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LONG-TERM OUTLOOK FOR THE TROPICAL TIMBER MARKET

A Final Report Prepared for the International Tropical Timber Organization

by Dr James A. Turner

28 February 2010

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Acronyms

ACP	African, Caribbean and Pacific Group of States
ACS	Association of Caribbean States
AFLEG	African Forest Law Enforcement and Governance
AMU	Arab Maghreb Union
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
BREEAM	Building Research Establishment Environmental Assessment Method
BRIC	Brazil, Russia, India and China
BRIIC	Brazil, Russia, India, Indonesia and China
BSEC	Black Sea Economic Cooperation
CARICOM	Caribbean Community
CDM	Clean Development Mechanism
CEMAC	Central African Economic and Monetary Community
CERFLOR	Programa Brasileiro de Certificação Florestal
CET	Common external tariff
CIS	Commonwealth of Independent States
CoC	Chain of custody
COMESA	Common Market for Eastern and Southern Africa
EAC	East African Community
ECA	Economic Commission for Africa
ECOWAS	Economic Community of West African States
EFTA	European Free Trade Association
ESPP	Environmental Services Payment Program
EU	European Union
FAO	Food and Agriculture Organization
FLEGT	Forest Law Enforcement, Governance and Trade
FONAFIFO	National Forestry Financing Fund
FONAG	Fund for the Protection of Water
FSC	Forest Stewardship Council
GCC	Gulf Cooperation Council
GDP	Gross domestic product
GFPM	Global Forest Products Model
GFTN	Global Forest and Trade Network
GHG	Green house gas
ha	hectare
HTI	Hutan Tanaman Industri (Indonesian Industrial Timber Estate programme)
IBSA	India-Brazil-South Africa Trilateral
IIF	Institute of International Finance
IISD	International Institute for Sustainable Development
IMF	International Monetary Fund
IRR	Internal rate of return
ITA	Investment Tax Allowance
ITTO	International Tropical Timber Organisation
IUCN	International Union for Conservation of Nature
LEED	Leadership in Energy and Environmental Design
LEI	Lembaga Ekolable Indonesia (Indonesian Ecolabelling Institute)
LOHAS	Lifestyles of Health and Sustainability
m^3	Cubic metre
MEFTA	Middle East Free Trade Area
MERCOSUR	Mercado Comun del Cono Sur (Southern Cone Common Market)
MoU	Memorandum of understanding
MTCC	Malaysian Timber Certification Council
NAFTA	North American Free Trade Agreement
NGO	Non-governmental organization
NTFP	Non-timber forest product
OECD	Organisation for Economic Co-operation and Development
PCF	Prototype Carbon Fund
PEFC	Programme for the Endorsement of Forest Certification
PELPS	Price endogenous linear programming system
PES	Payments for environmental services

PPP	Purchasing power parity	SPWP	Secondary processed wood products
PVC	Polyvinyl chloride	STEEP	Social, Technological, Economic, Environmental, Political
REDD	Reducing Emissions from Deforestation and Degradation	t	tonne
RTA	Regional Trade Agreement	TIMO	Timber Investment Management Organization
RTFP	Regional Trade Facilitation Programme	UK	United Kingdom
SAARC	South Asian Association for Regional Cooperation	UNCTAD	United Nations Conference on Trade and Development
SADC	Southern Africa Development Community	UNFCCC	United Nations Framework Convention on Climate Change
SAR	Synthetic Aperture Radar	USA	United States of America
SFM	Sustainable forest management	VPA	Voluntary Partnership Agreement
SME	Small and medium enterprises	WWF	World Wildlife Fund

Executive summary

Changes in the global trading environment for tropical timbers are occurring at a rapid pace. This requires a longer term view to enable tropical timber industry policy decisions to be effective. Knowledge of how the tropical forest products sector could evolve with the external changes that may occur to 2020 will allow those involved in the sector to make more informed decisions for the future.

The purpose of this study was to identify long-term trends and drivers of change, and their impact on tropical timber markets and forests. These were used to develop four alternative futures for tropical forests and the tropical timber market. Using economic tools, these scenarios formed the basis for forecasting the outlook for production, consumption, trade, prices and forest resources in tropical timber markets to 2020.

Historical trends in the tropical timber market

During the past decade factors external to the tropical forest sector have had a major impact on forests and their related industries. These factors include demographic changes, economic expansion accompanied by regional disruptions, trade liberalisation, and increasing environmental awareness.

Historically there has been more rapid growth in consumption of processed products than of raw materials, due to the trend towards increasing demand for greater variety of products as incomes grow. In the last decade consumption of raw material and primary processed forest products has switched from hardwoods to softwoods. Reflecting this shift in consumption topical producer countries, especially in Asia-Pacific and Latin America experienced a shift in log, sawnwood, and plywood production away from tropical hardwoods to non-tropical hardwoods and softwoods. At the same time the tropical producer countries, compared with consumer countries, have experienced rapid growth in production of fibre-based products (wood panels, wood pulp, and paper and paperboard), all be it from a small base.

Though North America and Europe remain the dominant producers and consumers, especially of softwood forest products, Asia-Pacific and Latin America are gaining, particularly in production of more processed products. Production and consumption of tropical logs, sawnwood and plywood is concentrated in the tropical producer countries with Indonesia, Brazil, Malaysia, China and India the largest producers and consumers. Tropical plywood is the only product for which developed countries are among the top consumers.

Historically forest product prices have been trending downwards, though from 2004 until very recently prices had been increasing, inline with growth in all commodity prices driven by the recent expansion in global demand fuelled by strong economic growth.

Between 1990 and 2005 world forest area decreased by 125 million ha; equivalent to the area of Angola. This forest loss occurred almost entirely in tropical producer countries. An important driver of deforestation is when the value of land in agriculture is greater than its value in forestry. Important underlying influences on this are government forestry and agricultural policies, population growth, and land tenure security.

Methodology

Acknowledging that the long-term futures of tropical timber markets and forests are unpredictable this study developed a set of scenarios for the future. These scenarios are distinct, plausible pictures of the world in which the tropical forest industry may operate in 2020. The scenarios were developed through a scenario planning process. This involved

expert interviews and a STEEP literature review which looked for likely forces related to **s**ocial, **t**echnological, **e**nvironmental, **e**conomic, and **p**olitical aspects that could affect key trends in the tropical forest industry. A workshop was then used to structure this information. From this workshop four scenarios for the future of tropical forests and the tropical timber market to 2020 were developed. These scenarios, along with the literature review, were reviewed by an ITTO Consultative Group.

Quantitative predictions of forest resources and wood products consumption, production, trade and prices to 2020 under the four scenarios were made using a modified version of the Global Forest Products incorporating tropical timber and secondary processed wood products. The GFPM is an economic model of the global forest sector, which integrates the four major components of the sector; wood supply, wood processing, product demand, and trade. Forest products are interrelated by supply and demand equations, and manufacturing input-output coefficients and costs. Countries are linked by trade.

Key future trends and drivers

The seven key issues in the tropical forestry and timber markets identified from the expert interviews were; perceptions of tropical timber products, payments for ecosystem services, the global economic crisis, planted forests, new regional political and trading blocs, financing for forest management and processing, and forest governance. The last serves to mediate the extent to which improvements occur in financing for forest management and processing and planted forests in different tropical producer countries.

Perceptions of tropical timber products

Tropical timber products are increasingly in higher value end uses, e.g. indoor and outdoor furniture, flooring, and builder's carpentry, where tropical timber has advantages, in being from old-growth forests, in its natural durability, appearance, colour consistency, and higher quality. A key trend in perceptions of tropical timber products though is the increasing requirement for confirmation of sustainable forest management (SFM) and chain of custody (CoC), through certification, particularly in North America, Europe, and Australasia. Increasingly this is being distilled into an issue of legality through government procurement policies, and bilateral agreements such as Forest Law Enforcement, Governance and Trade and Voluntary Partnership Agreements. Drivers of this trend are consumer awareness and demand for eco-labelling, and retailer and government responses to environmental NGO.

The future of tropical timber products in markets demanding SFM and legality is unclear. Firstly, it is not certain the extent to which tropical producer countries will be able to meet certification requirements due to weak forest governance, the scale of processing necessary to support CoC, costs of monitoring and verification, and the benefits of improved market access and price premiums potentially not offsetting these costs. Secondly, it is uncertain that consumer's are able to disentangle "tropical" and "illegal" and accept certification of SFM and legality, due to the variety of certification schemes and complexity of the underlying issues.

Multiple values from tropical forests

Among the major types of ecosystems, forests provide the greatest number of services (carbon, biodiversity, watershed protection, etc.). These services are seen as an emerging economic sector in tropical countries. Already payments for ecosystem services through market-based mechanisms such as Reducing Emissions from Deforestation and Degradation (REDD), Clean Development Mechanism (CDM), conservation offsets, etc. are emerging. These payments could potentially offset the decline in tropical timber product revenues, potentially reaching US$1,420 billion by 2020; compared with an estimated value of total forest products consumption of US$824 billion. Growth in payments for ecosystem services has been driven by the desire of companies and governments to be green in response to criticisms from environmental NGO, of landowners to earn more income from their forests, and in the case of carbon sequestration, attempts to address climate change.

The extent to which the predicted value of payments for ecosystem services is realised is uncertain, particularly for the largest market, carbon, which is dependent on a post-Kyoto agreement. Also uncertain is the degree to which tropical producer countries will be able to establish profitable markets for ecosystem services. It is not certain that the revenue from markets for these services exceeds the total costs of establishing and managing them. These costs are potentially high in tropical countries due to poorer investment environments, and the challenges of monitoring and verification, particularly where forest governance is weak.

A new global economy from the global economic crisis

The global economic crisis is predicted to lead to a contraction in economic growth of 1.7% in 2009, with the largest reductions in the developed economies. Global trade is predicted to fall by up to 9.0%; the steepest decline since World War II. At the same time emerging economies that are dependent on trade to support economic growth face increased measures to restrict trade and capital flows as developed economies move to protect jobs. The immediate causes of the slowing in growth and trade have been reduced household spending in the developed economies and reduced capital supply by banks. A broader, underlying cause is the global imbalance between debtor and creditor nations that has developed over the last 20 years as the United States increased debt and China developed savings. A key uncertainty around the economic crisis is the extent to which the global economy will recover from the crisis. This critically influences, and in turn is influenced by, the extent of increased trade and financial protectionism, and attempts by emerging economies, especially China, to shift from its dependence on exports to the United States and Europe, to domestic-led growth.

New types of forestry in the tropics

Planted forests in the tropics are used for timber, fuelwood, fibre for pulp and bioenergy, carbon sequestration, and environmental protection. A key trend has been the expansion of planted forest area, and timber supply from these, particularly for fibre-based products. By 2030, 60% to 80% of the world's industrial roundwood supply could be from plantations, including an increasing proportion from the tropics. This has been driven by greater economic returns from plantations compared with natural forests. This is especially the case in the tropics due to higher growth rates, lower labour costs, expansion of pulp and paper mill capacity, and increased demand for timber in these regions. The growth in wood supply from tropical planted forests is uncertain though, and is dependent on their successful establishment. There is also uncertainty around the future demand for timber products from planted forests due to perceptions of them negatively impacting on natural forests and forest communities, and the poorer quality of solidwood products from plantation grown wood.

New political and trading regions

The rise of new political and trading regions, in particular the BRIIC (Brazil, Russia, India, Indonesia and China) emerging markets has been recognised since 2003. International trade by these countries is predicted to triple by 2025, with India and China joining the United States and European Union as dominant economies, and Russia and Brazil as significant exporters. At the same time there has been a proliferation of regional trade agreements, particularly in Latin America and Asia-Pacific, but recently also in Africa. These trends have been driven by rapid economic growth in the BRIIC, and other emerging economies, and slow progress on multilateral trade liberalisation. The extent to which countries will continue to grow through these regional political and trading blocs is, however, dependent on progress in reducing barriers to trade and improving trade facilitation.

Investing and financing for forest management and processing

Financing for forest management and processing is essential to growing tropical forestry sectors, through SFM, planted forests, payments for ecosystem services, and value-added processing. Sources of investment include family and friends, banks, global institutional investors, donor organisations, domestic and foreign government, and international organisations. A key trend in investment in the tropical forest industry is the sustained low level of investment in many countries, due to the general poor business environment, political and economic instability, complex taxation, the negative image of commercial forestry in the tropics, insecure land tenure, weak governance, and the small size of most businesses.

Addressing this trend is the emergence of new sources of financing based on socially and environmentally responsible investments, such as the opportunity to invest in ecosystem service provision from tropical forests. The degree to which tropical producer countries will be able to attract investment in forest management and processing is dependent on improvements in governance to create a more attractive investment environment, and returns from tropical forest timber and non-timber values that match the risks. The latter requires that the challenges of establishing ecosystem service markets and meeting legality and certification requirements be addressed. The global economic crisis is another uncertainty. If it is prolonged it could negatively impact on access to capital, and political and economic stability.

Corruption and changing forest governance

Governance is “the traditions and institutions by which authority in a country is exercised for common good”. Corruption is more narrowly “abuse of public office for private gain”. A third of the ITTO producer countries in the Transparency International Corruption index had a perceived level of corruption in the lower quarter of the index. A key trend in tropical producer countries has been the improvement in perceived levels of corruption. Associated with this has been the move to forest governance becoming more decentralised, through participatory approaches, and increased participation of civil society and market incentives, e.g. forest certification. These trends are driven by a desire for better governance from aid donors, demands for greater recognition and participation of local communities, a desire of governments to reduce their financial burden, particularly associated with oversight of SFM and CoC, and increasing strength of environmental NGO. There is still uncertainty though around the extent to which these new approaches will bring about stronger forest governance given the challenges in some tropical country forests. These include the high costs of monitoring and verification due to the remoteness of many forests, rapid changes in country social and economic conditions, and political instability.

The critical uncertainties from each of the above seven key trends formed the basis for identifying four possible future scenarios for tropical forests and the tropical timber market. Each scenario reflected different directions in these critical uncertainties, recognising that a

number of these are related. For example, a long period of weak economic growth is likely to be associated with low levels of investment in tropical forestry.

Alternative futures for the tropical timber market in 2020

The first two scenarios, *Tropical Timber – Symbol of Tropical Forest Livelihoods* and *Tropical Forests – Tackling Climate Change*, have similar outcomes and are predicated on a strong recovery from the global economic crisis. They differ, however, in their key drivers. The former is driven by recognition of the role of tropical timber in forest protection and community livelihoods, the latter by the role of tropical forests in mitigating climate change. The other two scenarios are variants on a retraction of the market for tropical timber, precipitated by a weak recovery from the global economic crisis. The first, *North & South*, is based on an alignment of the BRIIC and developing economies as a new political bloc. The second, *Tropical Timber – Symbol of Tropical Forest Destruction*, is based on a declining global acceptance of tropical timber products, driven by increasing trade protectionism couched in environmentalism.

Tropical timber – Symbol of tropical forest livelihoods

By 2020 there is acceptance, by consumers, retailers and governments, of tropical timber products from SFM and planted forests. Global cooperation ensures a strong recovery from the global economic crisis, and encourages action to address trade and investment imbalances in the global economy. This enables international organisations, e.g. World Bank, FAO, ITTO, etc. to increase their role in assisting in the development of tropical country timber industries and forestry. As a result forest loss in tropical producer countries, especially in Asia & Pacific, slows due to expansion of planted forests and protected forest areas, though the loss is not reversed by 2020.

While wood product prices dip during the global economic crisis, they increase following the crisis, due to consumption of wood products growing at a faster than historical rate, stimulated by strong economic growth and a reduction in trade barriers. Growth in consumption is especially strong for reconstituted wood panels, paper and paperboard, and plywood (including tropical). Though consumption of tropical timber products by North America and Europe grows slightly through the “fair trade” label, the main source of growth is China, India, Malaysia, Indonesia and Brazil, due to stronger economic growth in these regions.

The production of tropical timber products continues to be concentrated in the tropical producer countries and China, in part due to investment in improved processing, particularly in Malaysia, Indonesia, Brazil, Peru and India. New larger-scale producers also emerge, such as the Philippines, Peru, Côte d’Ivoire, Nigeria, Cameroon and Ghana. China’s increased role in tropical timber production is also to meet its growing domestic demand and export of secondary processed products.

Tropical forests – Tackling climate change

By 2020 there is widespread uptake of strategies to mitigate the effects of climate change, including REDD, planted forests under the CDM, and bioenergy. This emerges from recognition of the need for international cooperation to avoid the negative impacts of climate change. As a result there is a reversal in the loss of tropical forests in producer countries, such as China, Malaysia, and India, due to expansion of REDD and planted forests. Forest loss in Brazil and Indonesia is slowed to almost zero by 2020.

While wood product prices dip during the global economic crisis they increase slightly afterwards, due to a strong recovery boosting wood product consumption and a reduction in wood supply associated with expansion of protected forest area. The price of fuelwood increases at rates similar to pre-crisis. Though consumption of tropical timber products by

North America and Europe is slightly higher through the “fair trade” label, the main source of growth is China, India, Malaysia, Indonesia and Brazil due to their higher economic growth.

Production of tropical timber products is increasingly concentrated in the tropical producer countries, particularly in Malaysia, Indonesia, Brazil, Peru and India due to improved processing. China, though, continues to increase its role in the production of tropical timber products, in large part so as to meet its growing domestic consumption and export of secondary processed products. New larger-scale producers also emerge, such as the Philippines and Côte d’Ivoire for tropical plywood.

North and south

By 2020 the BRIIC countries emerge as a global political and economic force. Developing countries align themselves with the BRIIC bloc as an important market and source of external finance for development in order to counter increasing trade and financial protectionism by Europe and North America after a weak recovery from the global economic crisis. Within the BRIIC bloc and aligned economies there is acceptance by consumers and governments of tropical timber products from natural and planted forests. Outside of these regions, the shift to environmentally based purchase decisions, and an increase in trade protectionism on environmental grounds, leads to a decline in demand for tropical timber products.

As a result forest loss continues in all tropical producer regions, though the rate of loss slows. This is in part due to slower than historical growth in wood product consumption due to lower economic growth and increased trade barriers. This also means that there is only weak recovery in wood product prices following the dip during the global economic crisis.

Consumption of tropical timber products by North America and Europe declines due to a continued shift in preference away from tropical wood products. However, demand for tropical products continues to grow in the emerging economies, especially China, India, Malaysia, Indonesia and Brazil though at a slower rate than prior to the economic crisis.

China continues to increase its role in the production of tropical timber products, especially plywood, despite slower economic growth. This is due to this country’s continued improvement in processing technology. The largest growth in production is, however, for fibre-based products. Reconstituted panel production from key Asia & Pacific producers (China, Malaysia and Thailand) surpasses North American production by 2020. The region also closes the gap in wood pulp production (China, Indonesia, and Republic of Korea).

Tropical timber – A symbol of tropical forest destruction

By 2020 tropical timber products are seen as a symbol of forest loss and illegal forest activities in tropical countries. At the same time there is a weak recovery of the global economy due to a failure to develop a unified response to the economic crisis. This leads to increased financial and trade protectionism, reducing investment in tropical forest industries and forests. As a result tropical forest loss continues, particularly in Brazil and Indonesia.

All wood product prices dip during the global economic crisis, and remain stagnant or declining following the crisis due to the weak economic recovery. This weak recovery, combined with increased protectionism, leads to slower than historical growth in wood product consumption. Consumption of tropical timber products by North America and Europe declines. Demand for tropical products continues to grow in the emerging economies, however, especially China, India, Malaysia, Indonesia and Brazil due to relatively higher economic growth. The rate of growth though is not as strong as historically.

Asia & Pacific, especially China, Malaysia, Indonesia and Thailand, and to a lesser extent Latin America, in particular Brazil, continue to experience relatively stronger growth in

production of a wood products, though this is mostly fibre-based products. These regions approach North American and European production of reconstituted panels, wood pulp and paper and paperboard, and China closes the gap in hardwood sawnwood production.

Using the alternative futures in decision making

This study developed four plausible alternative futures (or scenarios) for the tropical timber market to 2020 and determined the outcomes of these for the tropical timber trade and tropical forests using an economic model of the global forest sector. Identifying alternative futures recognises that the future is never known with certainty, and that strategic planning should be undertaken accordingly.

To this end the alternative futures developed here serve several purposes (Schwartz 1996). Firstly, they provide an insight into how key influences on the tropical timber market will impact on the tropical timber trade and forests, depending on which these influences come into play. Secondly, they provide the context for assessing how strategies developed today, such as under the ITTO Action Plan (ITTO 2008), will play out under each of the alternative futures. If a strategy looks good in only one scenario then it is high risk, especially if there is little control over the likelihood of that scenario occurring. Thirdly, desirable futures can be identified, and the key drivers for these influenced in order to increase the likelihood of that future. From this study key drivers for the *Forest Livelihoods* future are; (i) strengthening of forest governance in tropical producer countries, (ii) investment in improved processing in tropical producer countries, (iii) harmonisation of certification schemes, and (iv) relating to consumers the importance of tropical timber products in supporting forest community livelihoods and tropical forest protection. Fourthly, a set of leading indicators can be identified from the key drivers under each of the scenarios, and trends arising from these. These indicators can then be monitored to identify as soon as possible which of the alternative futures is emerging as history unfolds.

Finally, an important strength of the approach to producing forecasts of the tropical timber market used here is that all the assumptions in the economic model of the global forest sector are explicit. Furthermore, all the projections can be reproduced and the assumptions deemed unrealistic changed. By making the software and the data available it is hoped that many such experiments with alternative scenarios would be conducted. In so doing scientific economic analysis can be merged with the art of scenario planning to arrive at increasingly richer and useful projections of the tropical timber market.

Recommendations

In order for ITTO member countries to benefit from the outlook for the tropical timber market to 2020 presented in this report, the following recommendations are made based on the discussion above of how to make use of the alternative futures in decision making.

ITTO

i) Assess the ITTO Action Plan 2008-2011 (ITTO 2008) against the four alternative futures to determine whether or not the actions will achieve the desired outcomes under all of the alternative futures. Where actions are unlikely to lead to expected outcomes under two or more of the alternative futures, actions may need to be adapted to make them more robust if the desired future does not arise
ii) Use the alternative futures, and drivers, trends and outcomes for these, to inform the development of the next ITTO Action Plan. This should particularly help in setting priorities for actions that (a) increase the likelihood of the most desirable futures for the tropical timber market and tropical forests (*Forest Livelihoods* or *Tackling Climate Change*) in 2020, and (b) achieve their desired outcome under all alternative futures.

iii) The findings from this study suggest that important drivers under the influence of the ITTO that would lead to a favourable future for tropical forests and timber markets are:
   a) Continuing to support actions that improve the investment environment for processing, planted forests and SFM in tropical producer countries, particularly continuing efforts to strengthen forest governance
   b) In conjunction with the first, continuing actions to support increased human capability in tropical producer countries for implementing REDD and provision of other ecosystem services from tropical forests and for improving processing, particularly log and timber conversions
   c) Actions to demonstrate and promote to consumers in all markets (especially Europe, North America, Brazil, China, and India) the positive environmental and social benefits of tropical timber products. These benefits include mitigating climate change, improving forest community livelihoods, increasing the value of tropical forests relative to non-forested uses of the land, and sustainably produced products
   d) Continuing to provide supporting data on tariff and non-tariff barriers to tropical timber products in both producer and consumer countries to support negotiation of equitable bilateral and multilateral trade agreements

iv) Support at least three (one from each producer region) tropical producer countries in undertaking their own country level scenario planning exercises, including quantitative analysis of the scenarios using the economic model developed as part of this study. This will improve the country specific results of the current study and enable development of capability in producer countries to develop an outlook for the tropical timber industry in their own country. Critical to ensuring ownership of the scenarios developed is that key stakeholders within these countries lead and undertake the scenario planning process themselves

v) Provide support to tropical producer countries, where appropriate, to make use of the four alternative futures and economic model developed as part of this study to assess forest and trade policy development in their own countries

vi) Gather data to support decision-making under the four alternative futures. Areas where data could be improved, but for which information on emerging trends critically influences the future that unfolds are:
   a) Ecosystem services from tropical forests and demand for these. This could build on the existing criteria and indicators work and also support work demonstrating the environmental and social benefits from tropical timber products. This data is essential to understanding the supply of ecosystem services from tropical forests, and how this matches up with potential demand for these services.
   b) Processing technology in tropical producer countries, especially a comparison of conversion efficiencies and manufacturing costs among products and countries. This will help improve production statistics for tropical timber products, and enable monitoring of improvements in processing, as well help in any future develop of the economic model used in this study

vii) Develop a set of leading indicators that can be used by the ITTO, tropical timber producer and consumer countries, and forest industry to determine as soon as possible which of the four alternative futures is closest to that actually unfolding. These leading indicators include
   a) Economic growth in major markets, especially Europe, the United States, Brazil, India, and China
   b) Trends in consumer perceptions of the environmental and social credentials of tropical timber products in major markets, especially in the emerging markets of China and India
   c) Trends toward alignment of forest certification and timber procurement schemes in tropical timber consuming countries
   d) Trends in the growth of payment for ecosystem services in tropical timber producing countries, such as tropical forest area under biodiversity offsets, watershed protection, forest certification, Clean Development Mechanism, REDD and SFM
   e) Trends in the proliferation of tariff and non-tariff barriers affecting tropical and non-tropical timber products
   f) Trends in tropical producer country processing efficiency, including conversion efficiency and manufacturing cost

Governments in tropical timber producing countries

i) Consider the use, where appropriate, of the four alternative futures and economic model developed as part of this study to assess forest sector and trade policies and actions that could impact on tropical timber markets and tropical forests. This would help to inform policy development and ensure policies achieve desired outcomes under each of the alternative futures.
ii) The findings from this study suggest that a critical driver under the influence of the governments of tropical timber producing countries that would lead to the *Forest Livelihoods* or *Tackling Climate Change* futures is improvement in the investment environment for processing, planted forests and SFM, including continuing efforts to
    a) strengthen forest governance
    b) Increase country human capability in the forest sector
    c) Address policies that may act as barriers to investment in timber processing, SFM and planted forests
    a) Participate with tropical timber consuming countries and non-governmental organisations in consultative processes for developing timber procurement and certification to ensure a move toward harmonisation of these schemes

Governments in tropical timber consuming countries

i) Consider the use, where appropriate, of the four alternative futures and economic model developed as part of this study to assess forest sector and trade policies and actions that could impact on tropical timber markets and tropical forests. This would help to inform policy development and ensure policies achieve desired outcomes under each of the alternative futures.
ii) The findings from this study suggest that important drivers under the influence of the governments of tropical timber consuming countries that would lead to the *Forest Livelihoods* or *Tackling Climate Change* futures are:
    a) Undertake activities to demonstrate and promote to consumers in their respective countries the positive environmental and social benefits of tropical timber products, including climate change mitigation, contribution to improving forest community livelihoods, and sustainably produced products.
    b) Continue to work with tropical timber producing countries and non-governmental organisations in consultative processes for developing timber procurement and certification that move toward harmonisation of these schemes and demonstrate the social and environmental benefits of tropical timber products
    c) Support bilateral and multilateral trade agreements that address tariff and non-tariff barriers to tropical timber products in both producer and consumer countries

Forest industry and trade

i) Consider the use, where appropriate, of the four alternative futures and economic model developed as part of this study to assess strategies that could impact on their markets. This would help to inform strategy development and ensure strategies achieve desired outcomes under each of the alternative futures.
ii) The findings from this study suggest that a key driver under the influence of the tropical forest industry that would lead to the *Forest Livelihoods* or *Tackling Climate Change* futures are activities to achieve, demonstrate and promote to consumers in all markets the positive environmental and social benefits of tropical timber products, including climate change mitigation, biodiversity protection, contribution to forest community livelihoods, and sustainably produced products.

1. Introduction

It has been almost 16 years since the long-term outlook for tropical timber markets was last comprehensively assessed (Drake et al. 1993). In that time changes in the global trading environment for tropical timbers have occurred at a rapid pace. It is therefore timely to again take a longer term view to enable tropical timber trade and industry policy decisions to be effective. Knowledge of how the tropical forest products sector could evolve with the external changes that may occur in the next 5-20 years will allow those involved in the sector to make more informed decisions for the future.

Objectives

The purpose of this study was to identify long-term drivers of change in and their impact on tropical timber markets, and based on these develop a set of plausible scenarios for the outlook for tropical forests and the tropical timber market to 2020.

