.1%	135	0.1%	113	0.1%	153	0.1%
Congo, Democratic Republic of	21	0.0%	16	0.0%	24	0.0%	24	0.0%
Cameroon	74	0.0%	36	0.0%	75	0.0%	68	0.0%
Côte d'Ivoire	272	0.2%	199	0.1%	72	0.0%	56	0.0%
Others	418	0.3%	326	0.2%	710	0.4%	715	0.4%
Africa (client countries)	**1,552**	**1.0%**	**1,453**	**1.0%**	**1,485**	**0.8%**	**1,472**	**0.8%**
Africa (total)	**1,552**	**1.0%**	**1,507**	**1.0%**	**1,485**	**0.8%**	**1,519**	**0.8%**
E Asia and Pacific (non-client countries)	**9,530**	**6.4%**	**16,024**	**10.8%**	**13,973**	**7.8%**	**19,320**	**10.8%**
China	15,349	10.3%	19,479	13.1%	13,912	7.8%	16,014	8.9%
Indonesia	10,128	6.8%	1,873	1.3%	11,978	6.7%	3,376	1.9%
Malaysia	6,770	4.5%	1,760	1.2%	4,141	2.3%	2,183	1.2%
Viet Nam	39	0.0%	58	0.0%	50	0.0%	51	0.0%
Philippines	596	0.4%	833	0.6%	496	0.3%	499	0.3%
Others	3,292	2.2%	5,322	3.6%	4,525	2.5%	9,541	5.3%
E Asia and Pacific (client countries)	**36,174**	**24.2%**	**29,323**	**19.8%**	**35,102**	**19.6%**	**31,666**	**17.7%**
E Asia and Pacific (total)	**45,704**	**30.6%**	**45,348**	**30.5%**	**49,075**	**27.3%**	**50,986**	**28.5%**
Europe and C Asia (non-client countries)	**34,710**	**23.2%**	**36,147**	**24.4%**	**49,630**	**27.6%**	**46,922**	**26.2%**
Russian Federation	3,036	2.0%	2,126	1.4%	6,305	3.5%	5,628	3.1%
Poland	2,410	1.6%	2,248	1.5%	2,809	1.6%	3,121	1.7%
Turkey	1,078	0.7%	1,316	0.9%	835	0.5%	1,126	0.6%
Romania	433	0.3%	435	0.3%	508	0.3%	556	0.3%
Belarus	374	0.3%	348	0.2%	570	0.3%	485	0.3%
Others	3,235	2.2%	2,480	1.7%	6,670	3.7%	6,901	3.9%
Europe and C Asia (client countries)	**10,566**	**7.1%**	**8,952**	**6.0%**	**17,695**	**9.9%**	**17,817**	**10.0%**
Europe and C Asia (total)	**45,276**	**30.3%**	**45,099**	**30.4%**	**67,325**	**37.5%**	**64,739**	**36.2%**
L A and Caribbean (non-client countries)	**149**	**0.1%**	**226**	**0.2%**	**201**	**0.1%**	**267**	**0.1%**
Brazil	3,558	2.4%	2,617	1.8%	3,320	1.8%	1,849	1.0%
Chile	844	0.6%	446	0.3%	782	0.4%	786	0.4%
Argentina	590	0.4%	448	0.3%	1,274	0.7%	1,208	0.7%
Mexico	606	0.4%	764	0.5%	1,272	0.7%	1,285	0.7%
Ecuador	380	0.3%	296	0.2%	336	0.2%	335	0.2%
Others	821	0.5%	827	0.6%	1,231	0.7%	1,423	0.8%
L A and Caribbean (client countries)	**6,799**	**4.6%**	**5,398**	**3.6%**	**8,214**	**4.6%**	**6,884**	**3.8%**
L A and Caribbean (total)	**6,948**	**4.7%**	**5,625**	**3.8%**	**8,415**	**4.7%**	**7,151**	**4.0%**
Mid East and N Africa (non-client countries)	**180**	**0.1%**	**1,430**	**1.0%**	**149**	**0.1%**	**1,266**	**0.7%**
Iran (Islamic Republic of)	383	0.3%	384	0.3%	331	0.2%	331	0.2%
Morocco	35	0.0%	67	0.0%	111	0.1%	88	0.0%
Algeria	50	0.0%	107	0.1%	88	0.0%	147	0.1%
Tunisia	104	0.1%	136	0.1%	214	0.1%	258	0.1%
Egypt	81	0.1%	202	0.1%	164	0.1%	346	0.2%
Others	73	0.0%	319	0.2%	28	0.0%	401	0.2%
Mid East and N Africa (client countries)	**725**	**0.5%**	**1,214**	**0.8%**	**936**	**0.5%**	**1,570**	**0.9%**
Mid East and N Africa (total)	**905**	**0.6%**	**2,644**	**1.8%**	**1,085**	**0.6%**	**2,837**	**1.6%**