Outline

Chapter 2 summarises the major historical trends in forest resources and forest products production, consumption, trade and prices, including tropical forest products. Critical to projecting future trends are demographic and economic trends. These are also summarised in Chapter 2. Chapter 3 describes the scenario development methodology used to identify key future social, technological, environment, economic and political (STEEP) trends, uncertainties, and drivers based on key expert interviews and a STEEP literature review. This information was used to produce the set of long-term scenarios for the tropical timber market. Chapter 3 also describes the economic model of the global forest sector used to make projections of the tropical timber market under each of the long-term scenarios.

Chapter 4 describes the seven key future trends and drivers in the tropical timber market identified from the key expert interviews and a STEEP literature review. Chapter 5 presents the four alternative futures for the tropical timber market in 2020, which were developed based on the major uncertainties around the seven key future trends. For each of the alternative futures the quantitative predictions for forest product production, consumption, trade and prices to 2020 from the economic model of the global forest sector are also described. Chapter 6 provides a more detailed description of the projections of the tropical timber market to 2020. Finally, Chapter 7 provides some conclusions, including recommendations for using the alternative futures described and the findings of this study.

The Appendices to the report include a description of the scenario development (Appendix 2) and timber market projection (Appendix 4) methodologies, and the key future STEEP trends, uncertainties, and drivers from the expert interviews (Appendix 3).

2. Historical Trends in the Tropical Timber Market

Introduction[1]

During the past decade factors external to the forest sector have had a major impact on forests and their related industries. These factors include demographic changes, economic expansion accompanied by regional disruptions, trade liberalisation, and increasing environmental awareness.

Past trends of wood products consumption illustrate the effects of population and economic growth on demand. From 1961 to 2007, the world population more than doubled from 3.1 billion to 6.6 billion (World Bank 2009a), and the world economy (as measured by gross world product in real terms) increased more than five times from US$8,823 billion[2] to US$54,584 billion (World Bank 2009a). Over the same period, consumption of forest products, including fuelwood, but excluding secondary processed wood products[3], more than doubled from US$415 billion to US$925 billion (derived from FAO data).

The world population is expected to grow to 9.1 billion by the year 2050. Almost all of this increase will occur in developing countries (UN 2008), affecting the ability of these countries to protect their forests. Global forestry faces the increasingly difficult challenge of meeting the growing demand for forest products while safeguarding a range of environmental services from forests (FAO 1997).

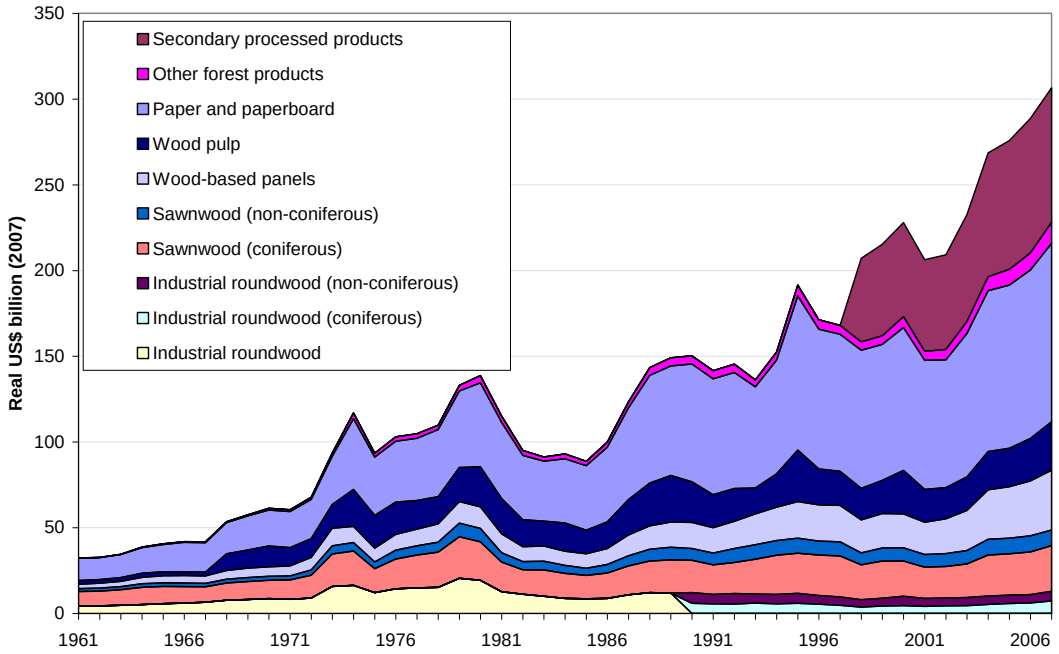
Successive rounds of the General Agreement on Tariffs and Trade, and a burgeoning number of bilateral and regional trade agreements (UN 2005) have reduced the barriers to trade in wood products. Under the Uruguay Round the average tariff was reduced to 14.8% of its 1930 level (Bowen et al. 1998). At the same time as global trade has been liberalised, the value of the forest products trade has increased eight-fold, in real terms, from US$61 billion in 1961 to US$500 billion in 2007 (Figure 2.1), with recent growth driven by a period of strong economic growth and housing expansion in the United States. ITTO producer countries have shared less in this growth in export value than consumer countries and non-ITTO members (Figure 2.2).

[1] Material in this Introduction section was drawn from ITTO. 2007. *Annual Review and Assessment of the World Timber Situation 2007*. Division of Economic Information and Market Intelligence, International Tropical Timber Organization, Yokohama, Japan, and Turner, J.A., J. Buongiorno, F. Maplesden, S. Zhu, S. Bates, and R. Li. 2006. World Wood Industries Outlook: 2005-2030. *Forest Research Bulletin 230*. Scion, Rotorua, New Zealand.

[2] All monetary values are in US$ real (base year 2007)

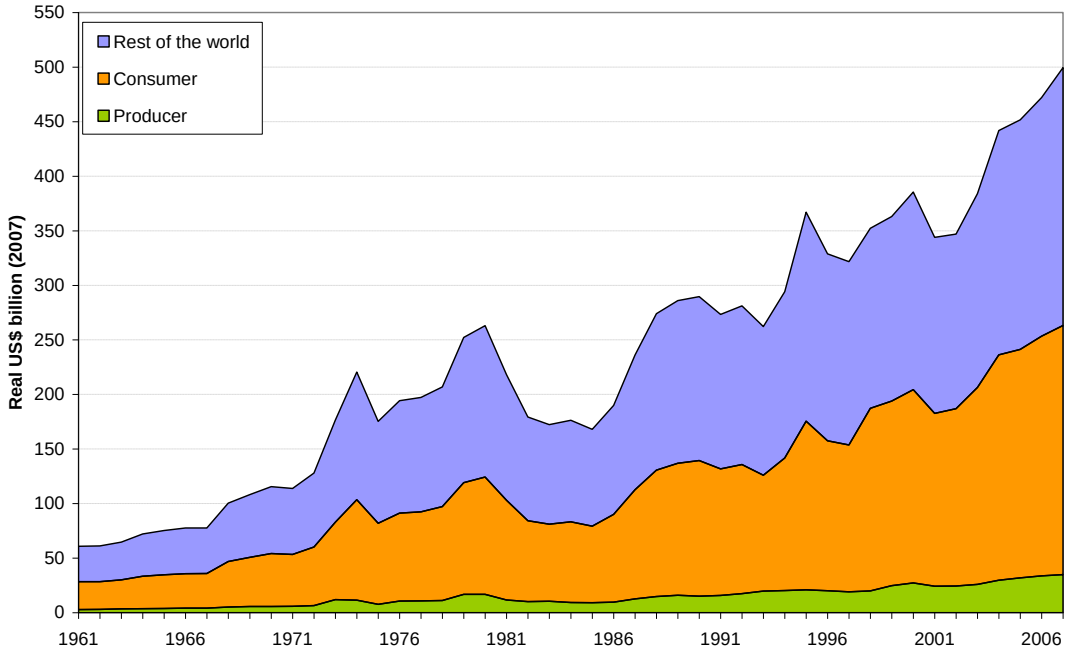
[3] Secondary processed wood products are mouldings and millwork, builder's carpentry and joinery, and wooden furniture

Figure 2.1 World export value of major forest products, at constant 2007 prices, from 1994 to 2007[1]. Source: FAO and ITTO



[1] export values for secondary processed wood products are from 1997

Figure 2.2 World export value of major forest products by ITTO producer and consumer countries and the rest of the world; at constant 2007 prices, from 1994 to 2007



Trends in forest resources

Between 1990 and 2005 world forest area decreased by 125 million ha (Table 2.1); an area approximately that of the land area of Angola. Deforestation, due to logging and conversion of forest to agricultural uses (Contreras-Hermosilla 2000), occurred almost entirely in the tropics, particularly in Africa and Latin America. Nevertheless, the same regions, especially Latin America, did offset some the loss of natural forests through establishment of plantation forests (FAO 2005). The area of forests in Europe increased by 12 million ha between 1990 and 2005, and in Asia-Pacific by 3 million ha between 2000 and 2005 (Table 2.1). This was due to establishment of new forests as plantations and to the conversion of abandoned marginal agricultural lands to forests (FAO 2001).

Table 2.1 Country and regional forest area and forest area change. Source: FAO (2005)

	Forest area (million ha)			Annual growth rate (%)	
Region	1990	2000	2005	1990-2000	2000-2005
Africa	699	656	635	-0.6	-0.6
North America	678	678	677	0.0	0.0
Latin America	924	882	860	-0.5	-0.5
Asia & Pacific	787	775	778	-0.2	0.1
Europe	989	998	1001	0.1	0.1
ITTO producers	1 290	1 215	1 175	-0.6	-0.7
Non-tropics	2 787	2 773	2 777	0.0	0.0
World	4 077	3 989	3 952	-0.2	-0.2

Trends in world consumption

Table 2.2 shows the world consumption of forest products in 1961, 1980, 2000 and 2007. Global consumption increased over the past 40 years, though for most wood products world consumption grew more slowly from 1980 to 2000 than from 1961 to 1980, possibly due to slower global economic growth during that period than in the 1960s and 1970s (World Bank 2009). From 2000 to 2007 world consumption of most forest products, particularly sawnwood and fibreboard, grew more rapidly than in the preceding two decades, due to recent strong economic growth (World Bank 2009).

The consumption of paper and paperboard and wood-based panels increased more rapidly than that of other wood products, while the consumption of industrial roundwood, sawnwood and wood pulp increased at the slowest rates. World consumption of roundwood and sawnwood increased 68% and 31%, respectively. Consumption of wood-based panels, particularly particleboard and fibreboard, increased 10 times, wood pulp increased three times, and paper consumption five times.

There appears to have been a switch to consumption of softwood logs (industrial roundwood) and sawnwood from hardwoods in the last decade. During the 1960s and 1970s consumption of hardwood sawnwood grew more rapidly than of softwoods. More recently consumption of softwood logs and sawnwood has grown at twice the rate of hardwoods (Table 2.2).

More rapid growth in consumption of processed products than of raw materials occurred for several reasons. Firstly, wood products, like other agricultural products, follow a trend towards increasing demand for greater variety of products as incomes grow (Antle 1999), resulting in an increasing share of processed products in global consumption. This trend is reflected in income growth being associated with stronger increases in demand for more processed forest products, compared with less processed products (Simangunsong & Buongiorno 2001). Secondly, there has been a reduction in tariff escalation, reducing the price of more processed wood products relative to raw materials (WTO 2001).

Table 2.2 World consumption (000 m^3 or 000 t) of wood products, tropical and non-tropical. Source: FAO

					Annual growth rate (%/ yr)		
Product	1961	1980	2000	2007	1961-1980	1980-2000	2000-2007
Wood fuel	1324 822	1532 626	1795 720	1885 334	0.8	0.8	0.7
Industrial roundwood	1017 671	1448 183	1608 989	1707 215	1.9	0.5	0.9
Industrial roundwood (softwood)			1019 220	1100 663	-	-	1.1
Industrial roundwood (hardwood)			589 769	606 552	-	-	0.4
Sawnwood (softwood)	246 289	306 558	278 720	310 566	1.2	-0.5	1.6
Sawnwood (hardwood)	77 738	115 692	110 101	113 248	2.1	-0.2	0.4
Plywood[1]	17 843	43 631	67 083	82 641	4.8	2.2	3.0
Particleboard	3 935	40 324	83 778	103 355	13.0	3.7	3.0
Fibreboard	4 584	16 725	36 968	70 784	7.0	4.0	9.7
Wood pulp	61 284	125 056	171 387	176 470	3.8	1.6	0.4
Paper & paperboard	74 250	168 233	325 005	382 681	4.4	3.3	2.4

[1] Plywood includes veneer sheets

Trends in regional production and consumption

Table 2.3 to Table 2.10 show regional production of major forest products in 1995, 2000, 2005, and 2007. At the global level, wood fuel production increased 0.7% per year from 1995 to 2007. Production continued to increase after 2000, although Asia-Pacific's, and North America's production decreased 0.9% per year (Table 2.3). These historic trends reflect an increased use of alternative fuels and a corresponding decline in demand for wood fuel as countries become more wealthy (Whiteman et al. 2002, Simangunsong & Buongiorno 2001). More recently, however, there has been an increase in wood fuel production for biofuels, particularly in North America (Table 2.3).

During the period from 1995 to 2007 topical producer countries all experienced a shift in log, sawnwood, veneer and plywood production away from tropical hardwoods to non-tropical hardwoods and softwoods (Table 2.4 to Table 2.7). As a result tropical hardwoods have had a declining share in production of these products by tropical producers, especially in Asia-Pacific and Latin America. This trend may in part be driven by a shift from natural to plantation forests, for pulp and energy production, and a shift to lesser used species due to forest resource degradation and deforestation (ITTO 2007). Possibly related to this shift to fibre from plantation forests the tropical producer countries have experienced more rapid growth, compared with consumer countries, in production of particleboard, fibreboard, wood pulp and paper and paperboard (Table 2.8 to Table 2.10).

From 1995 to 2007 global log harvests (tropical and non-tropical hardwood, and softwood) grew a modest 12.5%, and growth has been slowing. This was particularly the case for tropical and softwood logs, which had declining production from 2005 to 2007. While tropical producer country production is, not surprisingly, predominantly tropical hardwoods (67% in 1995), production declined in 2007 to just over 50% of their total log production. At the same time production of softwoods and especially non-tropical hardwoods has increased (Table 2.4). ITTO producers more than doubled their production of non-tropical hardwoods from 1995 to 2007. The Asia-Pacific region has had the largest decline in tropical hardwood production, while African production increased 82%.

From 1995 to 2007 global production of sawnwood (tropical and non-tropical hardwood, and softwood) grew nearly 14%, though this mostly occurred in the period 2000 to 2005, with a more recent decline in production (Table 2.5). Most growth in sawnwood production was in softwoods, with modest growth in non-tropical hardwoods, with just a 2% increase from 1995 to 2007, and tropical production remained unchanged. While tropical producer country sawnwood production is predominantly tropical hardwoods (85% in 1995), production declined to 64% of their total production in 2007. At the same time production of softwood sawnwood quadrupled, with a large increase in Latin America (Table 2.5). The Asia-Pacific region has had the largest decline in tropical hardwood production, while African production more than doubled.

From 1995 to 2007 global production of veneer (tropical and non-tropical (hardwood and softwood)) grew 86%, though more recently production has declined (Table 2.6). Most growth in veneer production was non-tropical, with tropical veneer production only increasing 31%. While tropical producer country veneer production is almost entirely tropical (nearly 100% in 1995), production of tropical veneer has declined to 75% of total production in 2007. This was especially the case in Asia-Pacific. At the same time production of non-tropical veneer by producer countries increased 30-fold, with a large increase in Asia-Pacific (Table 2.6). During the period from 1995 to 2007 Africa doubled its production of both tropical and non-tropical veneer.

From 1995 to 2007 global production of plywood (tropical and non-tropical (hardwood and softwood)) was unchanged, with a small decline in tropical plywood and modest increase in non-tropical plywood production (Table 2.7). While tropical producer country production is predominantly tropical (96% in 1995), production declined to 79% of total plywood production in 2007. This was especially the case in Asia-Pacific and to a lesser extent in Latin America.

Over the same period ITTO consumer countries increased their production of both tropical and non-tropical plywood. During the period from 1995 to 2007 Africa increased its production of both tropical and non-tropical plywood (Table 2.7).

Although Europe is still the largest producer of particleboard and fibreboard, Asia-Pacific and Latin America have increased their production from 1995 to 2007 (Table 2.8). Asia's production grew at a similar rate to Europe's, and Latin America's grew almost twice as fast. While tropical producer countries are a small share of global production (less than 4% in 2007), their production grew at twice the rate of consumer country production from 1995 to 2007.

While North American production of wood pulp declined from 1995 to 2007, Latin America's production nearly doubled and Asia-Pacific's increased 43% (Table 2.9). There was a similar trend for paper and paperboard, though Latin American production grew less rapidly (Table 2.10). While tropical producer countries are a small share of global production of wood pulp (12% in 2007) and paper and paperboard (8% in 2007), they more than doubled their production of wood pulp and increased paper and paperboard production by over 50% from 1995 to 2007. During the same period consumer country production of wood pulp declined (Table 2.9) and paper and paperboard production increased a more modest 31% (Table 2.10).

Table 2.3 Regional production of wood fuel (000 m^3). Source: FAO

					Annual growth rate (%)		
Region	1995	2000	2005	2007	1995-2000	2000-2005	2005-2007
Africa	501 862	526 128	568 597	603 089	0.9	1.6	3.0
Asia & Pacific	799 199	846 938	807 941	797 688	1.2	-0.9	-0.6
Latin America	246 606	262 020	271 862	274 023	1.2	0.7	0.4
North America	95 681	48 857	46 765	53 602	-12.6	-0.9	7.1
Europe[1]	119 793	161 471	196 507	197 604	6.2	4.0	0.3
Producer	**839 303**	**882 949**	**887 512**	**899 477**	**1.0**	**0.1**	**0.7**
Consumer	**394 448**	**397 938**	**474 178**	**494 482**	**0.2**	**3.6**	**2.1**
World[2]	**1735 453**	**1797 256**	**1849 670**	**1886 182**	**0.7**	**0.6**	**1.0**

[1] Europe includes the Russian Federation, [2] Regions do not sum to world total due to discrepancies in the countries included in regional aggregates

Table 2.4 Regional production of industrial roundwood; tropical hardwood, non-tropical hardwood, and softwood (000 m^3)

Product	Region	1995	2000	2005	2007	Annual growth rate (%)		
						1995-2000	2000-2005	2005-2007
Tropical hardwood	Africa	9 896	20 366	17 356	18 029	15.5	-3.1	1.9
	Asia & Pacific[1]	90 592	85 964	79 904	73 726	-1.0	-1.5	-3.9
	Latin America[2]	32 751	35 214	34 205	33 151	1.5	-0.6	-1.6
	North America	0	0	0	0	-	-	-
	Europe[3]	0	0	0	0	-	-	-
	Producer[4]	**133 239**	**141 545**	**131 465**	**124 906**	**1.2**	**-1.5**	**-2.5**
	Consumer[5]	**488**	**356**	**1 502**	**1 351**	**-6.1**	**33.4**	**-5.2**
	World	**133 727**	**141 901**	**132 967**	**126 257**	**1.2**	**-1.3**	**-2.6**
Softwood	Africa	13 230	12 862	9 313	9 187	-0.6	-6.3	-0.7
	Asia & Pacific	122 348	121 991	122 816	127 231	-0.1	0.1	1.8
	Latin America	69 702	71 940	83 975	83 867	0.6	3.1	-0.1
	North America	429 034	445 813	465 732	429 588	0.8	0.9	-4.0
	Europe	314 951	366 422	420 796	448 959	3.1	2.8	3.3
	Producer	**37 847**	**53 661**	**65 266**	**55 686**	**7.2**	**4.0**	**-7.6**
	Consumer	**505 809**	**743 464**	**838 294**	**775 186**	**8.0**	**2.4**	**-3.8**
	World	**949 614**	**1019 380**	**1102 984**	**1099 184**	**1.4**	**1.6**	**-0.2**
Non-tropical hardwood[6]	Africa	43 335	35 499	40 815	41 758	-3.9	2.8	1.1
	Asia & Pacific	91 225	70 048	80 925	89 794	-5.1	2.9	5.3
	Latin America	40 633	50 192	67 384	64 512	4.3	6.1	-2.2
	North America	163 027	173 724	157 971	156 720	1.3	-1.9	-0.4
	Europe	93 115	116 559	119 388	127 321	4.6	0.5	3.3
	Producer	**26 798**	**35 810**	**39 601**	**54 179**	**6.0**	**2.0**	**17.0**
	Consumer	**136 301**	**254 630**	**261 015**	**264 769**	**13.3**	**0.5**	**0.7**
	World	**431 873**	**446 796**	**466 010**	**479 787**	**0.7**	**0.8**	**1.5**

[1] is Asia and Oceania in the FAO regions, [2] Latin America is Central and South America in FAO regions, [3] includes the Russian Federation, [4] ITTO producer countries, [5] ITTO consumer countries, [6] Non-tropical hardwood calculated as FAO reported all hardwood minus ITTO reported tropical hardwood. Regions do not sum to world total as there are discrepancies in the countries included in the regional aggregates

Table 2.5 Regional production of sawnwood; tropical hardwood, non-tropical hardwood, and softwood (000 m^3). Source: FAO and ITTO

Product	Region	1995	2000	2005	2007	Annual growth rate (%)		
						1995-2000	2000-2005	2005-2007
Tropical hardwood	Africa	2106	4246	4676	4574	15.1	2.0	-1.1
	Asia & Pacific	23232	21434	19191	19260	-1.6	-2.2	0.2
	Latin America	16310	15819	16744	17429	-0.6	1.1	2.0
	North America	0	0	0	0	-	-	-
	Europe	748	641	267	339	-3.0	-16.1	12.7
	Producer	**41648**	**41499**	**40611**	**41263**	**-0.1**	**-0.4**	**0.8**
	Consumer	**2146**	**2281**	**1098**	**1989**	**1.2**	**-13.6**	**34.6**
	World	**43 794**	**43 780**	**41 709**	**43 253**	**0.0**	**-1.0**	**1.8**
Softwood	Africa	2 687	2 411	3 155	3 091	-2.1	5.5	-1.0
	Asia & Pacific	53 882	36 820	47 262	51 428	-7.3	5.1	4.3
	Latin America	12 399	17 685	21 564	22 627	7.4	4.0	2.4
	North America	99 147	110 526	127 656	109 639	2.2	2.9	-7.3
	Europe	100 098	112 070	125 031	131 286	2.3	2.2	2.5
	Producer	**6 957**	**12 214**	**22 228**	**23 227**	**11.9**	**12.7**	**2.2**
	Consumer	**229 010**	**216 635**	**245 277**	**236 266**	**-1.1**	**2.5**	**-1.9**
	World	**268 298**	**279 630**	**324 822**	**318 291**	**0.8**	**3.0**	**-1.0**
Non-tropical hardwood	Africa	3 450	1 663	1 212	1 435	-13.6	-6.1	8.8
	Asia & Pacific	26 641	11 823	16 026	20 454	-15.0	6.3	13.0
	Latin America	2 602	2 854	3 181	4 571	1.9	2.2	19.9
	North America	30 437	31 015	29 550	27 009	0.4	-1.0	-4.4
	Europe	21 046	19 330	19 107	20 196	-1.7	-0.2	2.8
	Producer	**200**	**1 194**	**345**	**176**	**43.0**	**-22.0**	**-28.5**
	Consumer	**50 386**	**42 002**	**47 522**	**51 544**	**-3.6**	**2.5**	**4.1**
	World	**50 886**	**43 216**	**47 869**	**51 721**	**-3.2**	**2.1**	**3.9**

Table 2.6 Regional production of veneer; tropical and non-tropical (000 m^3). Source: FAO and ITTO

Product	Region	1995	2000	2005	2007	Annual growth rate (%) 1995-2000	2000-2005	2005-2007
Tropical	Africa	**390**	**716**	**756**	**826**	12.9	1.1	4.5
	Asia & Pacific	**1631**	**1588**	**1531**	**1570**	-0.5	-0.7	1.3
	Latin America	**325**	**372**	**377**	**359**	2.7	0.2	-2.4
	North America	**0**	**0**	**0**	**0**	-	-	-
	Europe	**225**	**122**	**12**	**30**	-11.6	-37.1	58.1
	Producer	**2346**	**2676**	**2664**	**2755**	**2.7**	**-0.1**	**1.7**
	Consumer	**408**	**423**	**932**	**853**	**0.7**	**17.1**	**-4.3**
	World	**2 754**	**3 098**	**3 596**	**3 607**	**2.4**	**3.0**	**0.2**
Non-tropical[1]	Africa	79	140	134	162	12.2	-0.8	9.9
	Asia & Pacific	861	1 590	5 551	4 744	13.1	28.4	-7.6
	Latin America	507	954	557	914	13.5	-10.2	28.2
	North America	581	900	1 280	1 000	9.1	7.3	-11.6
	Europe	1 632	1 698	2 229	2 066	0.8	5.6	-3.7
	Producer	**31**	**707**	**799**	**914**	**86.9**	**2.5**	**7.0**
	Consumer	**3 111**	**3 450**	**6 051**	**5 686**	**2.1**	**11.9**	**-3.1**
	World	**3 420**	**4 940**	**8 598**	**7 898**	**7.6**	**11.7**	**-4.2**

[1] Non-tropical calculated as FAO reported total production minus ITTO reported tropical production

Table 2.7 Regional production of plywood; tropical, tropical and non-tropical (000 m^3). Source: FAO and ITTO

						Annual growth rate (%)		
Product	Region	1995	2000	2005	2007	1995-2000	2000-2005	2005-2007
Tropical	Africa	224	369	426	422	10.5	2.9	-0.5
	Asia & Pacific	13 623	14 373	11 505	11 860	1.1	-4.4	1.5
	Latin America	1 255	1 275	1 740	1 188	0.3	6.4	-17.4
	North America	0	0	0	0	-	-	-
	Europe	440	469	488	451	1.3	0.8	-3.9
	Producer	**15 102**	**16 016**	**13 671**	**13 469**	**1.2**	**-3.1**	**-0.7**
	Consumer	**5 139**	**4 281**	**5 802**	**5 707**	**-3.6**	**6.3**	**-0.8**
	World	**20 241**	**20 297**	**19 473**	**19 176**	**0.1**	**-0.8**	**-0.8**
Non-tropical	Africa	206	276	236	328	6.0	-3.1	17.9
	Asia & Pacific	15 216	14 657	31 866	36 905	-0.7	16.8	7.6
	Latin America	1 023	1 847	3 340	3 257	12.5	12.6	-1.3
	North America	18 971	19 515	16 771	14 502	0.6	-3.0	-7.0
	Europe	5 116	6 870	9 405	9 975	6.1	6.5	3.0
	Producer	**702**	**1 691**	**4 136**	**3 578**	**19.2**	**19.6**	**-7.0**
	Consumer	**29 487**	**33 084**	**44 300**	**52 525**	**2.3**	**6.0**	**8.9**
	World	**34 897**	**34 841**	**35 665**	**35 962**	**0.0**	**0.5**	**0.4**

Table 2.8 Regional production of particleboard and fibreboard (000 m^3). Source: FAO

Region	1995	2000	2005	2007	Annual growth rate (%) 1995-2000	2000-2005	2005-2007
Africa	780	461	587	751	-10.0	5.0	13.1
Asia & Pacific	10 166	9 590	14 454	16 726	-1.2	8.6	7.6
Latin America	1 730	2 959	3 777	4 332	11.3	5.0	7.1
North America	19 738	31 526	34 688	31 078	9.8	1.9	-5.3
Europe	35 013	42 735	51 011	58 502	4.1	3.6	7.1
Producer	**2 182**	**3 136**	**4 028**	**4 172**	**7.5**	**5.1**	**1.8**
Consumer	**54 749**	**72 367**	**81 737**	**83 036**	**5.7**	**2.5**	**0.8**
World	**65 282**	**84 997**	**100 648**	**106 144**	**5.4**	**3.4**	**2.7**

Table 2.9 Regional production of wood pulp (000 t). Source: FAO

Region	1995	2000	2005	2007	Annual growth rate (%) 1995-2000	2000-2005	2005-2007
Africa	2 422	2 793	2 649	2 926	2.9	-1.1	5.1
Asia & Pacific	21 059	25 113	28 056	30 197	3.6	2.2	3.7
Latin America	9 477	12 384	15 081	18 205	5.5	4.0	9.9
North America	86 295	84 527	80 259	74 512	-0.4	-1.0	-3.6
Europe	47 531	52 733	56 035	58 157	2.1	1.2	1.9
Producer	**10 207**	**14 693**	**20 090**	**21 543**	**7.6**	**6.5**	**3.6**
Consumer	**138 819**	**141 605**	**138 194**	**136 819**	**0.4**	**-0.5**	**-0.5**
World	**161 712**	**171 707**	**175 026**	**176 986**	**1.2**	**0.4**	**0.6**

Table 2.10 Regional production of paper and paperboard (000 t). Source: FAO

					Annual growth rate (%)		
Region	1995	2000	2005	2007	1995-2000	2000-2005	2005-2007
Africa	2 682	3 965	4 998	4 285	8.1	4.7	-7.4
Asia & Pacific	80 612	98 229	126 512	145 766	4.0	5.2	7.3
Latin America	12 437	14 311	18 650	16 479	2.8	5.4	-6.0
North America	104 239	107 211	103 195	101 939	0.6	-0.8	-0.6
Europe[1]	82 008	100 144	110 863	114 977	4.1	2.1	1.8
Producer	**20 429**	**27 046**	**32 144**	**31 527**	**5.8**	**3.5**	**-1.0**
Consumer	**247 336**	**277 745**	**305 624**	**325 087**	**2.3**	**1.9**	**3.1**
World	**282 042**	**324 048**	**364 381**	**383 603**	**2.8**	**2.4**	**2.6**

Table 2.11 to Table 2.22 show the world's top ten consumers and producers of the major forest products. Most of the world consumption and production is concentrated in these countries, reflecting the concentration of global income in the top ten countries (74% of gross world product). In 2007, these ten countries accounted for more than 70% of the world consumption and production of forest products.