South Asia (non-client countries)	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**
India	348	0.2%	348	0.2%	631	0.4%	624	0.3%
Pakistan	110	0.1%	127	0.1%	149	0.1%	149	0.1%
Afghanistan	1	0.0%	2	0.0%	1	0.0%	2	0.0%
Sri Lanka	15	0.0%	26	0.0%	42	0.0%	71	0.0%
Nepal	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Others	22	0.0%	27	0.0%	31	0.0%	31	0.0%
South Asia (client countries)	**496**	**0.3%**	**530**	**0.4%**	**854**	**0.5%**	**877**	**0.5%**
South Asia (total)	**496**	**0.3%**	**530**	**0.4%**	**854**	**0.5%**	**877**	**0.5%**
Other countries	**48,505**	**32.5%**	**47,688**	**32.1%**	**51,269**	**28.6%**	**50,932**	**28.4%**
World total	**149,385**	**100.0%**	**148,440**	**100.0%**	**179,508**	**100.0%**	**179,040**	**100.0%**

Table 35: Pulp - current and projected supply and demand by World Bank operational region

Pulp	1996				2010			
	Production		Consumption		Production		Consumption	
	(1,000 MT)	%	(1,000 MT)	%	(1,000 MT)	%	(1,000 MT)	%
Africa (non-client countries)	**0**	**0.0%**	**2**	**0.0%**	**11**	**0.0%**	**11**	**0.0%**
South Africa	1,547	0.9%	1,177	0.7%	1,888	0.9%	1,693	0.8%
Nigeria	7	0.0%	14	0.0%	6	0.0%	8	0.0%
Congo, Democratic Republic of	0	0.0%	0	0.0%	4	0.0%	4	0.0%
Cameroon	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Côte d'Ivoire	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Others	380	0.2%	194	0.1%	365	0.2%	267	0.1%
Africa (client countries)	**1,934**	**1.1%**	**1,385**	**0.8%**	**2,262**	**1.1%**	**1,972**	**1.0%**
Africa (total)	**1,934**	**1.1%**	**1,387**	**0.8%**	**2,273**	**1.1%**	**1,982**	**1.0%**
E Asia and Pacific (non-client countries)	**13,501**	**7.5%**	**16,389**	**9.2%**	**15,617**	**7.5%**	**17,153**	**8.3%**
China	24,751	13.8%	26,809	15.0%	35,330	17.0%	36,467	17.6%
Indonesia	2,635	1.5%	2,143	1.2%	2,753	1.3%	2,810	1.4%
Malaysia	103	0.1%	167	0.1%	997	0.5%	998	0.5%
Viet Nam	133	0.1%	167	0.1%	94	0.0%	137	0.1%
Philippines	149	0.1%	201	0.1%	152	0.1%	243	0.1%
Others	3,312	1.8%	6,132	3.4%	5,144	2.5%	9,111	4.4%
E Asia and Pacific (client countries)	**31,082**	**17.4%**	**35,619**	**20.0%**	**44,469**	**21.4%**	**49,766**	**24.0%**
E Asia and Pacific (total)	**44,583**	**24.9%**	**52,009**	**29.1%**	**60,086**	**28.9%**	**66,919**	**32.2%**
Europe and C Asia (non-client countries)	**32,620**	**18.2%**	**38,530**	**21.6%**	**41,910**	**20.1%**	**42,311**	**20.4%**
Russian Federation	3,725	2.1%	2,758	1.5%	2,936	1.4%	2,734	1.3%
Poland	848	0.5%	969	0.5%	935	0.4%	1,316	0.6%
Turkey	354	0.2%	500	0.3%	203	0.1%	621	0.3%
Romania	247	0.1%	258	0.1%	273	0.1%	267	0.1%
Belarus	31	0.0%	36	0.0%	217	0.1%	217	0.1%
Others	1,116	0.6%	1,016	0.6%	3,304	1.6%	3,097	1.5%
Europe and C Asia (client countries)	**6,321**	**3.5%**	**5,536**	**3.1%**	**7,868**	**3.8%**	**8,252**	**4.0%**
Europe and C Asia (total)	**38,941**	**21.7%**	**44,066**	**24.7%**	**49,778**	**23.9%**	**50,564**	**24.4%**
L A and Caribbean (non-client countries)	**52**	**0.0%**	**56**	**0.0%**	**21**	**0.0%**	**21**	**0.0%**
Brazil	6,225	3.5%	4,258	2.4%	7,144	3.4%	4,363	2.1%