In the past, wood product consumption and production has been concentrated in the developed countries of North America and Europe. However, production has increased rapidly in Asia-Pacific and Latin America, and the growth of consumption has been especially strong in Asia. Though North America and Europe remain the dominant producers and consumers, especially of softwood products, Asia-Pacific and Latin America are gaining, particularly in production of more processed products such as plywood, wood pulp, and paper and paperboard. This change has been driven by a combination of factors in Asia and Latin America, including stronger economic growth, relatively low manufacturing costs, development of forest plantations, and protection of processing industries (Turner et al. 2006).

The United States is currently the largest consumer and producer of most forest products, except wood fuel. India and China are the top two for wood fuel. Canada is the second largest producer of softwood logs and sawnwood. China is the largest consumer and producer of plywood and second largest consumer and producer of wood pulp, and paper and paperboard. The European countries of Sweden, Finland, France and Germany are both major consumers and producers of all forest products. Together they account for 15% of world paper and paperboard production (Table 2.22). Russia figures prominently as a producer of non-tropical hardwood and softwood logs and sawnwood, and is also a significant producer of softwood plywood. Russia's importance as a producer reflects the country's vast forest resources, providing a relatively low-cost raw material.

Not surprisingly production and consumption of tropical logs, sawnwood and plywood is concentrated in the tropical producer countries (Table 2.12, Table 2.15 and Table 2.18). Indonesia, Brazil, Malaysia and India are the largest producers and consumers of tropical logs, accounting for 68% of world production and 66% of consumption. These countries are also the largest producers of tropical sawnwood (63% of world production) and plywood (59% of world production). China is though the second largest producer of tropical plywood, having passed Indonesian production (Table 2.18). Brazil, India and Indonesia are also large consumers of tropical sawnwood, followed by China, Vietnam and Malaysia (Table 2.15). Tropical plywood is the only tropical solidwood product for which developed countries are among the top 10 consumers; Japan (16% of world consumption), the United States (7.4%) and France (1.8%) (Table 2.18).

The largest African producer and consumer of logs and sawnwood is Nigeria accounting for 4.8% of log production and consumption and 4.4% of sawnwood. Ghana and Côte d'Ivoire are the largest producers of tropical plywood, both accounting for 1.7% of world production.

Table 2.11 The world top 10 consumers and producers of wood fuel in 2007. Source: FAO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	India	307 097	16.3	India	307 018	16.3
2	China	199 760	10.6	China	199 737	10.6
3	Brazil	139 831	7.4	Brazil	139 831	7.4
4	Ethiopia	97 131	5.2	Ethiopia	97 131	5.1
5	Congo, Dem Rep	73 209	3.9	Congo, Dem Rep	73 209	3.9
6	Indonesia	67 825	3.6	Indonesia	67 825	3.6
7	Nigeria	61 999	3.3	Nigeria	62 000	3.3
8	United States	50 696	2.7	United States	50 690	2.7
9	Russia	44 800	2.4	Russia	45 000	2.4
10	Mexico	38 595	2.0	Mexico	38 600	2.0
	Total	1 080 943	57.3	Total	1 081 041	57.3

Table 2.12 The world top 11 consumers and producers of tropical hardwood industrial roundwood, in 2007. Source: ITTO and FAO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	Indonesia	34 098	23.2	Indonesia	34 170	23.2
2	Brazil	24 498	16.7	Brazil	24 500	16.7
3	India	22 082	15.0	Malaysia	21 263	14.5
4	Malaysia	16 735	11.4	India	20 313	13.8
5	China	12 601	8.6	Nigeria	7 100	4.8
6	Nigeria	7 030	4.8	Thailand	5 100	3.5
7	Thailand	5 148	3.5	China	4 350	3.0
8	Vietnam[1]	3 965	2.7	Myanmar	4 045	2.7
9	Myanmar	2 391	1.6	Vietnam	3 861	2.6
10	Cameroon	2 008	1.4	Gabon	3 400	2.3
11	Peru	1 963	1.3	Papua New Guinea	2 858	1.9
	Total	132 521	90.1	Total	130 960	89.0

[1] Figures for Vietnam are FAO reported non-coniferous

Table 2.13 The world top 10 consumers and producers of non-tropical hardwood industrial roundwood, in 2007. Source: FAO and ITTO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	United States	119 479	25.8	United States	121 657	26.3
2	China	42 874	9.3	Russia[1]	41 900	9.1
3	Brazil	40 242	8.7	Brazil	40 250	8.7
4	Canada	36 486	7.9	China	37 320	8.1
5	Russia	27 900	6.0	Canada	35 063	7.6
6	Finland	13 482	2.9	South Africa	12 629	2.7
7	South Africa	12 531	2.7	Australia	12 496	2.7
8	Australia	12 325	2.7	Chile	10 921	2.4
9	Chile	10 871	2.3	France	9 570	2.1
10	Sweden	8 578	1.9	Germany	8 871	1.9
	Total	324 767	70.1	Total	330 677	71.5

[1] Russia, South Africa and Chile are FAO reported statistics

Table 2.14 The world top 10 consumers and producers of softwood industrial roundwood, in 2007. Source: FAO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	United States	266 126	24.2	United States	271 656	24.7
2	Canada	158 092	14.4	Canada	157 932	14.4
3	Russia	85 324	7.8	Russia	120 100	10.9
4	China	84 177	7.6	Sweden	66 500	6.0
5	Sweden	66 275	6.0	China	60 754	5.5
6	Germany	57 455	5.2	Germany	59 158	5.4
7	Finland	50 476	4.6	Finland	44 895	4.1
8	Brazil	40 290	3.7	Brazil	40 381	3.7
9	Chile	27 712	2.5	Chile	27 773	2.5
10	Poland	26 232	2.4	Poland	25 480	2.3
	Total	862 159	78.3	Total	874 628	79.6

Table 2.15 The world top 10 consumers and producers of tropical hardwood sawnwood, in 2007. Source: ITTO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	Brazil	13 231	31.1	Brazil	14 837	32.0
2	India	4 992	11.7	Malaysia	5 122	11.0
3	Indonesia	3 567	8.4	India	4 889	10.5
4	China	3 545	8.3	Indonesia	4 330	9.3
5	Vietnam	3 255	7.6	Vietnam	3 150	6.8
6	Malaysia	2 905	6.8	Thailand	2 850	6.1
7	Nigeria	1 893	4.4	Nigeria	2 000	4.3
8	Myanmar	961	2.3	Myanmar	1 530	3.3
9	Thailand	844	2.0	China	1 450	3.1
10	Peru	694	1.6	Peru	932	2.0
	Total	35 886	84.3	Total	41 091	88.6

Table 2.16 The world top 10 consumers and producers of non-tropical hardwood sawnwood, in 2007. Source: FAO and ITTO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	United States	23 755	39.3	United States	25 608	43.5
2	China	17 280	28.6	China	16 140	27.4
3	Turkey	2 456	4.1	Russia	2 785	4.7
4	Russia	2 285	3.8	Turkey	2 373	4.0
5	Italy	1 738	2.9	Romania	1 984	3.4
6	Canada	1 638	2.7	France	1 750	3.0
7	Spain	1 599	2.6	Canada	1 401	2.4
8	France	1 439	2.4	Germany	1 142	1.9
9	Thailand	1 276	2.1	Australia	1 135	1.9
10	Australia	1 139	1.9	Spain	1 117	1.9
	Total	54 605	90.4	Total	55 435	94.2

Table 2.17 The world top 10 consumers and producers of softwood sawnwood, in 2007. Source: FAO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	United States	88 103	28.4	United States	58 755	18.5
2	Canada	19 037	6.1	Canada	50 883	16.0
3	Germany	19 020	6.1	Germany	24 028	7.5
4	Japan	18 333	5.9	Russia	20 415	6.4
5	China	14 992	4.8	Sweden	18 490	5.8
6	France	11 242	3.6	Finland	12 400	3.9
7	United Kingdom	10 718	3.5	China	11 931	3.7
8	India	9 908	3.2	Japan	11 411	3.6
9	Brazil	8 149	2.6	Austria	11 027	3.5
10	Sweden	7 423	2.4	India	9 900	3.1
	Total	206 925	66.6	Total	229 241	72.0

Table 2.18 The world top 10 consumers and producers of tropical hardwood plywood[1], in 2007. Source: ITTO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	China	5 004	24.6	Malaysia	6 103	26.8
2	Japan	3 273	16.1	China	5 150	22.6
3	India	2 327	11.4	Indonesia	3 965	17.4
4	United States	1 506	7.4	India	2 400	10.5
5	Republic of Korea	1 501	7.4	Brazil	948	4.2
6	Indonesia	1 295	6.4	Japan	645	2.8
7	Malaysia	588	2.9	Philippines	405	1.8
8	Philippines	477	2.3	Ghana	395	1.7
9	France	375	1.8	Côte d'Ivoire	395	1.7
10	Thailand	365	1.8	Ecuador	373	1.6
	Total	16 709	82.1	Total	20 779	89.6

[1] includes tropical veneer

Table 2.19 The world top 10 consumers and producers of non-tropical hardwood plywood, in 2007. Source: FAO and ITTO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	China	11 577	52.5	China	11 879	72.0
2	United States	4 764	21.6	United States	2 002	12.1
3	Japan	1 292	5.9	Italy	822	5.0
4	Italy	896	4.1	Finland	541	3.3
5	Germany	595	2.7	Canada	368	2.2
6	United Kingdom	508	2.3	Poland	355	2.2
7	Poland	385	1.7	Spain	165	1.0
8	Spain	324	1.5	France	89	0.5
9	France	267	1.2	Nepal	69	0.4
10	Canada	227	1.0	Mexico	57	0.3
	Total	20 835	94.5	Total	16 346	99.0

Table 2.20 The world top 10 consumers and producers softwood plywood, in 2007. Source: FAO and ITTO

	Consumer	000 m^3	Percentage of world total	Producer	000 m^3	Percentage of world total
1	China	13 821	35.7	China	21 587	43.9
2	USA	11 616	30.0	USA	10 835	22.1
3	Japan	2 694	7.0	Russia	2 929	6.0
4	Canada	1 999	5.2	Japan	2 434	5.0
5	Russia	1 526	3.9	Brazil	2 411	4.9
6	Korea, Rep.	1 228	3.2	Canada	2 297	4.7
7	Germany	1 047	2.7	New Zealand	1 110	2.3
8	Mexico	822	2.1	Korea, Rep.	978	2.0
9	New Zealand	818	2.1	Finland	928	1.9
10	United Kingdom	725	1.9	Indonesia	868	1.8
		36 296	93.9	Total	46 377	94.4

Table 2.21 The world top 10 consumers and producers of wood pulp in 2007. Source: FAO

	Consumer	000 t	Percentage of world total	Producer	000 t	Percentage of world total
1	United States	52 243	29.6	United States	52 277	29.5
2	China	15 641	8.9	Canada	22 235	12.6
3	Japan	12 681	7.2	Finland	12 856	7.3
4	Canada	12 323	7.0	Sweden	12 588	7.1
5	Finland	10 710	6.1	Brazil	12 083	6.8
6	Sweden	9 505	5.4	Japan	10 850	6.1
7	Germany	7 437	4.2	Russia	7 010	4.0
8	Brazil	5 819	3.3	China	6 435	3.6
9	Russia	5 205	2.9	Indonesia	5 177	2.9
10	Italy	3 992	2.3	Chile	4 675	2.6
	Total	135 556	76.8	Total	146 186	82.6

Table 2.22 The world top 10 consumers and producers of paper and paperboard in 2007. Source: FAO

	Consumer	000 t	Percentage of world total	Producer	000 t	Percentage of world total
1	United States	87 818	22.9	United States	83 826	21.9
2	China	78 594	20.5	China	78 026	20.3
3	Japan	28 927	7.6	Japan	28 930	7.5
4	Germany	21 519	5.6	Germany	23 172	6.0
5	United Kingdom	12 197	3.2	Canada	18 113	4.7
6	Italy	11 894	3.1	Finland	14 334	3.7
7	France	11 133	2.9	Sweden	11 902	3.1
8	Spain	9 855	2.6	Korea, Rep.	10 932	2.8
9	Korea, Rep.	8 710	2.3	Italy	10 112	2.6
10	Mexico	8 543	2.2	France	9 871	2.6
	Total	279 191	73.0	Total	289 218	75.4

International trade

There has been a general upward trend in the value of forest products exports during the past forty years (Figure 2.1). Since 1961, the real value of log exports has tripled to US$13 billion in 2007; sawnwood has more than trebled to US$36 billion; wood pulp and wood-based panels (veneer, plywood, particleboard and fibreboard) have increased more than thirteen times to US$28 billion and US$35 billion, respectively; and paper and paperboard has increased eight times to US$104 billion.

Growth in trade occurs because of the difference in growth of production and consumption within individual countries, and has been stimulated in part by global trade liberalisation. Since World War II there have been increasing numbers of regional trade agreements, such as the Southern Cone Common Market, the North American Free Trade Agreement, and the European Free Trade Association, as well as several rounds of the General Agreement on Tariffs and Trade. Progress has also been made on reducing non-tariff barriers in the form of subsidies, countervailing duties, and technical standards (Esty 1994). Nevertheless, some tariff escalation, the increase in tariff levels with increased processing, remains (WTO 2001).

The importance in trade of the major forest products has changed (Figure 2.2). While expanding in trade value, log's share of the value of total exports declined from 13% in 1961 to 4% in 2007. Within logs, hardwood's share declined more than softwood's share of export value. The wood pulp share of exports declined from 18% to 12%, and the share of softwood sawnwood dropped from 26% to 12%, and hardwood sawnwood from 5% to 4%. In contrast, the share of wood-based panels, paper and paperboard and secondary processed products increased, reflecting the growing emphasis on value-added forest products in world trade. In 2007, paper and paperboard products accounted for 34% of the value of world forest product exports, wood-based panels 11%, and secondary processed products 26%.

These trends have been driven, in part, by reductions in tariff escalation. The Uruguay Round of GATT, completed in 1994, intended to reduce import tariffs on manufactured products by one third from 1994 to 1999. By 2005, tariffs on some products including pulp and paper had been completely eliminated in developed economies. For manufactured products, tariff cuts have been implemented as agreed, while tariff escalation has also been reduced (WTO 2001).

Progress on liberalising global wood product trade has contributed to growth in trade exceeding growth in production (Turner et al. 2006). For logs, ratios suggest that tropical producer countries are more export orientated than producers of softwood and non-tropical hardwood logs (Figure 2.3); exporting 9% of production in 2008, compared with 4% of softwood production and 3% of non-tropical hardwoods. Reflecting a shift to increased domestic production by tropical producer countries (ITTO 2007), the ratio of exports to production for tropical logs has declined slightly from 13% in 1995.

A greater proportion of sawnwood and plywood production is exported (Figure 2.4 and Figure 2.5). For sawnwood there has been a strong increase in the proportion of tropical sawnwood production being exported, increasing from 19% in 1995 to 26% in 2008, approaching the level of softwood sawnwood production that is exported (Figure 2.4). A greater proportion of tropical plywood is exported than non-tropical or coniferous plywood; 45% in 2008, compared with 30% of softwood plywood and 17% of non-tropical hardwood plywood. However, from 1995 to 2008 there has been a steady decline in the proportion of tropical plywood being exported, from almost 67% in 1995. This is probably due to increased domestic consumption in tropical plywood producer countries, such as Malaysia, Brazil and Indonesia, for manufacture of furniture for export and in construction (ITTO 2007).

Figure 2.2 Individual forest product share of total forest product export value for major forest products from 1994 to 2008. Source: FAO and COMTRADE

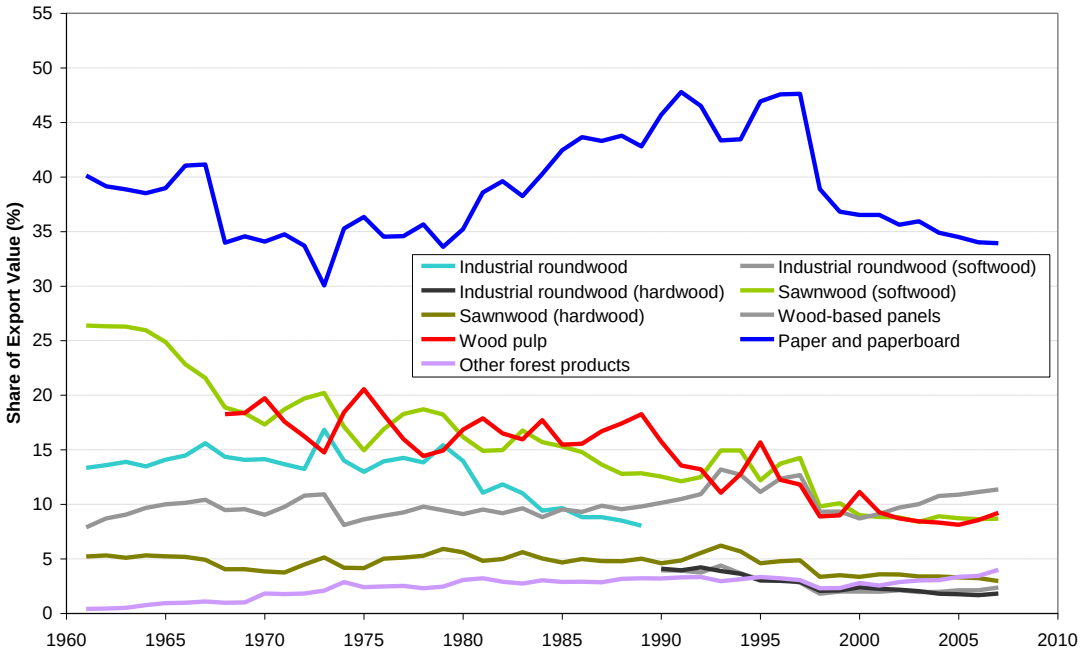


Figure 2.3 Ratio of world export to world production for industrial roundwood; tropical and non-tropical hardwood, and softwood, from 1995 to 2008. Source: ITTO

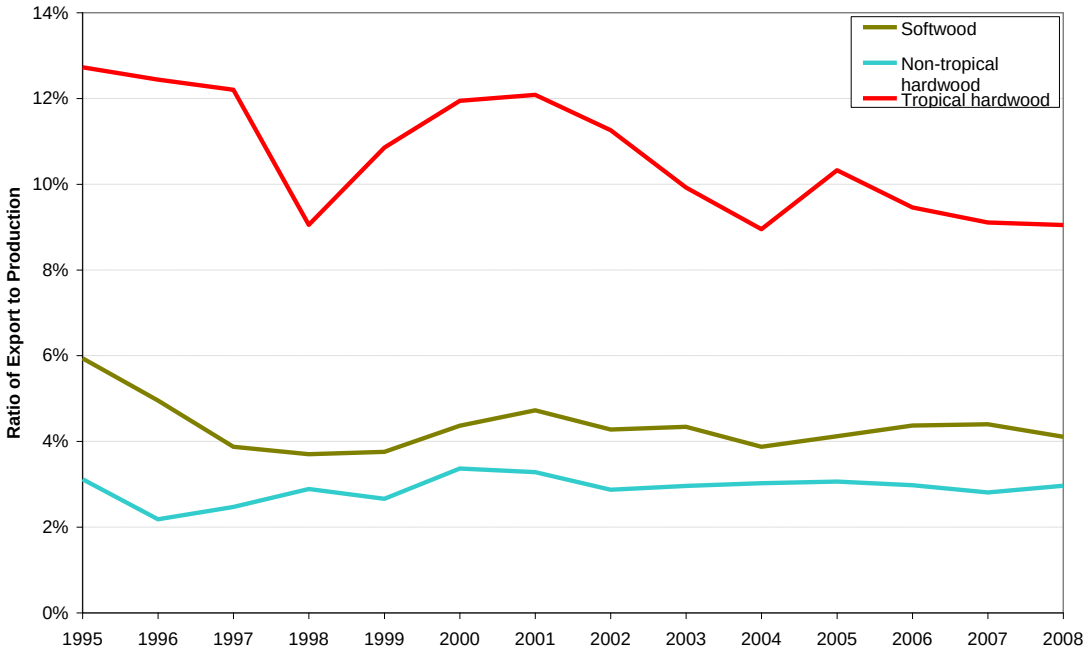


Figure 2.4 Ratio of world export to world production for sawnwood; tropical and non-tropical hardwood, and softwood, from 1995 to 2008. Source: ITTO

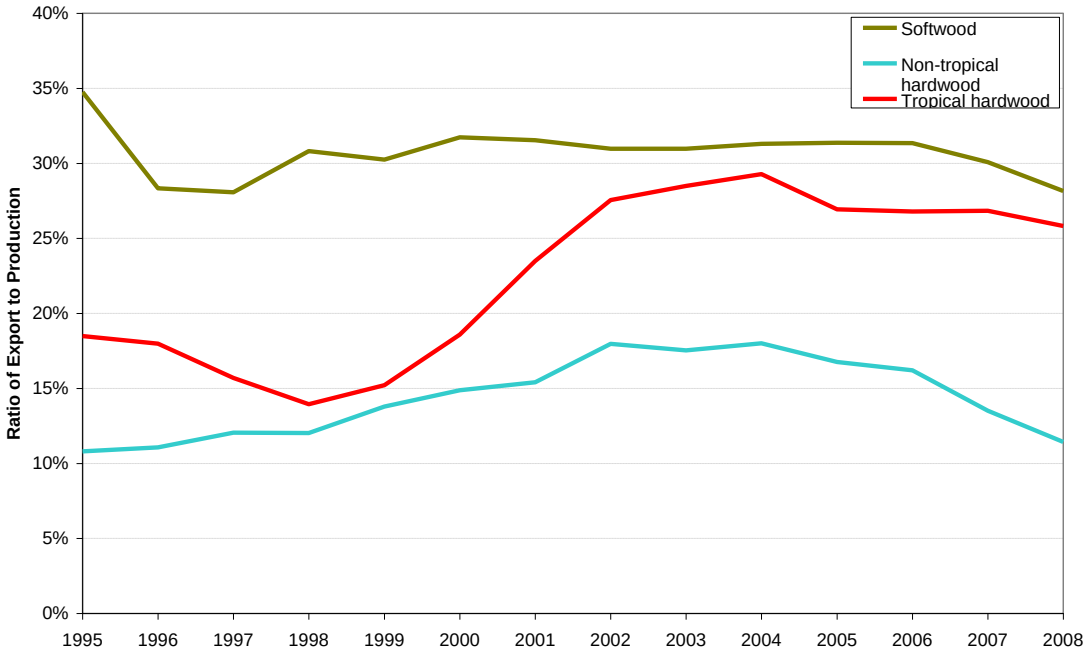
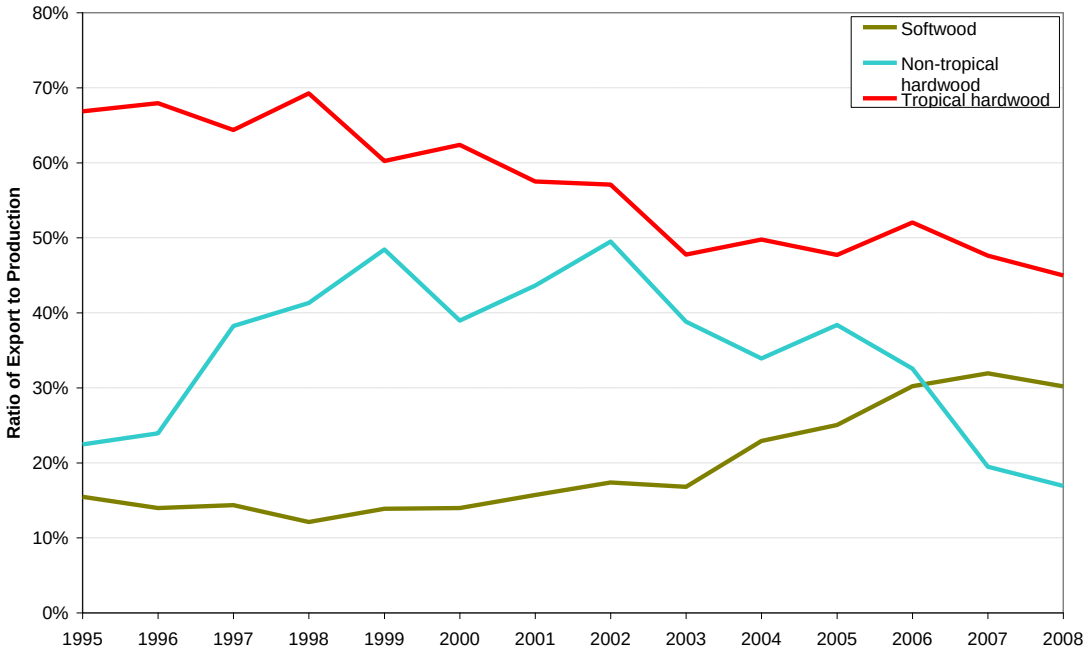


Figure 2.5 Ratio of world export to world production for plywood (including veneer); tropical and non-tropical hardwood, and softwood, from 1995 to 2008. Source: ITTO



Another feature of trade in forest products is the dominance of the developed countries, both in exports and imports. In value terms, developed countries accounted for over 80% of world exports in 2007. On the import side, they accounted for over 70%. The breakdown of exports and imports by region in 2007 clearly shows the dominance of Europe and North America as importers and exporters, and of Asia as an importer (Table 2.23 and Table 2.24). More rapid growth of wood-based panel production in Asia and Latin America (Table 2.7 and Table 2.8) has decreased the dominance of developed countries.

Overall, tropical producer countries are a much smaller share of world export and import value (Table 2.23 and Table 2.24). Within the tropical producer countries, Latin America has the largest share of export value, and has increased this share while Africa, Asia and the Pacific's share has decreased.

Although many countries are involved in trade, only a few account for the bulk of exports and imports (Table. 2.25 and Table 2.26). In 2007, the top ten countries exported 64% of world forest products. Canada, Germany and the United States alone accounted for almost 50% of world exports. Indonesia the only tropical producer country dropped from the top 10, with Brazil entering the top 10 in 2007 (Table 2.25). On the import side, the ten countries accounted for 61%. The United States and China alone imported nearly 40% of world exports (Table 2.26).

As their economies have grown, developing countries, particularly in Asia-Pacific, have increased their share of global imports, mainly of logs and semi-finished wood products. China alone accounts for one third of all developing country imports, a reflection of the size of the Chinese economy. Only plywood exports are dominated by developing countries; Indonesia, Malaysia, China, and Brazil. This reflects deliberate government encouragement of the plywood industry in these countries. Most of the exporting developing countries are in Asia, particularly for wood-based panels, logs, sawnwood, and paper and paperboard. Latin American countries, however, are the major developing country exporters of wood pulp. In the past decade, exports by the developing countries have gradually moved towards value-added products.

Table 2.23 Regional shares of total forest products export value in 2002 and 2007, tropical and non-tropical. Source: ITTO

	Region	2002	2007
Tropical	Africa	1.3	0.9
	Latin America	4.5	5.4
	Asia & Pacific	4.7	4.1
Non-tropical	Africa	2.3	1.8
	Latin America	4.0	5.9
	Asia & Pacific	14.4	15.2
	North America	27.6	20.7
	Europe	51.7	56.4

Table 2.24 Regional shares of total forest products import value in 2002 and 2007, tropical and non-tropical

	Region	2002	2007
Tropical	Africa	0.2	0.2
	Latin America	3.9	4.2
	Asia & Pacific	2.6	2.8
Non-tropical	Africa	1.9	2.6
	Latin America	3.9	4.4
	Asia & Pacific	29.0	28.6
	North America	19.1	14.7
	Europe	45.7	49.4

Table 2.25 Top 10 exporters of total forest products, by value (US$ billion nominal) in 2002 and 2007. Source: FAO

Rank	Countries	2002	Countries	2007
1	Canada	23.3	Canada	26.3
2	United States	13.8	Germany	21.0
3	Germany	11.4	United States	20.9
4	Finland	10.5	Sweden	16.6
5	Sweden	9.2	Finland	15.9
6	France	5.3	Russia	11.2
7	Indonesia	4.7	China	10.8
8	Austria	4.6	France	8.6
9	Russia	4.3	Austria	8.4
10	China	4.1	Brazil	7.2
	Total	91.3		146.8
	World share (%)	67.8		64.4

Table 2.26 Top 10 importers of total forest products, by value (US$ billion nominal) in 2002 and 2007. Source: FAO

Rank	Countries	2002	Countries	2007
1	United States	23.4	United States	28.8
2	China	15.4	China	25.1
3	Germany	11.8	Germany	18.2
4	Japan	10.5	United Kingdom	13.6
5	United Kingdom	8.7	Japan	12.3
6	Italy	7.4	Italy	12.0
7	France	7.0	France	11.5
8	Netherlands	4.3	Netherlands	7.4
9	Spain	4.2	Spain	7.3
10	Canada	4.0	Belgium	6.1
	Total	96.6		142.4
	Share	67.4		61.3

Inter- and intra-regional trade

Table 2.27 and Table 2.28 show the value and share, respectively, of forest products trade among regions in 2001 and 2006. With the exception of the smaller trading regions, Africa and Oceania, each region's largest trade is intra-regional. This pattern largely remained between 2001 and 2006 (Table 2.27). For the smaller regions, Africa's exports were predominantly to Europe and Asia, and Oceania's were predominantly to Asia. The two largest trade flows are within Europe and the Americas (Table 2.27), which is dominated by the United States-Canadian trade (Turner et al. 2006). This reflects the large size of these economies and the facilitation of trade within these regions through NAFTA in North America, and the European Union.

From 2001 to 2006 both Africa and to a lesser extent Oceania increased the share of trade that was within their regions (Table 2.28). At the same time the share of trade that was intraregional in Asia, the Americas and Europe decreased slightly. Africa also increased its share of forest product exports to Europe, and Asia and Oceania increased their share of exports to the Americas. There was less change in the mix of regions the America's and Europe were exporting to (Table 2.28).

Table 2.27 Total regional forest products export value (US$ million) in 2001 and 2006, by import region. Source: FAO

		Importer					
2001	Exporter	Africa	Asia	Americas	Oceania	Europe	**World**
	Africa	53	523	62	2	899	**1 539**
	Asia	226	11 871	1 500	339	1 511	**15 447**
	Americas	184	10 309	29 605	291	7 018	**47 408**
	Oceania	3	1 670	235	482	34	**2 425**
	Europe	1 142	8 155	4 620	498	52 246	**66 661**
	World	**1 608**	**32 528**	**36 022**	**1 612**	**61 709**	
2006	Africa	547	749	110	43	2 203	**3 651**
	Asia	640	17 596	4 262	774	2 302	**25 574**
	Americas	513	12 591	34 591	293	8 114	**56 103**
	Oceania	20	1 860	334	671	75	**2 959**
	Europe	2 745	15 225	6 998	750	83 916	**109 634**
	World	**4 465**	**48 020**	**46 296**	**2 531**	**96 609**	

Table 2.28 Regional share (%) of forest products export value in 2001 and 2006, by import region. Source: FAO

		Importer				
2001	Exporter	Africa	Asia	Americas	Oceania	Europe
	Africa	3.4	34.0	4.0	0.1	58.5
	Asia	1.5	76.9	9.7	2.2	9.8
	Americas	0.4	21.7	62.4	0.6	14.8
	Oceania	0.1	68.9	9.7	19.9	1.4
	Europe	1.7	12.2	6.9	0.7	78.4
2006	Africa	15.0	20.5	3.0	1.2	60.3
	Asia	2.5	68.8	16.7	3.0	9.0
	Americas	0.9	22.4	61.7	0.5	14.5
	Oceania	0.7	62.8	11.3	22.7	2.5
	Europe	2.5	13.9	6.4	0.7	76.5

Forest product price trends

Historically forest product prices have been trending downwards (Turner et al. 2006), though most recently prices have increased, inline with growth in all commodity prices driven by the recent expansion in global demand fuelled by strong economic growth (World Bank 2009). Figure 2.4 shows historical trends for tropical and non-tropical hardwood, and softwood log prices in real US dollars at the world level. The price is defined as the unit value of world exports, net of inflation. The prices for tropical and non-tropical hardwood logs are similar and have moved closely together, from 1995 to 2007, with both increasing in the last two years (Figure 2.4). Softwood logs have been priced lower than the hardwoods, especially since 1998.

Historically, the price of sawnwood has paralleled the price of logs (Figure 2.5), because roundwood is a major component of the total cost of sawmilling. Figure 2.5 shows that there is a clear difference in the price of tropical and non-tropical hardwood, and softwood sawnwood, with tropical hardwood sawnwood being priced lower than non-tropical.

Between 1995 and 2007, the price of plywood decreased slightly (Figure 2.6). Tropical and softwood plywood are priced similarly, while non-tropical hardwood is priced higher and appeared to respond more strongly to increased global demand from 2003. Given competitive markets the implication is that the supply of tropical and softwood plywood increased more rapidly than demand.

Figure 2.4 Real world export unit value prices of industrial roundwood; tropical and non-tropical hardwood, and softwood from 1995 to 2007. Source: ITTO

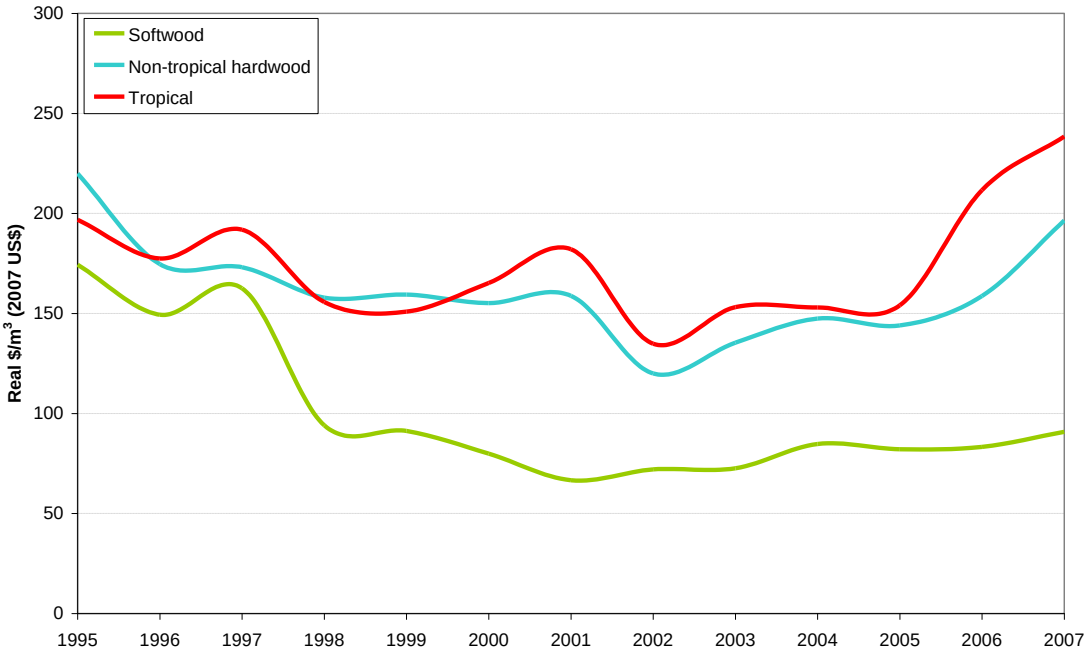


Figure 2.5 Real world export unit value prices of sawnwood; tropical, non-tropical hardwood and coniferous from 1995 to 2007. Source: ITTO

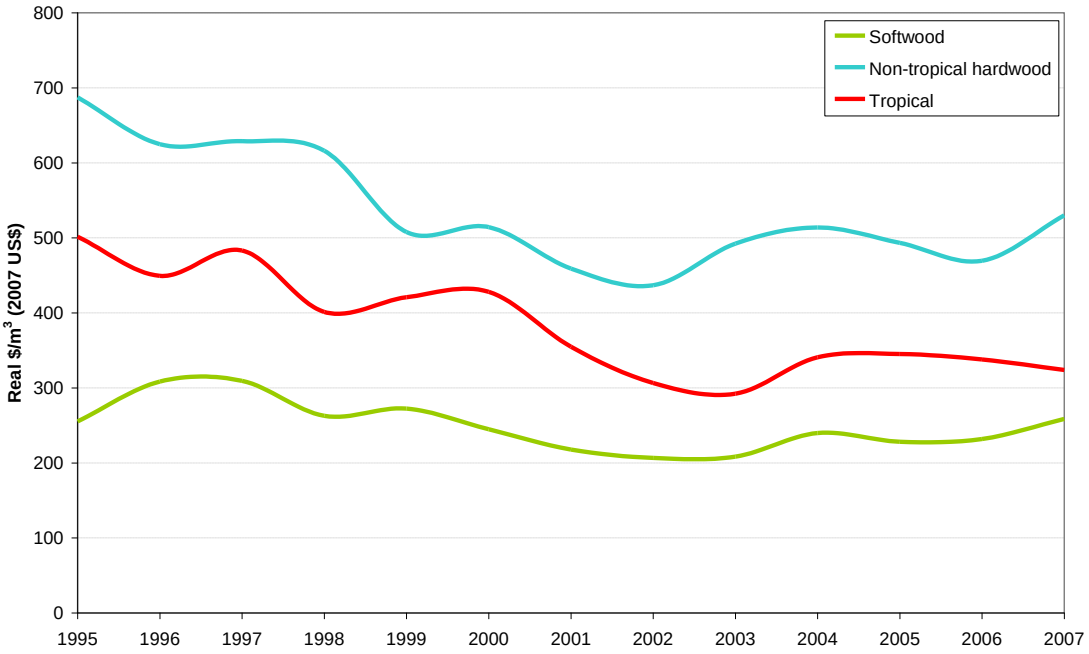
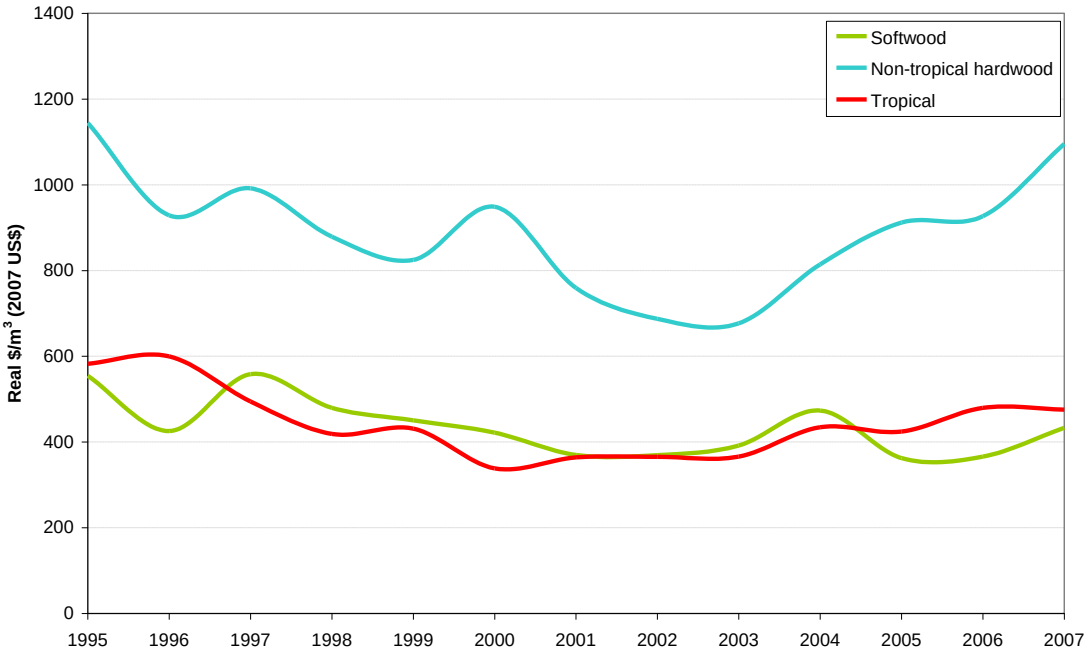


Figure 2.6 Real world export unit value prices of plywood; tropical and non-tropical hardwood, and softwood from 1995 to 2007. Source: ITTO



Secondary processed wood products

Figure 2.7 and Figure 2.8 show trends in the export value of secondary processed wood products. These products are mouldings and millwork, builder's woodwork, wooden furniture and parts, cane and bamboo furniture and parts, and other secondary processed products (ITTO 2007). ITTO consumer countries dominate the export of secondary processed products, and have experienced the most growth from 1994 to 2006. Major exporters are China (US$14.6 billion in 2006), Italy (US$7.6 billion), and Canada (US$5.4 billion). The producer countries in the Asia-Pacific region are also important producers. Indonesia (US$2.9 billion) and Malaysia (US$2.4 billion) are the major exporters from this region (Figure 2.7).

The trade of secondary processed products is dominated by wooden furniture and parts, accounting for nearly 60% of the value of trade in 2006. However, from 2001 to 2006 the strongest growth in exports was for mouldings (16% per year) and builder's woodwork (14% per year) (Figure 2.8).

Figure 2.7 Export value of secondary processed wood products, by major region, at constant 2007 prices, from 1994 to 2006. Source: ITTO (various years)

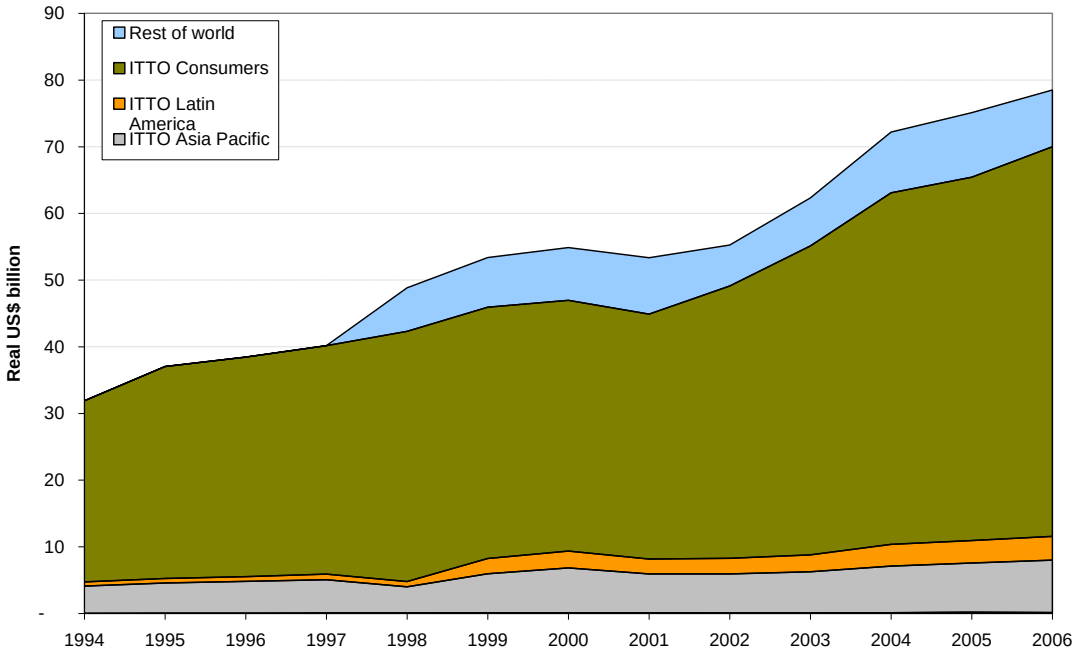


Figure 2.8 Export value of secondary processed wood products, by product, at constant 2007 prices, from 2001 to 2006. Source: ITTO (various years)

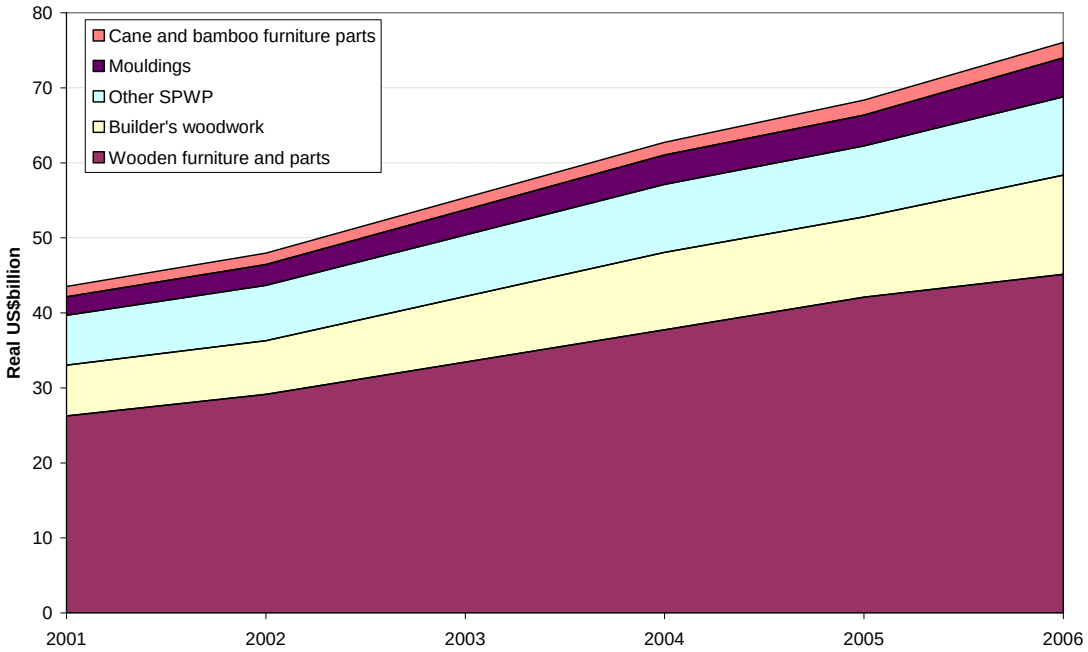


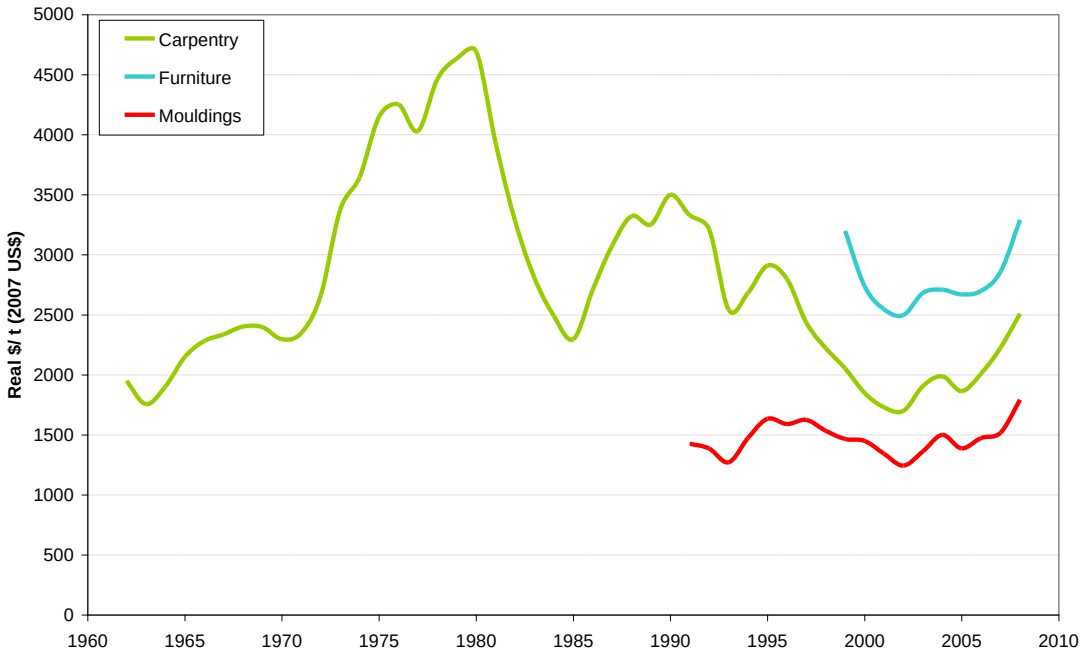
Table 2.29 shows the top ten exporters and importers of secondary processed wood products in 2006. China dominates exports, with nearly twice the value of the next largest exporter, Italy. A very large proportion of China's exports are wooden furniture. Indonesia and Malaysia are the only ITTO producer countries in the top ten exporters, together accounting for nearly 7% of world exports. The United States dominates imports of secondary processed products, with nearly four times the value of the next largest importer, Germany. The countries in the top 10 importers are all ITTO consumer countries

Table 2.29 Top 10 exporters and importers of secondary processed wood products, by value in 2006. Source: ITTO (2007)

	Exporter	US$ million	Percentage of world total	Importer	US$ million	Percentage of world total
1	China	14 123	18.6	United States	24 984	31.2
2	Italy	7 389	9.7	Germany	6 321	7.9
3	Germany	6 221	8.2	United Kingdom	5 863	7.3
4	Canada	5 197	6.8	Japan	4 131	5.2
5	Poland	4 815	6.3	France	3 550	4.4
6	Indonesia	2 833	3.7	Canada	2 893	3.6
7	Denmark	2 606	3.4	Netherlands	2 243	2.8
8	United States	2 540	3.3	Switzerland	2 206	2.8
9	Malaysia	2 347	3.1	Italy	2 168	2.7
10	Vietnam	2 267	3.0	Belgium	1 745	2.2
	Total	50 340	66.2	Total	56 105	70.1

As with solidwood and fibre products (Turner et al. 2006), the secondary processed product long-term price trend has been downward. More recently though prices, as for other commodities increased due to increased global demand driven by strong economic growth and housing starts, particularly in the United States.

Figure 2.9 Real import unit value of individual SPWP, from 1962 to 2005. Source: COMTRADE



Forest and trade policy trends

This section provides a brief review of forest and trade policy trends in the tropical timber trade. A more detailed description can be found under the various headings in the section on *Future Trends and Drivers*.

In tropical producer countries a key policy trend has been to encourage increased development of the forestry sector, particularly value-added processing and planted forests. A number of ITTO producer countries (e.g. Malaysia, Indonesia, and Ghana) have implemented policies that provide incentives to forestry firms to invest in value-adding activities. Incentives include exemption from customs duty and consumption tax on sawmilling equipment, logging and land development equipment, and wood working equipment (MTIB 2008; ITTO 2007a; ITTO 2007c). A number of governments have also implemented trade and production restrictions in an attempt to encourage adding value to scarce timber resources (FAO 2001). Restrictions include log export taxes, quotas or bans, and primary product export taxes. For example, Ghana has a ban on exports of logs from natural forests to discourage the export of logs and encourage more value-added production (ITTO 2007).

In general producer countries appear to more often use taxes to encourage value-added processing, possibly as this also provides revenue to the government. This is borne out in the different forms of trade protection by developed and developing countries in response to the global economic crisis. Overall developed countries appear to have relied on subsidies, while developing countries have applied a variety of forms of protection (subsidies, import duties, and import bans) (Gamberoni & Newfarmer 2009).

In ITTO consumer countries, especially in North America, Europe and Australasia a key policy trend has been to use trade and consumption related policies in an attempt to encourage sustainable forest management in tropical forests. Historically import tariffs on tropical timber products have been declining in line with trade liberalization, while non-tariff barriers appear to be increasing (Barbier et al. 1995). More recently, there has been an increasing requirement for confirmation of sustainable forest management (SFM) and chain of custody (CoC), through certification in consumer countries (Purbawiyatna & Simula 2008). Increasingly this is being distilled into an issue of legality through government procurement policies (Betser & Oliver 2009), and bilateral agreements such as Forest Law Enforcement, Governance and Trade and Voluntary Partnership Agreements (ITTO 2008a).

Future demographic and economic trends

The future global demographic and economic trends discussed here represent some of the background for the future scenarios in the *Alternative Futures* section of this report.

Demographic trends

Future demographic trends depend on fertility – children per woman – and mortality, age cohorts, and migration patterns. Depending on the assumed fertility rate the global population is predicted to grow from 6.7 billion in 2005 to up to 9.3 billion (Fésüs et. al 2008; Walker 2009) by 2050. Half of the world's projected population increase will be in nine countries: India, Pakistan, Nigeria, Democratic Republic of Congo, Bangladesh, Uganda, the United States, Ethiopia and China[4] (UN 2008).

The geographical concentration of the world's population is predicted to shift from developed to developing countries, particularly in Africa, over the next 50 years. While the population of developed countries will remain unchanged at 1.2 billion, the population in Africa is predicted

[4] Countries listed in order of decreasing contribution to population growth.

to increase to 3.0 billion by 2050 (Fésüs et al. 2008). Slightly countering this growth in Africa is the continuing net migration from developing to developed countries; 2.3 million per year (Fésüs et al. 2008).

Table 2.30 Predicted population and population growth rate for major countries. Source: UN (2008)

	Population (million)				Growth rate (% per year)		
Country	2005	2010	2015	2020	2005-2010	2010-2015	2015-2020
China	1 312.3	1 354.1	1 396.0	1 431.2	0.6	0.6	0.5
India	1 130.6	1 214.5	1 294.2	1 367.2	1.4	1.3	1.1
United States	302.7	317.6	332.3	346.2	1.0	0.9	0.8
Indonesia	219.2	232.5	244.2	254.2	1.2	1.0	0.8
Brazil	186.1	195.4	202.9	209.1	1.0	0.8	0.6
Germany	164.8	164.1	162.7	160.8	-0.1	-0.2	-0.2
Russia	143.2	140.4	138.0	135.4	-0.4	-0.3	-0.4
Japan	127.4	127.0	125.8	123.7	-0.1	-0.2	-0.3
United Kingdom	60.3	61.9	63.5	65.1	0.5	0.5	0.5
Republic of Korea	47.6	48.5	49.2	49.5	0.4	0.3	0.1
Uganda	28.7	33.8	39.7	46.3	3.3	3.3	3.1
Malaysia	25.6	27.9	30.0	32.0	1.7	1.5	1.3
Côte d'Ivoire	19.2	21.6	24.2	27.0	2.3	2.3	2.2
Cameroon	17.8	20.0	22.2	24.3	2.3	2.1	1.9

China and India are the world's most populous countries, and are predicted to grow to approximately 1.4 billion each by 2020 (Table 2.30; Appendix 1). The next most populous country is the United States, which is unique among the large developed countries (Germany, Japan and the United Kingdom) in that its population is predicted to continue to grow at a relatively high rate; reaching 346 million by 2020 (Table 2.30) This is attributed to higher fertility rates, particularly amongst immigrants to the United States from Latin America and Southeast Asia.