Chile	2,123	1.2%	479	0.3%	4,056	1.9%	514	0.2%
Argentina	822	0.5%	768	0.4%	1,005	0.5%	535	0.3%
Mexico	511	0.3%	887	0.5%	661	0.3%	860	0.4%
Ecuador	0	0.0%	5	0.0%	11	0.0%	111	0.1%
Others	559	0.3%	903	0.5%	1,067	0.5%	1,423	0.7%
L A and Caribbean (client countries)	**10,240**	**5.7%**	**7,301**	**4.1%**	**13,943**	**6.7%**	**7,805**	**3.8%**
L A and Caribbean (total)	**10,292**	**5.7%**	**7,357**	**4.1%**	**13,964**	**6.7%**	**7,826**	**3.8%**
Mid East and N Africa (non-client countries)	**9**	**0.0%**	**242**	**0.1%**	**38**	**0.0%**	**276**	**0.1%**
Iran (Islamic Republic of)	245	0.1%	269	0.2%	195	0.1%	279	0.1%
Morocco	104	0.1%	60	0.0%	9	0.0%	68	0.0%
Algeria	21	0.0%	84	0.0%	50	0.0%	151	0.1%
Tunisia	12	0.0%	52	0.0%	11	0.0%	47	0.0%
Egypt	60	0.0%	124	0.1%	77	0.0%	105	0.1%
Others	8	0.0%	79	0.0%	105	0.1%	145	0.1%
Mid East and N Africa (client countries)	**450**	**0.3%**	**669**	**0.4%**	**446**	**0.2%**	**794**	**0.4%**
Mid East and N Africa (total)	**459**	**0.3%**	**912**	**0.5%**	**484**	**0.2%**	**1,070**	**0.5%**
South Asia (non-client countries)	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**
India	1,870	1.0%	2,132	1.2%	2,375	1.1%	2,392	1.2%
Pakistan	165	0.1%	243	0.1%	128	0.1%	346	0.2%
Afghanistan	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sri Lanka	10	0.0%	21	0.0%	4	0.0%	52	0.0%
Nepal	15	0.0%	15	0.0%	9	0.0%	9	0.0%
Others	122	0.1%	129	0.1%	152	0.1%	195	0.1%
South Asia (client countries)	**2,182**	**1.2%**	**2,540**	**1.4%**	**2,669**	**1.3%**	**2,995**	**1.4%**
South Asia (total)	**2,182**	**1.2%**	**2,540**	**1.4%**	**2,669**	**1.3%**	**2,995**	**1.4%**
Other countries	**80,694**	**45.1%**	**70,148**	**39.3%**	**78,757**	**37.9%**	**76,184**	**36.7%**
World total	**179,083**	**100.0%**	**178,418**	**100.0%**	**208,009**	**100.0%**	**207,540**	**100.0%**

Table 36: Paper and paperboard - current and projected supply and demand by World Bank operational region

~~Paper~~	1996				2010			
	Production		Consumption		Production		Consumption	
	(1,000 MT)	%	(1,000 MT)	%	(1,000 MT)	%	(1,000 MT)	%
Africa (non-client countries)	**6**	**0.0%**	**30**	**0.0%**	**12**	**0.0%**	**45**	**0.0%**
South Africa	1,871	0.7%	1,708	0.6%	2,439	0.6%	2,616	0.7%
Nigeria	57	0.0%	111	0.0%	27	0.0%	209	0.1%
Congo, Democratic Republic of	3	0.0%	5	0.0%	4	0.0%	19	0.0%
Cameroon	5	0.0%	36	0.0%	0	0.0%	40	0.0%
Côte d'Ivoire	0	0.0%	52	0.0%	0	0.0%	13	0.0%
Others	258	0.1%	388	0.1%	453	0.1%	637	0.2%
Africa (client countries)	**2,194**	**0.8%**	**2,299**	**0.8%**	**2,922**	**0.7%**	**3,533**	**0.9%**
Africa (total)	**2,200**	**0.8%**	**2,330**	**0.8%**	**2,934**	**0.7%**	**3,578**	**0.9%**
E Asia and Pacific (non-client countries)	**32,832**	**11.5%**	**34,760**	**12.5%**	**51,163**	**13.0%**	**50,273**	**12.9%**
China	30,253	10.6%	32,917	11.8%	50,980	12.9%	48,098	12.3%
Indonesia	4,386	1.5%	3,372	1.2%	5,014	1.3%	4,278	1.1%
Malaysia	674	0.2%	1,442	0.5%	1,817	0.5%	2,333	0.6%
Viet Nam	125	0.0%	194	0.1%	245	0.1%	260	0.1%
Philippines	613	0.2%	948	0.3%	438	0.1%	1,304	0.3%