The wealthier Asian countries (Japan, Republic of Korea, China and Malaysia) are tending towards lower population growth rates (Table 2.30). Japan, in particular, has a negative growth rate, and the Republic of Korea's growth rate is predicted to approach zero by 2020. Russian population growth is one of the lowest in the world, at -0.4%, and is predicted to remain low through to 2020 (Boumphrey 2007).

There is a continuing trend toward an ageing population, particularly in the developed countries (Table 2.31), where the proportion of population over 60 is expected to increase from 20 percent to 32 percent by 2050. In developing countries, the number of people over 60 years of age is predicted to increase from 8 percent to 20 percent of the population (United Nations 2008a). Countries predicted to experience a large increase in the proportion of population over 60 are Japan, Germany, Republic of Korea, and China (Table 2.31).

Another key demographic trend is increasing urbanisation. 23 cities are expected to have populations of 10 million or more by 2015, with 19 of these in developing countries. 60% of the world's population will live in urban areas by 2030, compared with 47% in 2000 (World Bank 2001; RRG 2007) making urban dwellers more powerful in rural decision making. This will, however, also increase financial remittances to rural areas, which were US$200 billion in 2006 (RRG 2007).

These demographic trends should contribute to continued growth in demand for wood products and on forest resources. Continued growth in the United States suggests that it will remain an important consumer of wood products into the future, while Japan could decline in importance. Changes in the geographical distribution of the world population though should lead to a continuation of the shift in wood product consumption to Asia, particularly India and China. If age groups differ in their patterns of wood product consumption, there is the

possibility that the trend toward an ageing population in some countries will negatively affect wood demand per person.

Table 2.31 Changes in the proportion (%) of country population in different age cohorts from 2010 to 2020. Source: UN 2008a.

	Age cohort (years)			
Country	0-14	15-24	60-80	80+
China	-1.1	-4.3	3.8	0.6
India	-4.1	-1.4	2.1	0.2
United States	-1.1	-1.1	4.0	0.1
Indonesia	-3.7	-1.5	2.5	0.3
Brazil	-5.4	-0.9	3.3	0.5
Germany	-1.0	-1.5	2.2	2.1
Russia	1.7	-4.5	3.7	0.7
Japan	-1.6	-0.5	-1.9	5.9
United Kingdom	0.0	-1.5	1.2	0.3
Republic of Korea	-2.9	-2.3	5.6	1.6
Uganda	-1.3	0.1	-0.3	0.0
Malaysia	-3.8	-1.8	3.1	0.3
Côte d'Ivoire	-3.3	0.2	0.4	0.1
Cameroon	-2.5	-0.9	0.3	0.0

Economic trends[5]

The economic outlook is described in terms of trends in gross domestic product (GDP), economic growth, household income, and consumer spending power.

Gross world product is predicted to increase from approximately US$46,553 billion[6] in 2007 (World Bank 2009) to US$58,676 billion in 2020 (UNECE/FAO 2002, OECD 2004, EIA 2004). Predictions of longer term strong economic growth in Asia will result in this region surpassing Europe and North America by 2020, and accounting for almost a third of the gross world product. South America is another developing region that will increase its share of gross world product (Table 2.32). The major contributors to economic growth in these regions are China, India and South Korea in Asia, and Brazil in South America.

Table 2.32: Regional shares (%) of gross world product. Source: World Bank 2005

Country	1961	1970	1980	1990	2000	2010	2020
Africa	1.9	1.9	1.8	1.7	1.6	1.8	1.9
North/ Central America	37.7	34.5	29.8	28.5	30.2	30.6	30.6
South America	5.4	4.9	5.3	4.1	4.3	4.3	4.9
Asia	17.5	23.9	24.2	27.0	28.1	29.8	30.7
Oceania	2.0	1.9	1.6	1.5	1.6	1.7	1.7
Europe	35.5	32.9	37.3	37.3	34.1	31.9	30.2

The Chinese economy is predicted to grow from US$2,671 billion in 2007 to US$3,524 billion by 2020, to become larger than each of the French, United Kingdom or Italian economies (Table 2.33). Reflecting the strong growth of the Chinese economy, a key change in the shape of the global economy is the contribution of China, along with the United States, to

[5] The long-term economic trends discussed here assume a recovery from the Global Economic Crisis by 2010. The potential economic impacts of the Global Economic Crisis are discussed in the next section.

[6] Values are in US$ real, 2002 base year.

driving economic growth. China's demand differs from that of the United States by being predominantly for raw materials, rather than end products. This trend contributed to the reversal in the historical downward trend in commodity prices until the recent Global Economic Crisis (World Bank 2009).

Table 2.33: Top ten economies – GDP (US$ billion) and rank. Source: 2007 – World Bank (2008), 2020 – various

2007			2020		
Country	GDP	Rank	Country	GDP	Rank
United States	11,910	1	United States	15,803	1
Japan	3,849	2	Japan	8,116	2
Germany	2,922	3	Germany	3,615	3
China	2,671	4	China	3,524	4
United Kingdom	2,407	5	France	2,646	5
France	2,260	6	United Kingdom	2,130	6
Italy	1,827	7	Italy	1,701	7
Spain	1,261	8	Brazil	1,573	8
Canada	1,254	9	South Korea	1,461	9
Brazil	1,138	10	India	1,323	10

While the economies of China, Russia, India, Brazil, Malaysia and Indonesia are predicted to grow rapidly over the coming decade (Table 2.33; Appendix 1), there is a large difference amongst these countries in their average household incomes and proportion of households with significant earnings (Appendix 1). China, Indonesia and India are amongst the poorest of these emerging economies in terms of spending power. Chinese average household income in 2019 is predicted to be $US6,855 (only 1% of households are predicted to earn over US$30,000 by 2019). In Indonesia average household income is predicted to be $US7,008 (2% of households), and in India it is $US2,843 (1% of households) (Appendix 1). Brazil and Russia are comparatively wealthier with predicted average household incomes of $US28,558 (23% of households earning over US$30,000) and $US16,691 (19% of households), respectively. Malaysia is also relatively wealthy with a predicted average household income of $US16,351 (13% of households).

These economic trends, like the demographic trends, suggest there will be continued growth in demand for forest products. The growth in the economies of China, Brazil, India, Malaysia and Russia will contribute to a continuing increase in these countries' share of global forest product consumption. The higher average household income and greater proportion of households with significant earnings in Brazil, Malaysia and Russia suggest that these countries will also increase their consumption of more value-added forest products, such as wooden furniture and builder's woodwork.

3. Study Methodology

Acknowledging that the long-term future of tropical timber markets and forests is unpredictable this study developed a set of scenarios for the future. These scenarios are distinct, plausible pictures of the world in which the tropical forest industry may operate in 2020. The scenarios were developed through a scenario planning process. Key elements of these scenarios were then implemented in an economic model of the global forest sector to provide quantitative predictions of forest resources and wood products consumption, production, trade and prices to 2020 under the four scenarios developed.

This section provides an overview of the study methodology. A more detailed description of the scenario development process is provided in *Appendix 2: Scenario Development Methodology*. A detailed description of the method for developing quantitative predictions of the scenarios is provided in *Appendix 4: Timber Market Projection Methodology*.

Scenario development

Scenario development begins with identifying the focal issue, in this case the long term outlook for tropical timber markets. Expert interviews, based on van der Heijden's (1996) nine questions, were then undertaken to identify the major trends and forces acting on this focal issue. Van der Heijden's questions are designed to generate a list of the main uncertainties and concerns in the area being studied, in this case tropical forestry and the tropical timber market, and identify pivotal events that are important drivers of the focal issue.

From these interviews seven key areas of trends influencing tropical forestry and the tropical timber market were identified and explored further through a STEEP literature review.

i) Consumer country perceptions of tropical timber products
ii) Non-timber values placed on tropical natural forests
iii) Political stability, rule of law, and governance in tropical producer countries
iv) The nature of investments in tropical producer country forest management and processing
v) The global economic crisis
vi) The role of tropical planted forests in meeting countries' future timber needs
vii) The emergence of new trading and political regions

The review looked for likely forces related to society, technology, environment, economic, and political (STEEP) aspects that could affect the seven key trends.

A workshop was then used to structure the information from the interviews and STEEP literature review. The information was clustered and ranked to identify the key orthogonal driving forces and uncertainties in the tropical timber market. Critical uncertainties were those that are central to the tropical timber market, but also impossible to predict. Those forces that are most important as well as most uncertain have the most potential to create divergent future paths to base scenarios around. From these forces, four alternative futures for the long-term outlook for tropical forests and the tropical timber market were developed.

Timber market projections

The predictions of forest resources and wood products consumption, production, trade and prices to 2020 under the four alternative futures developed in the scenario planning process were made using a modified version of the Global Forest Products Model (GFPM; Buongiorno et al. 2003); an economic model of the global forest sector. The model integrates the four major components of the forest sector: wood supply, wood processing, product demand, and trade. Forest products are interrelated by supply and demand equations, and manufacturing input-output coefficients and costs. Countries are linked by trade. The economic optimisation

structure upon which the GFPM is built, the price endogenous linear programming system (PELPS; Zhang et al. 1993) was also used to develop the previous long-term forecast of the tropical timber market (Drake et al. 1993).

Table 3.1 Commodities in the modified Global Forest Products Model used in this study

Commodity Aggregate (used in the GFPM)	Constituent Commodities
Fuelwood and charcoal	Wood fuel
	Wood charcoal
Other industrial roundwood	Other industrial roundwood
Tropical industrial roundwood	Chips and particles (imports and exports only)
	Tropical pulpwood
	Tropical sawlogs
Non-tropical hardwood[1] industrial roundwood	Chips and particles (imports and exports only)
	Non-tropical hardwood pulpwood
	Non-tropical hardwood sawlogs
Softwood industrial roundwood	Chips and particles (imports and exports only)
	Softwood pulpwood
	Softwood sawlogs
Tropical sawnwood	Tropical sawnwood
Non-tropical hardwood sawnwood	Non-tropical hardwood sawnwood
Softwood sawnwood	Softwood sawnwood
Tropical plywood	Tropical plywood
	Tropical veneer sheets
Non-tropical hardwood plywood	Non-tropical hardwood plywood
	Non-tropical hardwood veneer sheets
Softwood plywood	Softwood plywood
	Softwood veneer sheets
Reconstituted panels	Particleboard
	Fibreboard
Wood pulp	Mechanical wood pulp
	Chemical wood pulp
	Semi-chemical wood pulp
Other fibre pulp	Other fibre pulp
Waste paper	Recovered paper
Paper & paperboard	Newsprint
	Printing and writing paper
	Other paper and paperboard
Carpentry	Builder's carpentry and joinery, of wood
Other SPWP	Mouldings and millwork
	Wooden frames
	Wooden cases, casks, drums, boxes, etc
	Wooden tools, tableware and ornaments
	Articles of wood, nes
Wooden furniture	Wooden furniture
	Seats with wooden frames

[1] non-tropical hardwood is referred throughout as hardwood

The GFPM was originally developed to produce the FAO provisional global forest sector outlook (FAO 1997). These projections were updated a year later, using revised assumptions and an improved model structure, for the FAO 1999 Global Forest Products Outlook Study (Zhu et al. 1998). Since then the model has been continually improved while being applied to a variety of issues. These include analysis of the effects of tariff liberalisation and regional trade agreements (Zhu et al. 2001; Turner et al. 2001, 2005), predicting the global impact of waste paper recycling in the United States (Zhu & Buongiorno 2002), analysis of the effects of illegal logging on the global forest sector (Li et al. 2008; Turner et al. 2008), and estimating the impact of the Russian log export tax on global forest products trade and forest resources

(Turner et al. 2008a). A validation of the GFPM for 1980 to 2000 showed that the model satisfactorily predicts long-run aggregate trends (Turner 2004).

The general principle of the GFPM is that global markets optimise the allocation of resources in the short-run (within one year). In the long-run, resource allocation is governed partly by market forces, as in trade, and also by external forces, such as economic growth, tariffs by trade policy, forest area and fuelwood demand by environmental policy, and techniques of production by investment in processing technology.

The modified version of the GFPM developed for this study deals with 180 countries (including all of the ITTO member countries), each of which produces, consumes, imports, or exports at least one of 19 wood products (Table 3.1). The key modifications to the existing GFPM for this study were to segregate sawnwood and plywood (including veneer) into tropical and non-tropical hardwood, and softwood, based on ITTO (ITTO 2009) and FAO (FAO 2009) data and include secondary processed wood products, based on COMTRADE (UN 2009) data. This required the estimation of supply and demand equations for these products, manufacturing coefficients for their use, and base year (2006) production, consumption, trade and prices. As there are no internationally comparable production data for secondary processed wood products (carpentry, wooden furniture and other SPWP), only their net imports and exports were modelled (Turner et al. 2008b).

The four alternative scenarios developed from the scenario planning exercise (see *Alternative Futures for the Tropical Timber Market*) were represented in the GFPM by implementing in the model the seven key trends under each of the scenarios:

i) Recovery from the global economic crisis
ii) Regional political and trading blocks
iii) Bioenergy demand
iv) Investment in improved processing
v) The profitability of sustainable forest management
vi) Expansion of planted forests
vii) Demand for ecosystem services

The extent to which some of the seven trends will occur in tropical producer countries is mediated by the extent to which the country's political and economic environment supports the changes, as described by the strength of forest governance. This is particularly the case for supply side trends; investment in processing, sustainable forest management, planted forest expansion, and provision of ecosystem services from tropical forests. To reflect country differences in support for forest protection and investment the ITTO producer countries were grouped into four categories from strongly supportive to weak or no support (see Appendix 4)

The first three trends were implemented in the product demand and trade components of the GFPM. The first trend, recovery from the global economic crisis was represented in the GFPM by GDP and GDP per capita growth rates. Economic growth rates during the global economic crisis were from World Bank (2009a), while post-crisis growth rates were based on IPCC estimates as described in Raunikar et al. (2009). The second trend, changes in regional political and trade blocks, was described by preferences for tropical timber products and the level of tariffs on forest products, including the Russian log export tax. The former was represented by changes in income elasticities of demand for tropical timber products based on the author's estimates. The latter were directly represented in the GFPM as changes in import and export tariffs based on the author's estimates. The third trend, increased bioenergy demand, was represented in the GFPM by the rate of growth in fuelwood demand based on IPCC estimates as described in Raunikar et al. (2009).

The fourth trend was implemented in the wood processing component of the GFPM. This trend was investment in improved processing, which was represented in the GFPM by a reduction in input-output factors (wood input required for production) for logs to processed products and a reduction in the cost of manufacture. The former was based on estimates of changes in total factor productivity from North American studies of wood processing (Bernstein 1994, Vahid & Sowlati 2007, Li et al. 2008, Helvoigt & Adams 2009). The latter

was directly described in the GFPM as a reduction in the cost of all other inputs to production, besides raw wood materials, based on estimates for North America from Yin (2000).

The last three trends were implemented in the GFPM wood supply component. The fifth trend was increased profitability of sustainable forest management. This was described by the rate of forest area change and impact of harvesting on forest stock loss. The former was represented in the GFPM using forest area change estimates from the IPCC as described in Raunikar et al. (2009). The latter was described by the forest stock loss associated with a cubic metre harvested based on estimates from a review of reduced impact logging by Boltz et al. (2003).

The sixth trend was expansion of planted forests, which was represented by the rate of forest area change and growth in forest stock based on Food and Agriculture Organization projections of planted forest area (Carle & Holmgren 2008). The final trend was increased demand for ecosystem services. This was described by the expansion of protected forest area and rate of tropical forest conversion to agriculture. The former was represented by a reduction in forest stock available for harvest based on the author's estimates. The latter was represented by an increase in forest area based on data for regional tropical forest area vulnerable to conversion to agriculture (Eliasch 2008, Grieg-Gran 2008, Miles et al. 2008).

It is impossible *a priori* to determine how the seven trends described in the GFPM will interact to impact on the tropical timber trade. This is because the trends directly influence either supply or demand, and in some cases both, and their direction and strength of influence differ among countries. For this reason it is necessary to undertake quantitative modelling to understand how these trends will interact with each other and among countries to influence the future of the tropical timber market.

An important strength of the approach to producing forecasts of the tropical timber market used here is that all the assumptions in the model are explicit. Furthermore, all the projections can be reproduced and the assumptions deemed unrealistic changed. By making the software and the data available it is hoped that many such experiments with alternative scenarios would be conducted. In so doing scientific economic analysis can be merged with the art of scenario planning to arrive at ever more richer and useful projections of the tropical timber market.

4. Future Trends and Drivers in the Tropical Timber Market

The seven key issues in the tropical forestry and timber markets identified from the interviews were; perceptions of tropical timber products, payments for ecosystem services, investment and finance for forest management and processing, the global economic crisis, tropical planted forests, new regional political and trading blocs, and forest governance. The main findings from the STEEP literature review of these are presented here.

Perceptions of tropical timber products

Key trends

Changing perceptions of tropical timber products is apparent in the shift in consumption away from tropical wood products to softwoods and non-tropical hardwoods (see *Historical Trends in the Tropical Timber Market*).

A key trend within this shift is the increasing requirement for confirmation of sustainable forest management (SFM) and chain of custody (CoC), through certification in consumer countries, particularly North America, Europe, and Australasia. Increasingly this is being distilled into an issue of legality through government procurement policies, and bilateral agreements such as Forest Law Enforcement, Governance and Trade and Voluntary Partnership Agreements.

Forest certification offers a mechanism to demonstrate that a forest is well-managed in accordance with social, environmental, cultural, and economic requirements (Abusow 2008). It is a market based mechanism in which an independent certification body provides an assurance to consumers that forest products conform to predetermined criteria of sustainable forest management (Meidinger 1997). For forest owners and managers, certification is a tool for gaining market access and potentially capturing price premiums (Ebaá Atyi & Simula 2002). For governments, certification is a soft policy instrument to promote sustainable forest management and consumption patterns (Bass & Simula 1999; Purbawiyatna & Simula 2008). For consumers, certification provides information about the management of the forests from which timber products have originated (ITTO 2007a).

While the demand for certified products is increasing, in part due to the inclusion of certification requirements in green building schemes and public procurement policy (Simula et al. 2009), it is not expected to take off until there is a sufficient and stable supply available without additional cost (Ekstrom & Goetzl 2007). European consumer reports indicate difficulty in obtaining commercial quantities of certified wood at the right price (de Lange & Janssen 2005).

Linked with increasing requirements for certification is the emergence of public and private procurement policies for tropical timber products (Simula et al. 2009). Some furniture retailers in the UK are gathering background information on product sources to defend any potential negative environmental campaigns against their products (Betser & Oliver 2009). Green procurement has also reached China; with the retail chain B&Q announcing that by 2010 all timber products sold would be from forests certified as sustainably managed (Rubin 2007).

European Union member governments are developing their own public procurement policies with little initial coordination or harmonisation (Oliver 2005). More recently, however, there have been efforts to increase harmonisation. For example, in Europe the CEN Technical Committee 350 on the sustainability of buildings is developing a harmonised framework for product declarations that has potential to contribute to a more consistent approach among

European countries (Simula et al. 2009). Green procurement policies for timber products in public buildings have come into effect in:

i) Germany, where since 2007 timber from credible certification schemes, e.g. FSC or PEFC, can be used (ITTO 2007). Additionally many local governments in Germany are acting on their own initiative to bring about sustainable timber procurement policies (Schwarz et al. 2005)
ii) France, where since 2005 tropical wood should be certified as being from sustainably managed forests (ITTO 2007)
iii) The UK, where central government policy demands 'certified sustainable' status for timber used in public projects (Betser & Oliver 2009)
iv) The Netherlands and Belgium, where CoC certification for tropical timber is favoured (de Lange & Janssen 2005)
v) Japan, where the 'Goho-wood' procurement policy allows individual companies to certify legality on a voluntary basis (JFWIA 2006)

Government procurement policy is increasingly shifting to seeking assurances of legality of timber. ITTO consumer country policies include:

i) The United States Lacey Act 2008 Amendment would extend the Act to imports of wood and wood products harvested from illegal sources (illegality being based on the supplier nation laws). In any prosecution, the burden of proof is on the United States government to demonstrate that the violators should have known of the violation. The amended Act also includes new import declaration requirements which have implications for tropical timber suppliers to the US market (Simula et al. 2009).
ii) Norway has already banned the use of all tropical timber in public building projects (Mongabay 2007; Simula et al. 2009).
iii) Listing on CITES. Certain species of timber, such as mahogany, have had a significant reduction in demand after being listed on CITES (Ekstrom & Goetzl 2007).
iv) The EU is planning to adopt a 'due diligence regulation' to address illegal logging at the global level. This measure is in addition to existing measures as not all tropical producer countries would find it feasible to sign a VPA. The regulation would require operators to apply due diligence to minimize the risk of illegally harvested timber and products entering the EU market (Europa 2008; ITTO 2009; Simula et al. 2009)..

Market demand for legal and sustainable tropical timber trade is expected to increase in the future. This is in part because of the introduction of "hard" regulatory instruments such as the United States Lacey Act Amendment and the planned EU due diligence regulation. These regulatory approaches could impact on tropical timber market share, particularly for exporters from Africa and Latin America who are more reliant on these markets (Simula et al. 2009).

Drivers of trends

There are a variety of drivers of substitution of tropical timber products by non-tropical timber as well as non-wood products. These drivers include:

i) Lack of regularity and reliability of supply of tropical timber (Bolton & Cooper 2001). For example, restrictions on availability of tropical timber due to non-certification and non-tariff barriers.
ii) Tropical timber product price relative to substitute non-tropical timber products (Uusivuori & Kuuluvainen 2001; Fischer & Helles 2005). Substitutability is more sensitive to changes in tropical prices than non-tropical prices and increases with the level of processing (Fischer & Helles 2005)
iii) Price volatility associated with tropical timber products, particularly plywood.
iv) Improvements in wood processing technology. This has been particularly apparent in the Japanese plywood market, where improvements in veneer manufacture are enabling the use of smaller-diameter softwood logs in place of hardwood logs, and imported softwood plywood is replacing tropical plywood imports (ITTO 2007).
v) Fashion and preference for alternative non-wood materials (such as metals, glass and polyvinyl chloride (PVC)). This has been occurring for over a decade in Western markets. For example, some substitutes for tropical timbers such as French oak have not performed as expected, particularly in durability and hardness in window markets,

leading to an increase in PVC windows. Substitution to non-wood products is also occurring in developing countries, e.g. Ghana in the housing and furnishing sectors (ITTO 2007)

The increasing requirement for certified timber products has been driven by:

i) Environmental NGO pressure culminating around 2001 to 2003 in anti-tropical timber campaigns. This led several governments to increase environmental requirements for timber used in public projects (Roda et al. 2007)
ii) Government support and policies for green procurement using certification schemes as a means of demonstrating compliance (Simula et al. 2009)
iii) Consumer awareness and demand for eco-labelling of products (Merry & Carter 1997; Oliver 2005; Deury 2006)
iv) Demand generated at the corporate level for sustainable procurement (FAO 2001)
v) A way of bringing brand differentiation to a company (Owari & Swanobori 2007).
vi) Forest industry lobby groups seeking to protect their (often softwood) certified domestic timber markets (Oliver 2005)

There is less pressure from consumers and NGOs on timber importers than on retailers to supply certified finished goods, which may explain the low demand from importers for certified timber (Deury 2006).

Uncertainties

The future of tropical timber products in markets demanding SFM and legality is unclear. Firstly, it is not certain the extent to which tropical producer countries will be able to meet certification requirements due to weaker forest governance, the scale of processing necessary to support CoC, costs of monitoring and verification, and the benefits of improved market access and price premiums potentially not offsetting these costs.

ITTO consumer countries are able to comply more readily with the requirements of certification due to national forest policies more closely aligned to certification requirements and a strong capacity to implement SFM (Durst et al. 2006). The share of certified forests in tropical regions, however, is less than 5% (Purbawiyatna & Simula 2008) due to:

i) Lack of resources, systems, skills, and processes to implement and audit certification schemes (Leslie 2004; Purbawiyatna & Simula 2008)
ii) The structural complexity and biodiversity present in wet tropical forests, which makes monitoring much more demanding and costly (Leslie 2004; Fischer 2005; Purbawiyatna & Simula 2008)
iii) Though tracking logs and monitoring harvested areas and deforestation rates is not without considerable challenges, increased access to information, transparency and empowerment leads to a greater ability to hold governments accountable. For example, the Republic of Congo has improved its capacity to monitor logging activities to provide greater transparency and better governance. This in turn enhances the confidence of wood product consumers (Mertens & Méthot 2008).
iv) Most of the wood products from tropical producer countries are sold domestically, not on international markets (Leslie 2004)
v) Lack of direct (particularly financial) rather than indirect benefits, and customer focus on product quality over environmental issues (Ratnasingam et al. 2008)
vi) A misunderstanding of the necessity of forest certification for market access. For example, a study of Malaysian furniture manufacturers (Ratnasingam et al. 2008) found little readiness to adopt certification schemes, as producers believed that by using plantation rubberwood this negated any need for certification.
vii) The waning influence of the traditional consumer countries on producer countries:
    a. Europe represents a small and decreasing proportion of tropical wood product consumption (less than 1% of tropical sawnwood and less than 6% of tropical plywood)
    b. The BRIC nations account for 45% to 50% of the tropical timber trade, and their demand and influence on producing nations is growing in importance (Roda et al. 2007).

viii) Requirements for certification are likely to impact most on African countries due to the anticipated demand for certified timber in Europe; a major market for Africa (Pedersen & Desclos 2005). Africa has just 0.6% of its forests certified (Purbawiyatna & Simula 2008).

Secondly, it is uncertain that consumer's of tropical timber products are able to disentangle "tropical" and "illegal" and accept certification of SFM and legality, due to the variety of schemes and complexity of the underlying issues. As a result consumer perceptions of certified forest products vary by product and country:

i) Consumers tend to focus on product quality over environmental issues (Basu et al. 2003).
ii) The perception of requirements for certification is dependent on the end uses of the timber. CoC certification is more widely used in verifying solid wood products, rather than in mechanically processed pulp and paper products (Pederson & Desclos 2005).
iii) NGOs and consumers express concern regarding the source and legality of garden and outdoor products but not when purchasing tropical timber mouldings (Betser & Oliver 2009).
iv) Consumers find the variety of certification schemes confusing, being more concerned with being able to identify a certification logo on products than in understanding what such a logo means (Duery 2006).
v) There are also confusing messages from NGOs and importers around the distinction of 'legality' versus 'sustainability' in the consumer marketplace.
vi) The level of acceptance and criteria for assessment used by certification schemes are not always transparent, nor are the sustainability provisions of various schemes 'comparable' (Purbawiyatna & Simula 2008).
vii) Demand for certified forest products is low in Japan (Owari & Swanobori 2007) and the European Union, except in the UK and Germany (Basu et al. 2003).

The five main certification schemes (FSC, LEI, MTCC, PEFC and CERFLOR) have developed to the point where the global marketplace strongly desires harmonisation of the processes and assessment criteria (Simula et al. 2009). Some harmonisation is already occurring. For example, many green building schemes and public procurement policies rely on forest certification schemes as a means of demonstrating compliance. Policies and standards do, however, appear to differ in acceptance of individual certification schemes though most country timber procurement policies recognize both FSC and PEFC certification (Simula et al. 2009).

The route by which further harmonisation might be achieved includes international standards (this is the preferred approach by FSC), mutual recognition or equivalence (this is preferred by PEFC), regional or international cooperation (e.g. ASEAN), bottom-up standards harmonisation, or unilateral recognition (Purbawiyatna & Simula 2008). However, challenges to harmonisation remain. PEFC has been subject to intensive criticism by NGOs in the UK for failing to provide a proof of both legality and sustainability. Recent revisions to the PEFC rules to also cover sustainability have increased its acceptance though. Despite this, FSC-supporting NGOs continue pursuing the acceptability of FSC only, in for example Denmark and the Netherlands (Simula et al. 2009).

There is also consumer confusion around concepts of "illegal" for tropical wood products. This is for two reasons. Firstly, the lack of international agreement on what 'illegal' timber is (Turner et al. 2008). Many emerging economies are still to adequately define what 'legal' timber means in terms of their national laws (e.g. Viet Nam) (IUCN 2009). There is also a lack of agreement around certification schemes' 'comparability' or 'alternative acceptability' status (Purawiyatna & Simula, 2008). Secondly, the challenges of proving the legality of a product sourced from many differing products and CoC, e.g. interior furniture products entering European markets (Betser & Oliver 2009). Another example is plywood from China which uses different face and core products, with the original source of face materials used in China largely unknown (Betser & Oliver 2009).

Multiple values from tropical forests

Forest lands have potential to increase their value through (Poore 2004):

i) conversion to agriculture, including bioenergy (ITTO 2008)
ii) the sale of valuable timber products produced through sustainable forest management
iii) forest conservation by sustaining and marketing ecosystem services.

Forests in several ITTO consumer (e.g. New Zealand) and producer (e.g. Brazil, Indonesia) countries continue to be converted to agriculture, in part due to relatively higher economic returns for land in agriculture (Barbier et al. 1994; Desjardins et al. 2004; Poore 2004; Smith & Horgan 2006; Grieg-Gran 2008; Eliash 2008; Table 4.1).

Forests are, however, important providers of ecosystem services; the benefits that people obtain from forest ecosystems. These benefits may be environmental, social, or economic. Examples of environmental outcomes include the protection of streams, reduced stormwater runoff, and increased carbon sequestration.

Table 4.1 Examples of land use returns (net present value in 2007 $ at a 10% discount rate over 30 years). Source: Grieg-Gran (2008)

Country	Land use	Returns ($/ha
Brazil	Soybeans	3,275
	Beef cattle (medium/ large scale)	413
	One-off timber harvesting	251
	Beef cattle (small scale)	3
Indonesia	Large scale oil palm	3,340
	One-off timber harvesting	1,099
	Smallholder rubber	72
	Rice fallow	28
Cameroon	Cocoa with marketed fruit	1,448
	Annual food crop, short fallow	821
	Annual food crop, long fallow	367

Among the major types of ecosystems in the world, forests provide the greatest number of ecosystem services (Costanza et al. 1997; MEA 2003; Pagiola et al. 2004):

i) more than 80% of many groups of plants and animals are found in tropical forests (CIFOR/Government of Indonesia/UNESCO 1999).
ii) economically valuable forest ecosystem services include watershed protection, biodiversity regulation (Higman et al. 2005), carbon storage and sequestration (Eliasch 2008), maintenance of water quality, and improved air quality (Pattanayak 2004; Bruijnzeel 2004; Tomich et al. 2004; Powell et al. 2002).
iii) the annual per hectare value of ecosystem services provided by tropical forests ($2,007 per ha) is estimated to be more than six times higher than that of temperate or boreal forests ($320 per ha) (Costanza et al. 1997).

This indicates that exclusion of ecosystem service values in the tropical timber trade could result in tropical forests being undervalued as the value of forest land fails to reflect additional benefits from forests (Seri 2002; Tomich et al. 2004; Eliasch 2008). Ecosystem services are seen as an emerging economic sector of importance to ITTO tropical producer countries, potentially offsetting the decline in primary tropical timber product revenues (ENS 2003).

To address this issue market-based mechanisms for capturing ecosystem services values are increasingly being explored. These approaches can remedy this type of market failure by providing powerful incentives and efficient means of conserving forests and the public goods they provide (Pagiola et al. 2002). Through effective market based mechanisms (e.g. forest certification, carbon trading, biodiversity offsets, etc.) sustainable forest management could ensure forest lands earn additional revenue, which serves as an alternative to forest conversion (ITTO 2007b).

Although it is recognised that forest ecosystem services are valuable economically (Costanza et al. 1998; Johnson et al. 2001; Leslie 2005; ITTO 2007b; Eliasch 2008), landowners are rarely paid for these services (Tomich et al. 2004; ITTO 2007b). As a result, land use changes are driven by fiscal returns from timber or agriculture, rather than environmental forest functions such as carbon sequestration (Contreras-Hermosilla 2000). The market (timber, nuts and honey) and non-market (landscape values, erosion control, etc.) benefits of forests should be accounted for (Higman et al. 2005).

Key trends

Ecosystem services still do not have well established markets, though development of markets is underway (Pagiola et al. 2002a). Already payments for ecosystem services through market-based mechanisms such as voluntary carbon markets, Clean Development Mechanism (CDM), conservation offsets, etc. are emerging and growing (Broadhead 2009).

Markets for ecosystem services are expected to grow in both developed and developing countries over the next three decades (Scherr et al. 2004; Leslie 2005; Mulder 2007; Table 4.2 and Table 4.3), with estimates of potential market size ranging from US$35 million to US$10 billion per year by 2010 (Mulder 2007). There are market opportunities for biodiversity offsets, carbon, watershed protection, non-timber forest products, bioenergy, and payment for other environmental services.

Table 4.2 Estimated future demand for environmental services (US$ billion) of forests to the year 2040 based on scenario building. Adapted from Leslie (2005)

Category	2010	2020	2030	2040
Watersheds	50	80	140	200
Recreation	100	110	120	140
Biodiversity	250	350	500	700
Climatic	500	700	1,000	1,300
Miscellaneous	150	180	200	220
Total	1,050	1,420	1,960	2,600

Table 4.3 Summary of direct and indirect markets for ecosystem services and potential growth. Adapted from Mulder (2007)

Ecosystem market	Current size (US$ per year)	Potential size (US$ per year) 2010	2050
Carbon sequestration through forestry	$100 million (much of this in developing countries)	$1,500 million (if EU ETS allows sinks)	$6,000 million
Certified products (timber and NTFPs)	$5,000 million (FSC)	$15,000 million	$50,000 million
Government payments for water-related ecosystem services	Mexico PES $15 million; Costa Rica PES $5 million; China state PES $1 billion	$3,000 million	$20,000 million
Private watershed management payments	$5 million	$50 million	$10,000 million
Bioprospecting	$17.5 – 30 million	$35 million	>$500 million
Voluntary biodiversity offsets	$20 million	$25 million	$150 million (if corporations adopt)
Government biodiversity offsets	$3,000 million	$4,000 million	$10,000 million

In the case of tropical forests, ecosystem services are recognised as important; however, selling ecosystem services is at present difficult (Nasi et al. 2002). Ecosystem services from tropical forests over the next decade are expected to increase in importance and value,

relative to “classical” forest products such as tropical hardwoods (Nasi et al. 2002; Leslie 2005; Scherr et al. 2004). By 2020 the estimated value of payments for ecosystem services could be US$1,420 billion (Leslie 2005; Table 4.2) compared with an estimated value of total forest products consumption of US$824 billion (Turner et al. 2006).

Drivers of trends

Demand-side drivers – In establishing market-based mechanisms, it is important to begin from the demand side, which is influenced by factors such as the desire of companies or governments to be green in response to criticisms from NGOs. For example:

i) Cerveceria Costa Rica signed a watershed protection contract with National Forestry Financing Fund. FONAFIFO implemented Costa Rica’s Environmental Services Payment Program (ESPP) for the benefit of small and medium producers whose properties have forests or are suitable for forestry activities, with the aim of promoting the conservation and recovery of the country's forest cover.
ii) Merrill Lynch, now owned by Bank of America, invested US$9 million in Sumatran rainforest conservation, with the goal of eventually selling carbon credits.
iii) Canopy Capital investment in Guyana will fund a “significant” part of the US$1.2 million conservation budget of the Iwokrama Forest Reserve (Ellison 2009).
iv) The Mexican Government established the US$20 million Mexican Forestry Fund to pay indigenous and other communities for forest ecosystem services produced by their land. This fund pays US$40 per ha per year to owners of forests in critical mountain areas and US$30 per ha per year to other forest types (Scherr et al. 2004).

Supply-side drivers – Desire of landowners, planners and land users to earn more income from forest management activities (e.g. the value of carbon sequestered in forests). Large forestry companies are aware of the potential carbon value of the forests they manage. Small forest companies are less well informed; therefore developing market based mechanisms usually comes from NGOs working on their behalf (Scherr et al. 2004).

Regulatory drivers – If market-based mechanisms do not emerge, government regulation may be put in place. This should, however, be accompanied by complementary market-based mechanisms to reduce the costs of compliance (Pagiola et al. 2002a; Scherr et al. 2004).

Intermediaries and ancillary service providers – In the carbon market, ancillary providers such as insurers and certifiers have taken on a catalytic role, pushing for increased use of flexibility mechanisms which they expect to generate more business. Similarly, wetland banks in the United States pushed for flexibility in meeting mitigation goals.

Uncertainties

The extent to which the predicted value of payments for ecosystem services is actually realised is uncertain. While the carbon market is potentially the largest ecosystem service market (Table 4.3) and is already quite sizeable, future growth of the market will depend on still unpredictable international rules of climate change mitigation (Scherr et al. 2004). This is reflected in the fact that large scale investment in ecosystem service provision from tropical forests, particularly carbon, has not been realised to date.

Key barriers to the establishment of profitable markets for tropical forest ecosystem services include (Mulder et al. 2006; Beder 2009; Robledo & Ma 2009):

i) Lack of evidence of financial benefits provided by ecosystems
ii) Lack of awareness of some key ecosystem benefits which leads to low investment
iii) Insecure land tenure and weak governance structures which hampers the involvement of important groups of people who live in natural areas and increases investment risks
iv) Challenges in bundling multiple ecosystem services

v) Differences in understanding of the meaning and content of payment for ecosystem services. For example, requirements for quantification of carbon potential are highly complex, require a high level of expertise and significant amounts of data that are often not available
vi) The requirement of permanence for carbon schemes
vii) The high costs of monitoring and validation

A key challenge is to establish a functioning international Reducing Emissions from Deforestation and Degradation (REDD) finance mechanism that can be included in an agreed post-2012 global climate change framework. Progress has been made and the need to meet the challenge is now reflected in the Bali Action Plan and the COP13 Decision 2/CP.13. A decision on inclusion of REDD in any follow-on to the Kyoto Protocol is scheduled for December 2009 at the COP15 meeting in Copenhagen. If REDD is included, emissions reductions of up to 34 million t per year are expected. In anticipation of this inclusion, a number of countries in Southeast Asia are 'gearing up' to become REDD ready (Broadhead 2009).

REDD faces a number of challenges, though, including (Peskett et al. 2008):

i) The definition of baseline deforestation rates is problematic (Broadhead 2009). A potential approach is an average historical deforestation rate assumed to continue into the future. REDD therefore potentially rewards past bad behaviour. Countries like India and Costa Rica which now have very low or even negative deforestation rates (FAO 2005) would have little carbon-based incentive to keep their forests.
ii) The highest deforestation rates tend to be in countries with weaker forest governance (Anderson 2000; World Bank 2000; Mickelwait, et. al. 1999; Morfit 1998), requiring high levels of political will and sustained donor support to deliver the necessary policy, governance and tenure reforms for REDD to work (Eliasch 2008; Hardcastle & Baird 2008).
iii) Government actions may have little effect on deforestation rates since 'extra-sectoral' factors like agricultural commodity prices (e.g. due to the biofuels boom) are a driver of deforestation (Contreras-Hermosilla 2000; Figure 4.1).

Another key uncertainty to earning revenue from forest ecosystem services is the extent to which the revenue generated by establishing markets for these services exceeds the total market costs, and that the "profit" is channelled equitably to the land stewards (Katila & Puustjarvi 2004). Developing new markets and market-based instruments that add financial value to forests is complex. Interested parties must be identified and they must adopt precise roles in transactions. These transactions must be developed by negotiation and supported by rules, contracts and methods of verification (Powell et al. 2002).

A new global economy from the global economic crisis

Key trends

The world economy was predicted to contract 1.7% in 2009 (World Bank 2009a; Table 4.4). The largest reduction in economic growth was predicted to occur in the high-income economies (growth 2.8 percentage points lower than previous forecasts), other Europe and Central Asia (4.8 percentage points lower), and Latin America (2.8 percentage points lower) (World Bank 2009a). While global economic growth is forecast to recover to 2.3% in 2010, this will remain lower than previously forecast and there is considerable uncertainty surrounding this forecast (World Bank 2009a,b) and time to economic recovery (IMF 2009).

Table 4.4 Global economic growth forecasts (real GDP growth % per year). Source: World Bank 2009a

Region	2008	2009	2010
World	**1.9**	**-1.7**	**2.3**
World (PPP weights)	3.1	-0.6	2.9
High-income	**0.8**	**-2.9**	**1.6**
OECD	0.7	-3.0	1.5
Euro area	0.7	-2.7	0.9
Japan	-0.7	-5.3	1.5
United States	1.1	-2.4	2.0
Non-OECD	2.8	-2.0	2.9
Developing	**5.8**	**2.1**	**4.4**
East Asia & Pacific	8.0	5.3	6.6
China	9.0	6.5	7.5
Indonesia	6.1	3.4	5.4
Thailand	2.7	-2.0	1.7
Europe & Central Asia	4.2	-2.0	1.5
Russia	5.6	-4.5	0.0
Turkey	1.5	-2.0	1.5
Poland	4.8	0.5	2.8
Latin America	4.3	-0.6	2.2
Brazil	5.1	-.5	3.2
Mexico	1.4	-2.0	1.8
Argentina	6.8	-1.8	1.9
Middle East/ North Africa	5.5	3.3	4.3
Egypt	7.2	4.0	4.8
Iran	5.2	3.0	4.0
Algeria	3.2	2.2	3.5
South Asia	5.6	3.7	6.2
India	5.5	4.0	7.0
Pakistan	5.8	1.0	2.5
Bangladesh	6.2	4.5	4.0
Sub-Saharan Africa	4.9	2.4	4.1
South Africa	3.1	1.0	3.1
Nigeria	6.1	2.9	4.2
Kenya	2.4	2.0	3.4
Developing excl China & India	4.6	0.0	2.6

PPP – purchasing power parity

Global trade was predicted to fall between 6.8% to 9.0%; the first decline since 1982 and the steepest since World War II (Elliot 2009, World Bank 2009a,b). Exports by Japan in February 2009 were 50% lower than in February 2008, while those of China were down 26% lower.

The predicted near-term impacts of the global economic crisis include:

i) emerging economies have had difficulty accessing capital, a key source of growth of the past five years, as domestic stimulus packages compete for global finance (Elliot & Gumbel 2009). Net private-sector capital flows to emerging markets were predicted to drop 80% from US$929 billion in 2007 to US$165 billion in 2009 (IIF 2009). The International Monetary Fund (IMF) is attempting to redress some of this decline (Anon 2009b)

ii) foreign direct investment is more stable, but is still forecast to decline to US$197 billion from $263 billion in 2008, with especially large declines in foreign direct investment (FDI) from China, Brazil, and India to mature economies (IIF 2009). FDI in Vietnam was 40% lower in the first quarter of 2009 than it was a year earlier (Anon 2009a)

iii) reduction in exports by emerging economies as imports by developed countries fall (World Bank 2009)

iv) increased competition for export markets. For example, Malaysian tropical timber exporters are already looking to new markets as exports fall to a 28-year low (ITTO

2009a). Peruvian exporters are shifting trade to domestic and non-traditional exports markets (ITTO 2009b) after a 50% drop in the value of wood exports in January-February 2009 compared with the previous year (ITTO 2009c)

v) an end to the recent commodity price boom, which was the largest since 1900. Commodity (including oil) prices halved since July 2008 (World Bank 2009). In the longer term agricultural commodity prices are forecast to decline 0.7% per year to 2030 (World Bank 2009a).

vi) increased unemployment, particularly in emerging country export sectors such as electronics, garments and textiles. In Cambodia, 17% of the garment workforce has been laid off since September. In Viet Nam, 100,000 garment workers were laid off in January and February (Anon 2009a)

vii) a return of some of the 200 million global migrant workers to their homelands, due to job loss or tighter immigration policies (Schuman 2009b). This could place increased stress on the welfare systems in the countries they are returning to

viii) a 5% reduction in remittances from overseas workers to the developing world from US$305.3 billion in 2008 to a forecast US$290 billion in 2009 (Elliot & Gumbel 2009; Schuman 2009b). The largest decline is expected to be in remittances to Europe and Central Asia (Ratha & Mohapatra 2009)

East Asia is potentially well placed to recover from the global economic crisis. After the financial crisis of 1997, countries in the region increased their foreign reserves. China has increased its reserves from US$150 billion a decade ago to nearly US$2 trillion today (Anon 2009b). Countries have also reduced government debt and strengthened bank regulation (Anon 2009b). However, some economies were predicted to contract; Malaysia and Cambodia by 1.0% and Thailand by 2.7% (Anon 2009c).

The impact of the global economic crisis on the Democratic Republic of Congo is an example of the potential implications of the crisis for developing countries dependent on natural resource exports (Anon 2009c):

i) potential halving of cobalt exports, leading to 300 000 miners laid off
ii) potential two-third reduction in FDI
iii) slowing of economic growth from 8% per year to 3% per year
iv) reduction in value of currency by more than a third
v) lack of funds to run the government, including paying teachers and military. This has raised concerns about political stability
vi) US$9 billion in aid from China for mining and infrastructure projects still to go ahead though.

The potential impact of the global economic crisis on China is of considerable importance given the growing dependence on China of some emerging economies (see *New political and trading regions* below) (Thompson 2009):

i) China was forecast to experience economic growth of 6.5% (Table 4.4, World Bank 2009a)
ii) rising unemployment; 60 000 enterprises closed in Guangdong Province in 2008, and 10 million migrant workers became unemployed (Schuman 2009a)
iii) rising inflation, particularly in food prices.

The Chinese government's response to these impacts was a US$565 billion stimulus package intended to maintain employment and tackle key domestic challenges such as improving health care (Thompson 2009).

Trade becomes controversial at times of economic crisis because, while its benefits are widely spread and difficult to measure, its costs are concentrated and often easy to see (Elliot 2009). This can lead to beggar-thy-neighbour policies, as occurred in the United States with the Smoot-Hawley tariffs during the Great Depression, and subsequent country retaliations (Elliot & Gumbel 2009). Since the economic crisis began 17 of the G-20 nations have implemented 47 measures that restrict trade at the expense of other countries, though these measures may not be a direct response to the crisis (Gamberoni & Newfarmer 2009). Trade measures adopted since the economic crisis began include (Gamberoni & Newfarmer 2009; Elliot 2009):

i) Ecuador raised tariffs on more than 600 items

ii) Argentina imposed new licensing arrangements for imports
iii) the European Union announced export subsidies on butter, cheese, and milk powder
iv) 13 countries granted subsidies to their automobile industries
v) the United States stopped a programme allowing Mexican trucks on US roads
vi) Mexico retaliated with tariff increases on imported United States goods
vii) after a period of slowdown, antidumping cases grew 15% from 2007 to 2008
viii) 11% to 13% rebates to exporters of furniture in China, and a proposal to do similar in Malaysia (ITTO 2009d).

Overall developed countries appear to be relying on subsidies, while developing countries are applying a variety of forms of protection (subsidies, import duties, non-tariff measures, and import bans) (Gamberoni & Newfarmer 2009).

Also emerging is financial protectionism as scarce capital is channelled into domestic stimulus packages (Elliot & Gumbel 2009) and politicians demand that taxpayers' money going to banks be lent domestically (Anon 2009e). The United States, the European Union members, China, Malaysia, Republic of Korea and others, have announced substantial stimulus packages, including spending on infrastructure (Anon 2009a). This would increase emerging countries' reliance on international donors to offset reduced FDI and export earnings (Anon 2009f). For example, Viet Nam is hoping to attract US$15 billion of investment to develop bauxite mining and aluminium refining projects by 2025 (Anon 2009a).

There is also the possibility of increasing protectionism against the international movement of people (Schuman 2009b):

i) 60 000 visas issued to Bangladeshis to work in Malaysia were revoked in mid-March
ii) Banks receiving bailouts from the United States government had restrictions on the hiring of foreign workers placed on them
iii) the United Kingdom raised education and salary standards for skilled professionals moving to there from outside of the European Union
iv) a 50% increase in the levy for foreign workers in Malaysia, which could adversely affect the Malaysian furniture industry (ITTO 2009e).

Drivers of trends

The immediate causes of the slowing in growth and trade were reduced household spending in the developed economies, due to uncertainty around employment and loss of wealth tied up in the stock market and homes, and reduced capital supply by banks (Elliot 2009).

A broader, underlying cause of the slowing was the global imbalance between debtor and creditor nations that developed over the last 20 years as the United States increased debt and China developed savings (Aziz & Dunaway 2007; Elliot & Gumbel 2009). The contribution of net-exports to China's growth has increased significantly, reflected in the increase in trade surplus as a share of GDP from 3% in 2000 to 8% in 2006 (Cui 2007).This has been compounded by the increasing domestic content of China's exports (Cui 2007).

Uncertainties

A key uncertainty around the economic crisis is how long the period of low economic growth will be. The effects of the economic downturn will potentially be felt for a long period after the recession is over (IMF 2009; Anon 2009g,h). Reductions in country output associated with recessions due to banking crises, such as has occurred with the global economic crisis, tend to be deeper and longer. Seven years after a typical banking crises output per capita is 10% lower on average than it would have been in the absence of a banking crisis. This prolonged reduction in output is due to the longer run effects of responses by firms to the crisis. For example, reduced overall investment in the business, lower spending on research and development, and workers decline in skills while out of work (IMF 2009; Anon 2009g,h).

How prolonged the period of low economic growth following the crisis is, influences the extent to which increased trade and financial protectionism occurs. Historically the use of non-tariff barriers to restrict trade has been rising (NZFRI 1999; Eastin & Fukuda 2001). This trend could accelerate under the global economic crisis if manufacturing employment declines and pressure on governments to protect domestic manufacturing rises (Cohen et al. 2003).

A final uncertainty is whether or not an alternative model for growth may be sought by the Asian economies, including:

i) more intensive programmes of rural development, e.g. land reform and rural infrastructure (Schuman 2009a).
ii) a shift away from savings to stimulating domestic demand, e.g. China, by (Aziz & Dunaway 2007):
    a. increasing the cost of capital by raising interest rates and allowing exchange rates to appreciate
    b. liberalising prices to reflect actual supply and demand conditions
    c. reforming financial markets to enable easier access of companies to capital, rather than relying on their own high savings
    d. shifting government expenditures to provision of key social services, so that families are not so dependent on their own savings as a form of self insurance to cover costs such as health care, retirement, etc.

China has come to be an important source of FDI in Asia as well as the largest export market for a number of Asian countries, particularly in intermediate products, which account for three-fifths of the increase in trade within Asia (Cui 2007). A structural change in the Chinese economy away from export-led growth to domestic-led growth could have important implications for trade within Asia (Cui 2007):

i) a decline in intra-regional trade of intermediate products, or trade overall if China fails to boost domestic consumption
ii) an increase in imports of higher-technology goods that China is unlikely to produce domestically
iii) a shift in production of labour-intensive goods such as toys, furniture, etc. away from China to lower-income countries as China's comparative advantage changes with rising labour costs.

New types of forestry in the tropics

Countries with large productive plantations include China (28.5 million ha); the United States (17 million ha) and Russia (12 million ha). Tropical countries with large productive plantations include Brazil (5.4 million ha); Sudan (4.7 million ha) and Indonesia (3.4 million ha) (FAO 2005; Table 4.5). Establishment of plantations has been rapid in West Africa (Côte d'Ivoire, Ghana, Nigeria, Benin, and Togo).

Major plantation species in the tropics include eucalypts (24%), acacias, poplars, teak, pine and rubberwood. Teak production is expanding rapidly and is expected to rise from 4 million m^3 per year in 1999 to more than 20 million m^3 by 2020 (Behaghel 1999). The traditional teak supply base has broadened to include small-diameter logs from Africa (mainly Côte d'Ivoire) and Latin America (Maldonado & Louppe 2000).

Wood from planted forests are utilised for timber, fuelwood, fibre for pulp and bioenergy, carbon sequestration, and environmental protection (FAO 2005; ITTO 2007d). Most plantation grown wood is consumed in the manufacture of wood pulp, particularly in Asia & Pacific and Latin America, followed by fibre-based products such as particleboard and fibreboard, and then sawnwood manufacture (Tomaselli 2007; Table 4.6).

Table 4.5 Plantation forest area and potential roundwood production for ITTO member countries. Source: [1] FAO (2005); [2] Cubbage et al. (2007) (medium growth scenario)

	Established plantation area* (000 ha)[1]			Potential roundwood production from plantations by 2020 (000 m^3)[2]	
REGION	1990	2000	2005	Industrial	Fuelwood
AFRICA					
Dem. Rep. of Congo	0	0	0		
Central African Republic	2	4	5		
Cameroon	0	0	0		
Rep. of Congo	51	51	51		
Côte D'Ivoire	154	261	337		
Gabon	36	36	36		
Ghana	50	60	160		
Liberia	8	8	8		
Nigeria	251	316	349		
Togo	24	34	38		
Egypt	44	59	67		
ASIA					
China	18,466	23,924	31,369	121,806	27,225
Japan	10,287	10,331	10,321	37,784	0
Nepal	49	52	53		
Korea	748	1,188	1,364	10,480	4,079
Cambodia	67	72	59		
India	1,954	2,805	3,545	26,789	84,057
Indonesia	2,209	3,002	3,399	16,228	4,518
Malaysia	1,956	1,659	1,573	923	495
Myanmar	394	696	849	243	678
Philippines	1,780	852	620	658	892
Thailand	2,640	3,077	3,099	1,654	1,974
EUROPE					
Austria	988	1,003			
Belgium/Luxembourg	331	312	303	2,386	0
Denmark	291	305	315	2,611	0
Finland	0	0	0		
France	1,842	1,936	1,968	9,240	0
Germany	0	0	0		
Greece	118	129	134		
Ireland	350	519	0	3,693	0
Italy	289	144	146	1,485	0
Netherlands	4	4	4	990	0
Poland	32	32	32		
Portugal	550	1,034	1,234	11,444	0
Spain	1,126	1,356	1,471	15,148	0
Sweden	523	619	667	402	0
United Kingdom	1,877	1,934	1,924	12,060	0
Switzerland	3	4	4		
Norway	222	255	262	450	0
LATIN AMERICA					
Bolivia	20	20	20		
Brazil	5,070	5,279	5,384	36,914	22,788
Colombia	136	254	328	828	719
Ecuador	0	162	164	692	160
Guatemala	32	88	122		
Guyana	0	0	0		
Honduras	31	26	30		
Panama	10	42	61		
Peru	263	715	754	742	2,061
Venezuela	0	0	0	3,874	924
Trinidad and Tobago	15	15	15		
Suriname	7	7	7		
OCEANIA					
Australia	1,023	1,485	1,766	15,606	0
New Zealand	1,261	1,769	1,852	35,588	0
PNG	63	82	92		
Fiji	80	101	101		
Vanuatu	0	0	0		
NORTH AMERICA					
USA	10,305	16,274	17,061	176,787	0
Canada	0	0	0		
Mexico	0	1,058	1,058		

** Includes productive and protected plantations in both forested and other wooded land*

Table 4.6 Proportion of planted forest wood consumed in different end uses, by region, in 2004. Source: ITTO (2007d)

Region	Sawnwood	Hardboard	Plywood	Particleboard	MDF	Wood pulp
Asia-Pacific	29%	5%	7%	2%	2%	55%
Africa	74%	3%	0%	7%	0%	16%
Latin America	30%	3%	8%	4%	1%	54%

Key trends

Planted forests are increasing their contribution to global timber supply. The bulk of tropical forest plantations are in the Asia & Pacific region (80%), followed by Latin America (13%), and 7% in Africa (Tomaselli 2007; Table 4.5). China increased its plantation forest area one and a half fold during 2001 to 2003, driven by growth in import demand for timber, which grew three-fold due to its increasing population and domestic demand, increasing demand for low-cost timber for manufacture of exports of finished timber product, and moving from straw-based pulp and paper products to wood-based products (Sun 2004; Leslie 2009). Planted forest area is projected to increase most rapidly in tropical regions (ITTO 2007d).

Currently most planted forests are young with over half less than 15 years old (Varmola 2005). However, it is estimated that by 2030, 60-80% of the world's industrial roundwood supply will be from plantations, with an increasing proportion of industrial roundwood harvested from tropical plantations (Carle & Holmgren 2008). While the total wood volume from plantations is expected to increase from 1.4 billion m^3 in 2005, to an average of 1.7 billion m^3 by 2030 (Carle & Holmgren 2008), there will be a lesser proportion of fuelwood and bioenergy, and greater proportion of pulp and wood products from plantations (Table 4.7).