Others	13,887	4.9%	15,551	5.6%	17,167	4.4%	24,436	6.3%
E Asia and Pacific (client countries)	**49,938**	**17.6%**	**54,424**	**19.5%**	**75,662**	**19.2%**	**80,708**	**20.6%**
E Asia and Pacific (total)	**82,770**	**29.1%**	**89,184**	**32.0%**	**126,825**	**32.2%**	**130,980**	**33.5%**
Europe and C Asia (non-client countries)	**73,403**	**25.8%**	**66,488**	**23.9%**	**100,810**	**25.6%**	**92,260**	**23.6%**
Russian Federation	3,212	1.1%	1,788	0.6%	4,252	1.1%	3,563	0.9%
Poland	1,525	0.5%	1,689	0.6%	2,515	0.6%	2,388	0.6%
Turkey	1,235	0.4%	1,772	0.6%	1,128	0.3%	1,366	0.3%
Romania	332	0.1%	320	0.1%	433	0.1%	402	0.1%
Belarus	131	0.0%	133	0.0%	239	0.1%	239	0.1%
Others	2,333	0.8%	2,553	0.9%	5,825	1.5%	6,730	1.7%
Europe and C Asia (client countries)	**8,768**	**3.1%**	**8,256**	**3.0%**	**14,391**	**3.7%**	**14,687**	**3.8%**
Europe and C Asia (total)	**82,171**	**28.9%**	**74,744**	**26.8%**	**115,201**	**29.2%**	**106,947**	**27.4%**
L A and Caribbean (non-client countries)	**57**	**0.0%**	**94**	**0.0%**	**59**	**0.0%**	**95**	**0.0%**
Brazil	5,885	2.1%	5,574	2.0%	7,714	2.0%	6,376	1.6%
Chile	597	0.2%	606	0.2%	910	0.2%	873	0.2%
Argentina	1,108	0.4%	1,630	0.6%	947	0.2%	2,006	0.5%
Mexico	3,047	1.1%	3,494	1.3%	5,094	1.3%	4,703	1.2%
Ecuador	86	0.0%	399	0.1%	460	0.1%	532	0.1%
Others	1,808	0.6%	3,234	1.2%	3,727	0.9%	4,100	1.0%
L A and Caribbean (client countries)	**12,531**	**4.4%**	**14,938**	**5.4%**	**18,852**	**4.8%**	**18,590**	**4.8%**
L A and Caribbean (total)	**12,588**	**4.4%**	**15,032**	**5.4%**	**18,911**	**4.8%**	**18,685**	**4.8%**
Mid East and N Africa (non-client countries)	**299**	**0.1%**	**1,113**	**0.4%**	**483**	**0.1%**	**2,000**	**0.5%**
Iran (Islamic Republic of)	205	0.1%	567	0.2%	502	0.1%	540	0.1%
Morocco	106	0.0%	239	0.1%	189	0.0%	356	0.1%
Algeria	78	0.0%	199	0.1%	193	0.0%	240	0.1%
Tunisia	90	0.0%	154	0.1%	66	0.0%	219	0.1%
Egypt	221	0.1%	483	0.2%	232	0.1%	824	0.2%
Others	74	0.0%	309	0.1%	276	0.1%	469	0.1%
Mid East and N Africa (client countries)	**774**	**0.3%**	**1,952**	**0.7%**	**1,458**	**0.4%**	**2,647**	**0.7%**
Mid East and N Africa (total)	**1,073**	**0.4%**	**3,065**	**1.1%**	**1,940**	**0.5%**	**4,647**	**1.2%**
South Asia (non-client countries)	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**
India	3,025	1.1%	3,369	1.2%	4,338	1.1%	4,340	1.1%
Pakistan	447	0.2%	661	0.2%	640	0.2%	840	0.2%
Afghanistan	0	0.0%	1	0.0%	0	0.0%	1	0.0%
Sri Lanka	25	0.0%	103	0.0%	89	0.0%	230	0.1%
Nepal	13	0.0%	13	0.0%	17	0.0%	17	0.0%
Others	160	0.1%	264	0.1%	314	0.1%	349	0.1%
South Asia (client countries)	**3,670**	**1.3%**	**4,412**	**1.6%**	**5,398**	**1.4%**	**5,777**	**1.5%**
South Asia (total)	**3,670**	**1.3%**	**4,412**	**1.6%**	**5,398**	**1.4%**	**5,777**	**1.5%**
Other countries	**99,912**	**35.1%**	**89,974**	**32.3%**	**122,744**	**31.2%**	**120,335**	**30.8%**
World total	**284,383**	**100.0%**	**278,740**	**100.0%**	**393,952**	**100.0%**	**390,950**	**100.0%**

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