Approximately 10% of global plantation forest harvests are used for bioenergy (Carle & Holmgren 2008). There is a predicted growth in demand for biomass, which is likely to come from plantation residues as well as dedicated plantation crops. If new policies are adopted that stimulate biofuel production global land use for biofuels may increase from 14 million to 49 million ha by 2030 (Contreras-Hermosilla et al. 2007). Unlike pulpwood and sawnwood, this biomass is likely to be domestically processed.

Table 4.7 Predicted wood supply from plantation forests by use, 2005 and 2030, for business as usual scenario (million m^3 per year). Source: Carle & Holmgren (2008)

	Fuel & bioenergy		Pulp & fibre		Wood products	
	2005	2030	2005	2030	2005	2030
Africa	11	10	9	15	55	56
Asia	79	88	141	146	264	321
North & Central Europe	17	18	123	129	166	185
Southern Europe	3	6	26	55	26	56
North & Central America	7	8	98	117	24	31
South America	19	23	133	173	91	115
Oceania	1	1	11	13	31	36

Drivers of trends

The expansion of planted forest area and wood supply from planted forests has been driven by a number of factors. Key is the greater economic returns from planted compared with natural forests. This is especially the case in the tropics due to higher growth rates, lower labour costs, expansion of pulp and paper mill capacity, and increased demand for timber in

these regions (Cossalter & Pye-Smith 2003; Bael & Sedjo 2006). Rates of return in the Americas were estimated to be higher for exotic planted forests compared with native forests (Cubbage et al. 2007). Native forest plantations in South America had internal rates of return of 5-13% compared with returns of 9-18% for pines, and up to 20% for eucalypts.

Incentives for forest plantation establishment include direct incentives (such as cost sharing, subsidised credit, insurance, loan guarantees and land tenure) and indirect incentives (such as market development, extension and education programmes, and research) (Williams 2001). For example, Brazil and Malaysia have historically provided strong incentives for encouraging forest plantation development, and forest-based industries have developed from these (Tomaselli 2007). Overall though, government subsidies to encourage planting are in decline globally, and are predicted to continue reducing, due to the high levels of planting by private commercial interests (Sedjo 1999).

Increased planted forest establishment is also occurring where agricultural expansion and the resulting loss of natural forests reduces timber supply. Where a growing population increases demand for timber at the same time, price increases may spur landowners to plant trees instead of crops (Sedjo & Lyon 1990; Fereya et al. 2002; Rudel et al. 2005; Varmola 2005). This is further encouraged where urbanisation leads to an increasing scarcity of agricultural labour, resulting in a shift to less labour-intensive forms of income (Williams 2001).

A final driver has been research to increase the returns from planted forests through improved quality of plantation grown timber, improved establishment survival rates (Williams 2001; Varmola 2005), providing insect and disease resistance (Merkle 2005), increase efficiencies in harvesting, transport and processing costs due to uniformity in size and shape, and increased efficiencies and recovery in pulping and sawn-timber end use (Maldonado & Louppe 2000; Cossalter & Pye-Smith 2003).

Biomass prices have traditionally been lower than pulpwood, but may become more competitive if petroleum and electricity prices rise. This would create an alternative investment to current tropical plantations for pulpwood (Contreras-Hermosilla et al. 2007; Cubbage et al. 2009). This may, however, put pressure on existing plantations and natural forests to supply a growing demand for both industries.

Uncertainties

There is uncertainty around the future demand for timber products from planted forests due to perceptions of plantation forests negatively impacting on natural forests and forest communities, and the poorer quality of solidwood products from plantation grown wood.

Monoculture fast-grown plantations are perceived as socially and environmentally harmful (Cossalter & Pye-Smith 2003). There is a concern from environmental groups that plantations, particularly eucalypts and fast-growing exotic species, are the cause of natural forest biodiversity loss, particularly where large plantations are established (Sedjo 1999; Varmola 2005; Erskine et al 2006; Feyera et al. 2002; Cossalter & Pye-Smith 2003). Concerns include that plantations have higher demands for water, compete for light and nutrients with surrounding natural forests, hamper native germination, change soil chemistry, release chemicals that inhibit the growth of natural plant species, and are particularly harmful to the ecosystem (Feyera et al. 2002). Multi-species “diverse’ forests have been found to achieve greater productivity and increased conservation of biodiversity (Erskine et al. 2006).

Local forest communities are concerned that planted forests do not offer the same benefits as natural forests in terms of non-timber forest products (Erskine et al. 2006; Cossalter & Pye-Smith 2003). Environmentalists claim that plantations, particularly those established by large multinationals, displace traditional agriculture and peoples from the land, and exploit local workers in the pursuit of export dollars (Sedjo 1999; Cossalter & Pye-Smith 2003). There are also concerns that establishment of pulpwood plantations rather than sawnwood plantations, provide fewer opportunities to create higher-value employment opportunities (Cossalter & Pye-Smith 2003).

Timber from old-growth forests often have superior perceived wood qualities to that from plantations, possibly reducing the market acceptance of plantation grown wood, with associated price reductions (Baudin et al. 2005; Tomaselli 2007). Manufacturers using teak logs from Côte d'Ivoire have raised concerns regarding variability in timber quality from plantation forests (Maldonado & Louppe 2000).

Strong forest governance is important for attracting investment and ensuring the success of afforestation or reforestation schemes (Rudel et al. 2005; Cubbage et al. 2009). Additionally, support of local community forest management and involvement of small farmers and shareholders in policies to promote forest plantations are required (Tomaselli 2007). An increasing number of plantations have been planted to meet owner needs, rather than providing industrial roundwood (Varmola 2005). For example, in China, trees in group ownership are used to provide a large quantity of non-timber forest products, creating significant rural employment and providing 80% of farmer income. The area of these has tripled from 1978 to 1998 due to lower taxes and secure land tenure

New political and trading regions

Key trends and drivers

The rise of the BRIIC (Brazil, Russia, India, Indonesia and China) emerging markets has been recognised since 2003, with international trade by the BRIIC countries predicted to triple by 2025. As a result India and China will join the United States and European Union as dominant economies, and Russia and Brazil as significant exporters (Barber 2007). The BRIC countries are also showing signs of banding together (loosely). The nations issued their own joint communiqué at a recent G20 banking meeting in Sao Paulo, demanding a bigger role in the reform of the global financial system (Viera 2008) and the first BRIC Summit was held in June 2009 in Russia.

The key features of the BRIIC countries include their:

i) high economic growth rates (Table 4.8); together they have contributed 43% to global GDP since 2000
ii) richness of resources, particularly in Brazil and Russia. Russia has large fossil fuel reserves, and will be an increasingly important player in the world energy markets. Brazil and Russia both have the largest forested cover of any nations (see *Historical trends in the tropical timber market*) (Eder et al. 2009)
iii) high population growth rates, particularly in India, Indonesia and China (Table 4.11)
iv) India has a very young population, with half the population under 25 (Table 4.11) (Reo 2009)
v) Per capita income expected to remain at less than a third of Western countries (Table 4.11) (Barber 2007)

Brazil, Russia, India and China are expected to be important to the global economy following the global economic crisis. The high economic growth rates of China and India (Table 4.11) are seen as essential to support the global economic recovery (Reo 2009). These economies have sounder economic fundamentals (relatively high savings, low debt, increasing consumer base, reducing poverty levels) than the more developed economies, and are expected to be better prepared for the impacts of the global economic crisis (Eder et al. 2009).

The rise of India and China is forecast to significantly impact emerging economies in terms of these two countries' high demand for resources, ability to utilise low-cost labour, becoming financial benefactors to African and Asian countries, and a growing dependency of emerging economies on exports to China and India (Roda et al. 2007; Goldstein et al. 2006; Zhang & Gan 2007). For example, the Republic of Congo has reduced timber exports to Europe from

80% of volume in 2001 to less than 15% in 2004, as sales were diverted to Asia (Roda et al. 2007). Côte d'Ivoire now exports a large share of its teak production to India (Maldonado & Louppe 2000).

Table 4.8 Key economic and demographic variables for the BRIIC countries and the United States, 2004 to 2009. Source: Global Demographics (2009)

Country	Population growth (% per year)	GDP growth (% per year)[1]	GDP per capita (US$)	Households earning over US$30,000 (000s)	Population under 25 (%)	Population over 65 (%)
Brazil	1.3	3.9	8,521	11,112	40.7	7.2
Russia	-0.1	6.6	10,743	4,150	28.7	15.3
India	1.4	8.3	1,172	1,071	50.0	5.4
Indonesia	0.9	5.7	2,095	700	46.7	4.4
China	0.3		3,119	837	31.9	9.7
United States	1.0	1.9	45,266	79,928	34.1	12.7

[1] GDP growth, GDP per capita and household incomes are in 2007 dollars

Slow progress on multilateral trade liberalisation has contributed to a proliferation of regional trade agreements (RTA) since the mid-1990s (Crawford & Fiorentino 2005), particularly in Latin America and Asia & Pacific. There has also been an expansion of cross-regional, developed-developing country, and developing-developing country regional trade agreements (UN 2005). In 2005 there were at least 170 RTA in effect, 20 RTA awaiting entry into force, and 70 RTA under negotiation or at the proposal stage (Crawford & Fiorentino 2005). This growth in regional trade agreements means that more than one-third of global trade is now between countries with RTA. Continued expansion of regional trade agreements is likely to contribute to continued strong growth of forest products trade.

There are four major trade agreements in terms of size and trade value (Table 4.9). Each regional trade agreement has various action plans and activities relating to the timber trade.

Table 4.9 Major regional trade agreements. Adapted from RB International Trade Services (2009)

RTA	Established	Number of members	Population (million)	GDP (US$ trillion)	Trade (US$ trillion)
ASEAN	1967	10	576	1.28	1.40
EU	1992	27	500	14.52	
MERCOSUR	1991	5 full and 5 associate	273	2.77	
NAFTA	1994	3	445	15.8	

Moves to increase intra-African trade are also an important trend. The value of intra-African trade increased to US$72 billion in 2007; a 16.9 % increase from 2006 (AFREXIMBANK 2008). This trade can be increased through a reduction in trade protection and increased trade facilitation, including transport, import and export procedures, and international trade standards (ECA 2004). In addition, some East African countries form part of transport corridor initiatives such as the Northern and Central Corridor linking landlocked countries to key seaports (ECA 2005). The EAC-SADC-COMESA Summit in October 2008 was historic because, for the first time, the key building blocks of the African Economic Community met to identify how to move towards deepening and widening integration within the African Union.

Table 4.10 Intra-regoinal trade as an average share (%) of total African trade, and growth in intra-regional and total exports (% per year), for 1996-2005. Source: UNCTAD (2006)

	Africa	CEMAC	COMESA	ECOWAS	SADC	WAEMU	AMU
Intra-regional trade	9.6	1.6	6.0	9.2	10.2	12.3	2.6
Intra-regional export growth	9	7	11	13	7	10	7
Total export growth	12	17	14	13	9	8	14

African intra-regional trade however remains low, accounting for less than 10% of the regions total exports between 1996 and 2007 (ECA 2008; AFREXIMBANK 2008; Table 4.10). During that period, African exports to the world grew faster than trade within the continent.

Uncertainties

The extent to which countries will continue to grow through these regional political and trading blocs is, however, dependent on progress in reducing tariff and non-tariff barriers to trade and improving trade facilitation. For example, the BRIIC countries could create a mutually beneficial regional forest products trade agreement, enhanced through a joint initiative for trade and economic development. Such an agreement could include (Eder et al. 2009):

i) regional trade regulation
ii) enhanced institutions
iii) stronger BRIIC business relationships
iv) a joint BRIC Forest Certification System (probably based on PEFC) would significantly influence all other forest certification schemes and could gain acceptance as the international standard. Russia is also in the process of developing and finalising its criteria for a national certification standard to be used as part of the PEFC process (Seneca Creek 2007)
v) by enhancing trade between Brazil and Asia, Pacific commercial shipping routes will increase, favouring other nations in the Pacific Rim (Eder et al. 2009)
vi) increased influence on forest governance and setting new industry practices and business standards (Agrawal et al. 2008).

Investing and financing for forest management, processing and infrastructure

Investment and finance for forest management and processing is essential to growing tropical timber and non-timber production, through sustainable forest management, planted forests, payments for ecosystem services, and value-added processing.

Investor profiles in tropical forestry and processing are heterogeneous in terms of investment target, size of investment and key determinants for the investment decision (Table 4.11). Private investments in the tropics are more focused on planted forests than on natural forest management. Predominantly, it is small and medium scale groups that are interested in investing in natural tropical forests (Scholtens & Spierdijk 2007). In 2005, 15 private funds were investing in SFM in the tropics (Canby & Raditz 2005), with funding ranging from US$5.5 million (Ecologic Finance) to US$1 billion (GMO Renewable Resources). It is notable that lately global forest companies are showing interest also in smaller scale stand-alone planted forest based opportunities (Seppänen & Haltia 2007).

There are also cases where governments with the aid of international organisations such as the World Bank's Forest Investment Fund and the Forest Carbon Partnership Facility, are investing in SFM in the tropics. The Government of Guatemala and international organisations have worked with small and medium forest enterprises to provide finance for poverty alleviation and forest conservation. In the case of Peten, Guatemala, a grant of US$270,000 from government funds was provided for developing centralised processing facilities for primary and secondary transformation of lesser-known and high-value timber species (Donovan et al. 2006).

The sources of financing for forestry and processing differ between small and large firms (World Bank 2004). Small firms are largely financed by internal funds and funds from family and friends. Large firms utilise more financing from banks (Table 4.12). This is because large firms, especially those operating in developed countries, have generally lower risk and better stability.

Table 4.11 Profiles of investors in tropical forestry. Source: Seppänen & Haltia (2007)

Investor Group	Main Investment Target	Typical Size of Investment	Investor is Looking for	Investor is Avoiding
Global Forest Companies	Plantation forestry	50,000 – 150,000 ha	• Wood supply • Lately also stand alone businesses • Competitive wood cost • Compliance with corporate responsibility policy	• Image deterioration • Social conflicts • Write-offs due to failed projects
TIMO, Institutional investors	Plantation forestry	20,000 – 100,000 ha	• Long term profitability • Low risk / moderate return • Sustainable forest management within international criteria • Professional management skills • On-going projects that can demonstrate their capacity	• Totally new greenfield investments due to their risk profile • Procedures that do not comply with international criteria and forest certification
Small and medium scale investors and industry	Natural forests	50,000-200,000 ha	• Short / medium term profitability	• Financial losses • Risks
	Plantations	1,000 - 10,000 ha	• Exit opportunities with profit	

Table 4.12 Proportion of financing for small and large firms, by source. Adapted from World Bank (2004)

Sources	Small firms (%)	Large firms (%)
Internal funds	70	52
Family and friends	11	4
Banks	5	22
State sources	1	5
Other	13	12
Equity	0	5

Key trends

A key trend is the generally low level of investment in tropical forestry and processing, particularly sustainable forest management. Planted forests are generally considered more likely to attract significant institutional investment. This is due primarily to the proven track record of planted forests in investment terms, whereas investment conditions in tropical natural forests are less known and not as easily understood (Larsen 2006). Global institutional investment in planted forests was US$25,000 million in 2005 (Binkley et al. 2005), though this was almost exclusively in non-tropical forests.

Counter to this trend is the emergence of a variety of investment institutions developed to address the constraints to investment in tropical forestry:

i) Some international banks which invest in forestry and agriculture have made commitments to use certification as a criterion in their due diligence procedures, to ensure their investments do not have negative social and environmental impacts (Higman et al. 2005).

ii) The Global Environment Fund has combined forest expertise with developing country experience (Canby & Raditz 2005) to compensate developing countries for the

incremental costs of undertaking investments that generate global environmental services as well as local development benefits (Dixon & Pagiola 2001)

iii) UBS Timber Investors and GMO Renewable Resources both use organisational skills and resources to select good investment prospects and to manage risk effectively.

iv) Donor organisations and NGOs have provided funding and technical support to overcome problems posed by start-up costs and technical constraints (Pagiola et al. 2002). Examples include the World Bank's Prototype Carbon Fund (PCF); the Nature Conservancy's input to Fund for the Protection of Water (FONAG); and the Rainforest Alliance's design of the Eco-OK.

v) IFC's LAC Small and Medium-Sized Enterprise Facility with WWF's Global Forest and Trade Network (GFTN) are teaming up to develop environmentally responsible forest products trade in Latin America

vi) The Multilateral Investment Fund of The Inter-American Development Bank combines private and public investments

However, it remains a challenge for tropical countries to attract the capital required to undertake sustainable forest management, develop planted forests, and build value-added processing (ITTO 2007a). In an attempt to address this many ITTO producer countries have implemented policies that provide incentives to firms in the forestry sector, particularly to invest in value-adding activities. Incentives include exemption from customs duty and consumption tax on saw milling equipment, logging and land development equipment, and wood working equipment (MTIB 2008; ITTO 2007a; ITTO 2007c).

Drivers of trends

A number of factors have been identified as influencing the level of investment in forestry and wood processing in the tropics (Canby & Raditz 2005). Firstly, there are the relatively higher costs associated with sustainable forest management, particularly compared with alternative uses of the land. Many of the forest units in which sustainable forest management has been established have benefited from external financial and technical support from development assistance agencies and NGOs. The economic viability of SFM within these will be tested once support is withdrawn (Blaser et al. 2006; Larsen 2006)

Secondly, perceived weak forest governance and land tenure rights have been identified as risks associated with investment in both tropical natural (Blaser et al. 2006; ITTO 2007c) and planted forests (Nielson 2009, Cubbage et al. 2009). Timber Investment Management Organizations (TIMO) are considered unlikely to invest in tropical natural forests due to the higher perceived risk arising from weak land tenure rights, the complex structure of forest ownership arrangements, and poor forest information (Canby & Raditz 2005; Binkley 2007). This is exacerbated by many forest operations being too small or fragmented for many international investors (Blaser et al. 2006; Larsen 2006). Further commercial forestry in the tropics tends to have a negative image, often associated with forest destruction, relocation of indigenous populations, extinction of wildlife, etc. (Larsen 2006).

Thirdly, the general poor business environment and risk in developing countries due to difficult regulatory and tax environments, and legal systems (Blaser et al. 2006; Larsen 2006), lack of management capacity (Larsen 2006), and lack of exit opportunities (Larsen 2006). These perceived risks contribute to higher discount rates used when assessing investments in tropical countries (ITTO 2007c).

Uncertainties

The degree to which tropical producer countries will be able to attract investment in forest management and processing is dependent on improvements in governance to create a more attractive investment environment, and returns from tropical forest timber and non-timber values that match the risks. The latter requires the challenges of establishing ecosystem service markets and meeting legality and certification requirements to be addressed.

The three major concerns influencing private investment in the tropical timber industry are policy uncertainty, macroeconomic instability and taxation (Bolton & Cooper 2001; World Bank 2004; Table 4.13). Country specific issues identified for key tropical timber producer and consumer countries were identified by Ortiz (2004). For China, key challenges were increasing its domestic forest resource, development of knowledge in the wood processing industry, and increased consolidation in the fragmented industry. For Brazil the key challenge identified was the competitiveness of the overall investment environment due to a lack of economic reform. For India the key challenge was the overall lack of development in the forest industry, with a multitude of small to medium sized companies using outdated technology.

Table 4.13 Major concerns determining private investment in developing countries. Adapted from World Bank (2004)

Concern	Proportion of respondents citing concern (%)
Policy uncertainty	28
Macroeconomic instability	23
Taxation	19
Regulation	10
Corruption	10
Finance	2
Electricity	2
Skills	2
Crime	2

There has been increased interest in socially and environmentally responsible investments to support sustainable forest management in the tropics. Meeting the legality and sustainability requirements for investments contributes to reducing business risk for forestry companies and is likely to positively influence their investment costs (Simula et al. 2009). Several financing institutions participating in the Equator Principles Financing Institutions initiative are paying attention to legality and sustainability aspects of their lenders and the perceived risk influences the access to, and cost of, financing (Simula et al. 2009).

There are, however, a number of challenges faced with these types of investment (Scholtens & Spierdijk 2007):

i) they still compete with other green investment schemes
ii) the funds can be very risky and illiquid
iii) the investments tend to be altruistic rather than economically driven
iv) some of the claims of making a difference for sustainable development and local tropical communities cannot be substantiated.

Corruption and changing forest governance

Corruption is defined as “abuse of public office for private gain” (Kaufmann 2005). It may be decentralised; many bribe takers, without coordination among them, or centralised (Easterly 2002). The latter tends to be more damaging to economic growth.

There are two measures of corruption, cross-country, based on measures of perception of corruption (Mauro 1995, 1996) and firm-level, based on measures of actual corruption (Mocan 2004, Fisman & Svensson 2005). Complicating the picture is the fact that perceptions of corruption are influenced by the quality of institutions in a country (Mocan 2004). As such measures based on perception are only good enough to divide countries into three to four groups (Anon 1999; Svensson 2005).

Table 4.14 Transparency International Corruption Perception Index ranking of ITTO producer countries, 1998-2008. Adapted from Transparency International (2008)

Percentile of all countries	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Top 25%	0	0	0	0	0	0	0	0	0	1	0
2nd quartile	2	2	2	1	3	3	9	9	8	8	9
3rd quartile	6	6	5	7	7	7	3	4	6	7	11
Lower 25%[1]	9	9	8	10	8	11	12	14	16	15	12

[1] The number of countries in the lower 25% is likely to be biased as countries added to the index over time tend to be those with weak institutions.

The historical trend in the number of ITTO producer countries in the four quartiles of the Transparency International Corruption Perception Index shows an increasing number of countries in the 2nd quartile from 2004 onward. Malaysia is the only producer country in the top quartile of the index (Table 4.14).

Governance is more broadly defined as "the traditions and institutions by which authority in a country is exercised for common good" (Kaufmann 2005). Dimensions of governance are:

i) political – the process by which those in authority are selected
ii) economic – government's capacity to effectively manage its resources
iii) institutional – respect of citizens and governments for country's institutions.

86% of the world's 5.4 billion ha of forests and wooded areas are owned by central governments (FAO 2005, Siry et al. 2005). The main forms of governance in these forests are (Agrawal et al. 2008):

i) protected areas with restrictions on use
ii) private timber concessions
iii) decentralised and community-based
iv) civil society and market-based
v) bilateral and multilateral agreements, e.g. Voluntary Partnership Agreements, Clean Development Mechanism and REDD (RRG 2007).

Africa provides examples of these types of forest governance, with the type depending on the forest use (Nzala & Adadji 2008):

i) protected areas have historically been managed by central government with local populations excluded. More recently, though, there has been increased participation of rural populations within or near the protected area in management
ii) commercial forestry is carried out under concessions with management plans
iii) community forests have developed inline with the trend to decentralisation of forest management to ensure more equitable distribution of forest benefits.
iv) African Forest Law Enforcement and Governance (AFLEG) advocated a variety of actions to improve forest governance (IISD 2002), leading to:
    a. the majority of countries putting in place new forest policies
    b. civil society, international organisations, NGOs and donors have developed new partnerships
    c. a shift away from central government control to participatory approaches.

Poor overall governance within a country negatively impacts on country competitiveness, income distribution, and income per capita (Kaufmann 2005). The direction of causality is from better governance leading to higher economic growth (Kaufmann 2005). Higher incomes are not, therefore, necessary for better governance. The impact of weak governance on forest management is to (Contreras-Hermosilla 2000):

i) increase investment risks, reducing the likelihood of investing in sustainable forest management
ii) bias government activities towards those that attract bribes, e.g. sale of concessions
iii) lead to poor harvesting practices
iv) reduce the likelihood of forest policy reforms being implemented (Kishor & Belle 2004; Rudel et al. 2005).

The impact on the tropical timber trade is that perceptions of poor governance lead to non-tariff barriers, such as procurement policies and discriminatory Forest Law Enforcement Governance and Trade negotiations (Chan 2009).

Key trends

Private timber concessions remain the dominant form of forest governance in Southeast Asia, parts of the Amazon, and Central and West Africa. Use of concessions is driven by demand for logs and timber and governments' need for revenue (Agrawal et al. 2008). Where there is limited enforcement of concession agreements illegal logging and unsustainable practices can occur (Keller et al. 2007).

An increasing area of publicly owned forest is under governance regimes that place restrictions on human use and habitation (Agrawal et al. 2008). As at 2005, 12% of the world's forests were legislatively protected from harvest or exploitation (Siry et al. 2005). This is a doubling in area since 1992. Challenges these areas face include (Shahabuddin 2009):

i) equitable distribution of resources and costs associated with protected forests
ii) livelihood conflicts with local communities
iii) lax law enforcement
iv) lack of proper management.

Many natural forests are managed as common property for multiple uses by local communities (Hayes 2006). Governments and NGOs are recognizing the need to empower local communities through participatory processes as a component of good governance (Siwatibau 2009). Participatory approaches are becoming increasingly important with decentralisation of forest governance, particularly of commercially low-value forests (RRG 2007; Agrawal et al. 2008; Walpole & Shimamoto-Kubo 2009). Examples include Fiji, India, Lao PDR, Nepal and Bangladesh. More than 75% of developing countries are undergoing decentralisation and devolution processes (Contreras-Hermosilla et al. 2006).

Civil society organisations and market incentives (e.g. forest certification) are taking an increasing role in forest governance (Cashore et al. 2006; RRG 2007; Agrawal et al. 2008), particularly in temperate forests. 3% (Siry et al. 2005) to 5% (Ebaá Atyi & Simula 2002) of the world's forests are certified by one of the major forest certification schemes, though 93% of these forests are in developed countries (Siry et al. 2005).

Bilateral, e.g. VPA and multilateral, e.g. REDD and CDM, agreements are emerging as new forms of forest governance (RRG 2007; Agrawal et al. 2008). For example, the EU and Ghana recently signed a VPA under the EU's FLEGT program. This is designed to stop illegally felled timber from Ghana entering the EU by imposing stricter controls on harvesting, timber handling at ports, and requiring shipments to be verified as being legal (ITTO 2008a).

Cameroon, the Republic of Congo, Gabon, Liberia, Indonesia and Malaysia are involved in or are starting VPA negotiations with the EU (ITTO 2008a; Johnson 2008). African tropical producer countries are predominantly in these negotiations because of the importance of the EU as a market for these countries (Johnson 2008); accounting for over 60% of Africa's forest product exports (see *Historical trends in the tropical timber market*).

At the same time as there has been increasing influence of bilateral and multilateral agreements on forest governance, the importance of international and intergovernmental arrangements, e.g., UN Forum on Forests, the Food and Agriculture Organization, and the World Bank, has been declining (RRG 2007).

Drivers of trends

Trends in forest governance are driven by a desire for better governance from aid donors, demands for greater recognition and participation of local communities, a desire of

governments to reduce their financial burden, particularly associated with oversight of sustainable forest management (SFM) and chain of custody (CoC), and increasing organisational strength of environmental NGO.

Decentralisation of forest governance began in the mid- to late 1980s and was driven by (Agrawal et al. 2008):

i) a desire for better forest governance from aid donors
ii) demands for greater recognition of local communities' needs and more democratic participation in governance, though there has been an increase in tension with other forest users, and
iii) a desire of governments to reduce their financial burden.

Part of this decentralisation process has been an increase in community forest enterprises and involvement of local communities in protected area management. This trend has been attributed to (ITTO 2007b, Nzala & Adadji 2008):

i) a transition towards more democratic governments reducing tenure, policy and regulatory restraints
ii) the trend to ensure more equitable distribution of forest benefits
iii) mechanisms for public participation in development and implementation of forest law seen as essential to improving forest governance (ITTO 2007b)
iv) an increasingly vocal civil society that has secured land rights, and
v) development of agroforestry systems, particularly in India, which balance environmental services and income generation (Leslie 2009; ITTO 2007b).

Drivers of increased forest certification have been (Cashore et al. 2006):

i) as a civil society response to public concern about deforestation and pressing for accountability, e.g. Ghana (Ayee 2008)
ii) the increasing organisational strength of environmental NGOs
iii) countries making specific legislative provisions for forest certification as a way of reducing the need for oversight of SFM and CoC by forest authorities. In some countries this is encouraged by governments through a reduction in concessionary fees, etc. (e.g. Peru), or allowing certification to act as a substitute for government audits (e.g. Bolivia) (Purbawiyatna & Simula 2008).

Counter to this trend is the disadvantage of additional costs imposed by certification, hence the need for regulations that provide tangible incentives to certify forests (Purbawiyatna & Simula 2008).

Improvements in forest governance have also been brought about through increased access to information, transparency, and empowerment leading to a greater ability to hold governments accountable. For example, the Republic of Congo has improved its capacity to monitor logging activities to provide greater transparency and better governance. This in turn enhances the confidence of timber importers (Mertens & Méthot 2008).

The efficacy of trade measures such as certification, legality and government procurement requirements in improving forest governance are influenced by regional patterns of trade. Asian producer countries mainly export to other Asian countries, except China which also imports from Africa. African countries, however, mostly export to Europe. This increases the impact of VPA and certification on forest governance in Africa (Tacconi et al. 2003).

Uncertainties

There is still uncertainty around the extent to which the new approaches to forest governance (decentralisation, participatory approaches, civil society, market incentives, and bilateral and multilateral agreements) will bring about stronger forest governance given the challenges in some tropical country forests. Developing effective forest governance requires that (Dietz et al. 2003):

- forest use can be monitored and verified at a relatively low cost. Large distances to native public forests and governments without means to properly enforce de jour property rights make this difficult in many tropical forests (Amacher 2006)

- rates of change in forests, user populations, technology and economic and social conditions are moderate. As tropical producer countries move through the process of economic development change in economic and social conditions can be rapid
- communities maintain dense social networks which increase trust and induce rule compliance. Periods of political instability have been associated with a breakdown in control of resources (Smith et al. 2003; RRG 2007). In the past 20 years, 30 countries in the tropics have experienced significant conflict in forest areas. These conflicts have often been over contested rights and are sometimes financed in part by logging (RRG 2007).
- outsiders can be excluded from using the forest at relatively low cost. This again is a challenge given the large distances to many forests
- users support effective monitoring.

5. Alternative Futures for the Tropical Timber Market in 2020

The information on key trends, drivers of trends and uncertainties described in the previous section was clustered and ranked to identify the key unconnected driving forces and critical uncertainties in the tropical timber market. Critical uncertainties are those that are central to the tropical timber market, but also impossible to predict. Those forces that are important as well as uncertain have the most potential to create divergent future paths to base scenarios around (Schwartz 1996). From these forces, four alternative futures (or scenarios) for the long-term outlook for tropical forests and the tropical timber market were developed.

The first two scenarios, *Tropical Timber – Symbol of Tropical Forest Livelihoods* and *Tropical Forests – Tackling Climate Change*, have similar potential outcomes and are predicated on a strong recovery from the global economic crisis. They differ, however, in their key drivers. The former is driven by recognition of the role of the tropical timber trade in forest protection and community livelihoods, the latter by recognition of the role of tropical forests in mitigating climate change. The other two scenarios are variants on a retraction of the market for tropical timber products, precipitated by a weak recovery from the global economic crisis and varying degrees of trade and financial protectionism. The first, *North & South*, is based on an alignment of the BRIIC and developing economies as a new political and trading bloc. The second, *Tropical Timber – Symbol of Tropical Forest Destruction*, is based on a declining global acceptance of tropical timber products, driven by increasing trade protectionism couched in environmentalism.

The outcomes for the tropical timber market presented for each scenario are based on projections made using the Global Forest Products Model incorporating tropical wood products (see *Study Methodology*). The outcomes provide a high-level description of wood product production, consumption, trade and price trends under each scenario. Section 5 *The Tropical Timber Market to 2020: Alternative Projections* provides a more detailed description and comparison of trends across scenarios.

Tropical timber – symbol of tropical forest livelihoods

By 2020 there is acceptance, by consumers, retailers and governments, of tropical timber products from sustainable forest management (SFM) and planted forests in the tropics. Global cooperation ensured a strong recovery from the global economic crisis, and spurred action to address trade and investment imbalances in the global economy. This enabled private investors and international organisations, e.g. World Bank, IMF, FAO, ITTO, UNDP, UNEP, etc. to increase their role in assisting in the development of tropical country timber industries, including investment in improved processing, sustainable forest management, payment for ecosystem services and expansion of planted forests (Figure 5.1).

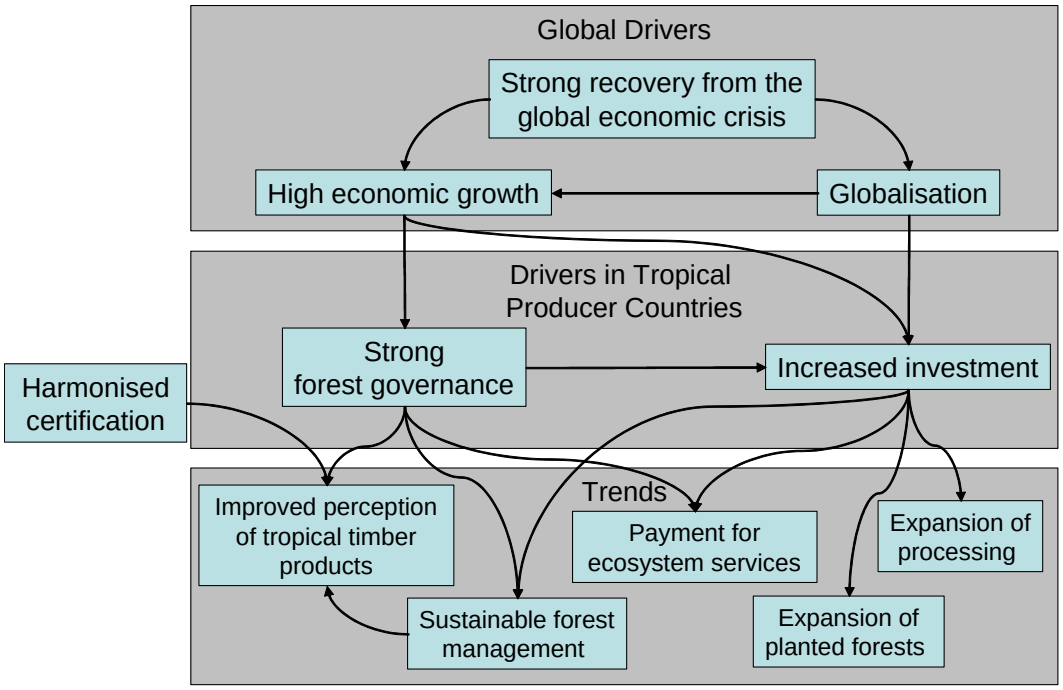
Assumptions and drivers

Consumers, retailers and governments understand the contribution of tropical timber products to ensuring valuable tropical forests are not converted to agriculture. This has arisen through a deeper understanding in the media of the relationship between the tropical timber trade, the value of tropical forests, forest community livelihoods, and avoided deforestation.

Supported by a desire to protect the livelihoods of forest communities tropical timber products are marketed positively in Germany, United Kingdom, and North America, along the lines of “fair trade furniture”. There is a willingness and ability to pay by consumers in these markets, driven by strong economic growth following a robust recovery from the global economic crisis, education and media raising awareness of environmental degradation and forest community

livelihoods in the tropics, and establishment of readily recognised and comparable standards for assessing the environmental and social credentials of forest products and services.

Figure 5.1 Links between global and tropical producer country drivers, and key trends to 2020 under the Tropical timber – symbol of tropical forest livelihoods scenario



With the support of consumer countries cost effective methods of monitoring, enforcing, verifying, and carrying out SFM (e.g. reduced impact logging, participatory approaches, etc.) in the tropics are developed. This ensures the profitability of SFM in tropical natural forests and increases consumer, retailer and government confidence in tropical timber products.

Expansion of forest certification in tropical countries arises through a reduction in the costs of certification due to improvements in certification processes and global harmonisation of standards, which fit with the complexities of tropical forest ecosystems. At the same time the benefits to producers of certification have increased due to consumers' willingness to pay for SFM timber and ecosystem services from tropical forests through purchase levies and price premiums for "fair trade furniture", etc.

Investment in high-technology processing of tropical timber to provide novel products and meet market needs is driven by an improved investment environment in tropical producer countries. This is supported by a reduction in country corruption and associated improvement in forest governance, through third-party monitoring. Investments are made by tropical country governments to support development of industry, and companies in emerging economies such as China and India to provide products for their expanding markets.

Efforts to improve tropical planted forest growth and quality and to meet forest certification requirements enable an increase in the supply of tropical plantation wood for fibre and solidwood products.

Outcomes

Forest area and stock loss in tropical producer countries, especially in Asia & Pacific, slows due to expansion of planted forests and protected forest areas, though the loss is not

reversed by 2020. The ongoing decline in forest stock is due to continued harvesting stimulated by strong economic growth following the economic crisis.

While wood product prices dip during the global economic crisis, they increase slightly following the crisis due to a strong economic recovery boosting demand and a reduction in wood supply in some countries due to expansion of protected forest area. Prices for tropical wood products, and especially tropical logs, however grow less than for softwood and hardwood products due to investment in improved processing reducing manufacturing costs.

Consumption of forest products grows at a faster rate than historically stimulated by strong economic growth and a reduction of trade barriers. Growth in consumption is especially strong for fibre-based products and plywood, including tropical plywood. Consumption of tropical timber products by North America and Europe grows slightly due to a stronger preference for tropical timber products through the "fair trade" label. However, the main source of growth in demand for tropical products is the emerging economies in Asia & Pacific (China, India, Malaysia and Indonesia) and Latin America (Brazil). This is due to higher economic growth in these regions and already relatively higher consumption of tropical wood products. These regions increase the share of tropical in their consumption of wood products

Despite this growth in consumption of tropical timber products the share of tropical logs in producer country wood consumption continues to decline. This is driven by investment in new processing improving conversion rates. Growth in tropical timber production in consumer countries in Asia & Pacific, notably by China to meet growth in domestic consumption, however stimulates an increase in the share of tropical logs in their wood consumption.

The production of tropical timber products continues to be concentrated in the tropical producer countries, and key consumers such as China, with this trend strengthened by increased competitiveness of the industry from improved processing in countries such as Malaysia, Indonesia, Brazil, Peru and India. New larger-scale producers of tropical plywood also emerge, such as the Philippines and Côte d'Ivoire.

Asia & Pacific, and to a lesser extent, Latin America continue to experience strong growth in production of wood products. As a result Asia & Pacific surpasses North American and European production of reconstituted panels (China, Malaysia, Thailand) by 2020, closes the gap in wood pulp (China, Indonesia, Republic of Korea) and paper (China, Indonesia) production, and maintains its dominance in secondary processed product exports (China, Indonesia, Malaysia, India). China also closes the gap in hardwood sawnwood production

Africa experiences strong growth in forest product production, particularly of tropical sawnwood and plywood. The main producers are Nigeria and Cameroon for tropical sawnwood, and Côte d'Ivoire and Ghana for tropical plywood. Africa's share of global production remains small though within the short timeframe to 2020.

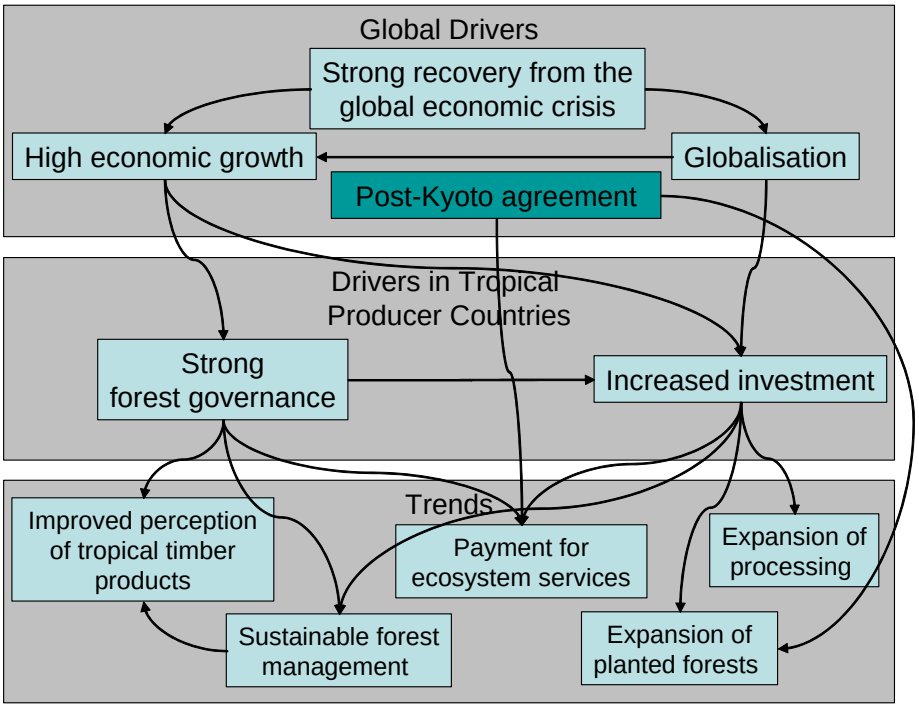
As has occurred historically the rate of growth in fibre-based product production (reconstituted panels, wood pulp, and paper and paperboard) and secondary processed product exports (builder's carpentry, wooden furniture and other SPWP) is more rapid than for solidwood products. This is stimulated by strong economic growth and improvements in processing technology in producer countries. As a result the key producers of fibre-based and secondary processed products in Asia & Pacific, China for reconstituted panels, wood pulp, paper and paperboard, and SPWP, Malaysia and Thailand for reconstituted panels and wooden furniture, and Indonesia for wood pulp, paper and paperboard and other SPWP, increase production by over 5.5% per year. The key producer in Latin America for fibre-based and secondary processed products, Brazil, increases production by over 6.5% per year.

Tropical forests – tackling climate change

By 2020 there has been widespread uptake of strategies to mitigate the effects of climate change, including Reducing Emissions from Deforestation and Degradation (REDD), planted

forests under the Clean Development Mechanism (CDM), bioenergy, and harvested wood products with high embodied carbon. This has emerged from recognition of the need for international cooperation to avoid the negative impacts of climate change.

Figure 5.2 Links between global and tropical producer country drivers, and key trends to 2020 under the Tropical forests – tackling climate change scenario



Assumptions and drivers

International cooperation ensured a strong recovery from the global economic crisis, avoiding a protracted period of trade protectionism and low economic growth. This ensured liquidity returned to financial markets to provide the much needed funds for investment in climate change mitigation and adaptation strategies. As a result a post-Kyoto Agreement was signed, which recognises the importance of regulatory and market-based mechanisms, e.g. cap-and-trade, carbon tax, etc. to mitigate climate change.

The BRIIC countries also signed-up to the post-Kyoto agreement as China emerges as a strong global leader, Russia and Brazil eye opportunities to benefit from carbon markets, India and Indonesia move in union with the BRIIC political bloc, and all five countries are able to use mitigation activities in other countries to offset their own emissions, e.g. planted forests for carbon in Africa. This reduced the impact of mitigation strategies on economic development in their own countries.

Tropical countries adopted cost-effective approaches to ensure strong forest governance; monitoring, verification, and enforcement. These approaches were supported by the need for purchasers of carbon credits to demonstrate these from REDD and CDM activities. Technologies are developed for planted forests in the tropics to provide cost-effective bioenergy and avoid negative climate change impacts on forests, e.g. loss due to forest pests.

Outcomes

There is a reversal in the loss of tropical forest area in producer countries due to expansion of REDD and planted forests leading to less conversion of tropical forest to agriculture. The

largest increases in forest area are in China, Malaysia, and India, and forest loss in Brazil and Indonesia is slowed to almost zero by 2020. The decline in forest stock in Asia & Pacific and Latin America is slowed, though not reversed due to continued harvesting stimulated by stronger than historical growth in consumption of wood products, especially fibre-based products, plywood (including tropical), and fuelwood. This is stimulated by a strong recovery from the global economic crisis, and the last by increased bioenergy demand.

While forest product prices dip during the global economic crisis they increase slightly afterwards due to a strong recovery boosting demand and a reduction in wood supply in some countries due to expansion of protected forest area under REDD. Prices for tropical wood products, and especially tropical logs, grow less than for softwood and hardwood products due to investment in processing reducing manufacturing costs. The price of fuelwood especially increases; reaching the level of softwood logs. This suggests potential for softwood pulp logs to be diverted to bioenergy.

Consumption of tropical timber products by North America and Europe is slightly higher due to a stronger preference for tropical timber products under the “fair trade” label, though the share of tropical in their consumption is largely unchanged. The main source of growth in demand for tropical products is the emerging economies in Asia & Pacific (China, India, Malaysia and Indonesia) and Latin America (Brazil). These regions increase the share of tropical in their consumption of wood products due to higher economic growth in these regions and already higher consumption of tropical wood products.

Despite the growth in consumption of tropical timber products the share of tropical logs in producer country wood consumption continues to decline, driven by investment in new processing leading to improved conversion rates.

There is an increasing concentration of the production of tropical timber products in the tropical producer countries due to improved processing in countries such as Malaysia, Indonesia, Brazil, Peru and India. China, though, continues to increase its role in the production of tropical timber products, in large part so as to meet its growth in domestic consumption. Countries such as the Philippines and Côte d’Ivoire also emerge as larger scale producers of tropical plywood.

Asia & Pacific, and to a lesser extent Latin America, experience large growth in the production of a number of wood products. As a result Asia & Pacific surpasses North American and European production of reconstituted panels (China, Malaysia, Thailand) by 2020, closes the gap in wood pulp (China, Indonesia, Republic of Korea) and paper (China, Indonesia) production, and maintains its dominance in secondary processed product exports (China, Malaysia, Indonesia, India). China also closes the gap in hardwood sawnwood production and maintains its dominance (along with Malaysia and India) in plywood production.

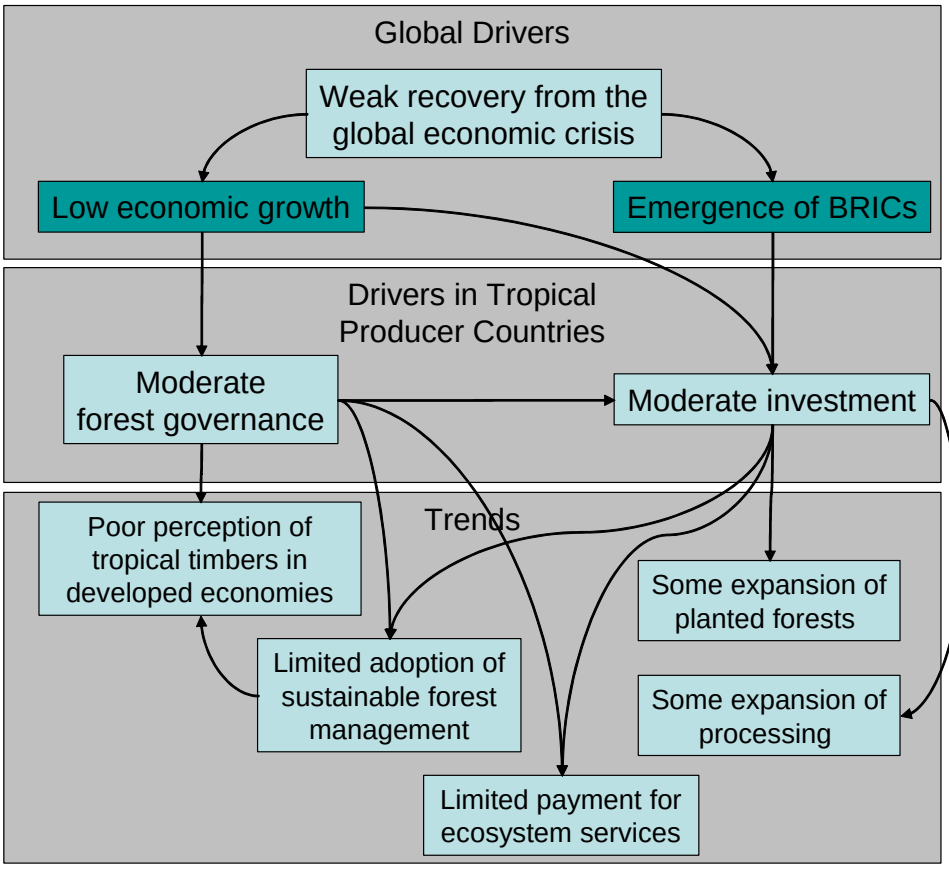
Africa also experiences strong growth in wood product production, particularly of tropical sawnwood and plywood. The main producers of sawnwood are Nigeria and Cameroon, and Côte d’Ivoire and Ghana for tropical plywood. Africa’s share of global production remains small though within the short timeframe to 2020.

As has occurred historically the rate of growth in production of fibre-based and secondary processed products (reconstituted panels, wood pulp, and paper and paperboard) is more rapid than for solidwood products, due to strong economic growth and improvements in processing technology in producer countries. As a result the key producers of these products in Asia & Pacific, China for reconstituted panels, wood pulp, paper and paperboard, and all SPWP, Malaysia and Thailand for reconstituted panels and wooden furniture, and Indonesia for wood pulp, paper and paperboard, and other SPWP increase production by over 5.5% per year. Brazil, the key producer of fibre-based and secondary processed products in Latin America increases production by over 6.5% per year.

North and south

By 2020 the BRIIC countries have emerged as a global political and economic force. Developing countries have aligned themselves with the BRIIC bloc as an important market and source of external finance for development in order to counter increasing trade and financial protectionism by Europe and North America after a weak recovery from the global economic crisis. Within the BRIIC bloc and aligned economies there is acceptance by consumers, retailers and governments of tropical timber products from natural and planted forests. Outside of these regions, the shift to environmentally based purchasing, and an increase in trade protectionism on environmental grounds, lead to weaker demand for tropical timber products.

Figure 5.3 Links between global and tropical producer country drivers, and key trends to 2020 under the North & South scenario



Assumptions and drivers

Meeting the demands of the North American and European markets for forest certification and legality proved to be too costly for tropical producer countries due to the variety of competing certification requirements, the high costs associated with demonstrating strong forest governance and increasingly stringent government procurement policies in these markets; partly driven by increasing trade protectionism in the guise of environmentalism.

The loss of access to North American and European markets was offset by significant and growing demand for timber products in the BRIIC countries, where forest certification and legality requirements are less stringent. BRIIC demand for tropical timber was driven by acceptance of and a preference for tropical timbers, modest economic growth in Africa, Asia & Pacific and Latin America, supported by consumption-led growth in China, and continued

export-led growth in India, Brazil and Indonesia. Regional trade agreements were established to support these new trade flows, e.g. Intra-African EAC-SADC-COMESA.

To meet the growing demand for pulp, paper, bioenergy, and solidwood products in the BRIIC and emerging economies there was establishment of tropical plantations for fibre and expansion of the wood processing sectors in the BRIIC and aligned economies. This development was supported by investment from the BRIIC countries.

Outcomes

Forest area and stock loss continues in all tropical producer regions, though the rate of loss slows. This is in part due to slower than historical growth in wood product consumption as a result of lower economic growth and increased trade barriers. There is also a small shift in tropical harvests away from producer countries to other tropical counties such as Viet Nam.

All wood product prices dip during the global economic crisis, and remain stagnant following the crisis due to a weak economic recovery leading to slower growth in wood product consumption. Consumption of tropical timber products by North America and Europe declines due to a continued shift in preference away from tropical wood products. However, demand for tropical products continues to grow in the emerging economies in Asia & Pacific (China, India, Malaysia and Indonesia) and Latin America (Brazil) though at a slower rate than prior to the economic crisis. As a result tropical wood products become a declining share of sawnwood and plywood consumption in these regions. African producer countries continue to have a higher share of tropical in consumption though, reflecting the already high share in this region. The share of tropical logs in producer country wood consumption continues to decline driven by softwood and hardwood products being more competitive.

China continues to increase its role in the production of tropical timber products, despite slower economic growth, due to its continued improvement in processing technology. As a result, China and other Asia & Pacific countries continue to experience growth in production of a number of wood products. Asia & Pacific surpasses North American and European production of reconstituted panels (China, Malaysia, Thailand) by 2020, closes the gap in pulp (China, Indonesia, Republic of Korea) and paper (China, Indonesia) production, and maintains its dominance in secondary processed product exports (China, Malaysia, India). China also surpasses North American hardwood sawnwood production, due to relatively stronger economic growth and continuing improvement in processing, and maintains its dominance (along with Malaysia and India) in plywood production.

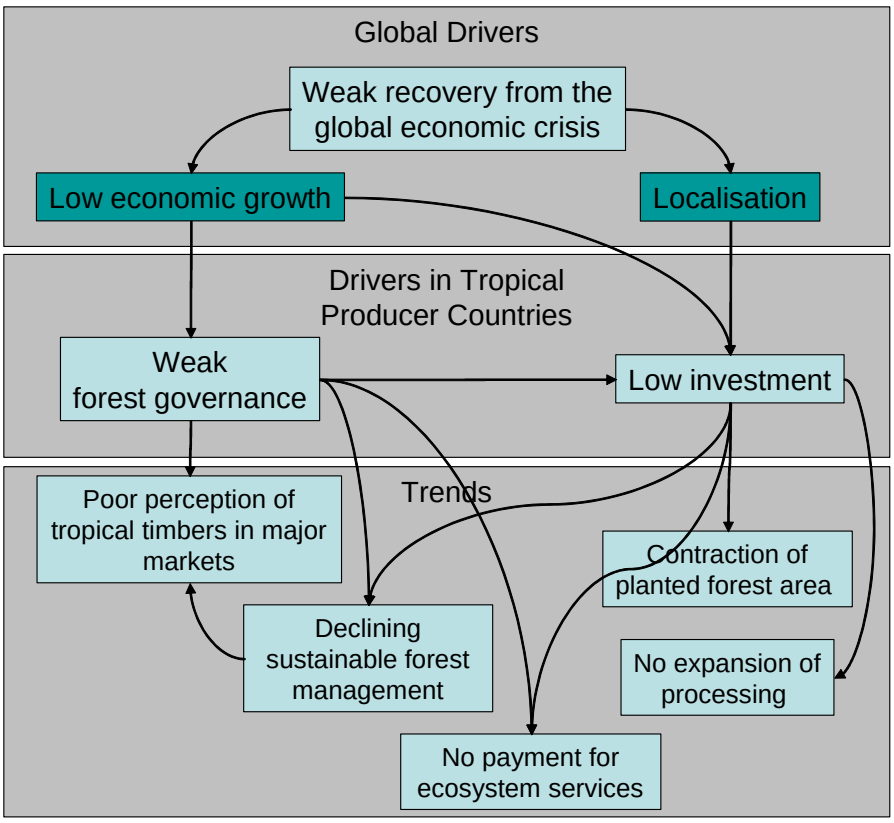
Africa also experiences continued growth in wood product production, particularly of tropical sawnwood and plywood. The main producers are Nigeria for tropical sawnwood and Côte d'Ivoire for tropical plywood. Africa's share of global production remains small though within the short timeframe to 2020.

As has occurred historically the rate of growth in production of fibre-based and secondary processed products (reconstituted panels, wood pulp, and paper and paperboard) is more rapid than for solidwood products, due to a stronger preference by consumers for fibre-based and secondary processed products. The strongest growth in production of these products continues to occur in Asia & Pacific (China for reconstituted panels, wood pulp, paper and paperboard, and all SPWP, Malaysia and Thailand for reconstituted panels and wooden furniture, and Indonesia for wood pulp and paper and paperboard), increasing production by over 3.0% per year, and Latin America (Brazil) increasing production by over 4.0% per year.

Tropical timber – a symbol of tropical forest destruction

By 2020 tropical timber products are seen as a symbol of forest loss and illegal forest activities in tropical countries. After a failure to develop a unified response to the global economic crisis, there was a weak recovery from the crisis, financial and trade protectionism increased, and investment in tropical forest industries was reduced.

Figure 5.4 Links between global and tropical producer country drivers, and key trends to 2020 under the Tropical timber – a symbol of tropical forest destruction



Assumptions and drivers

An image of tropical forests as the “lungs of the planet” develops as consumers and governments in North America and Europe continue to shift to environmental and ethical purchasing. This purchasing is, however, based on a simplistic environmental message, due to the challenges of resolving a variety of competing certification and legality schemes. The shift to environmental purchasing was also supported by increasing justification of financial and trade protectionism on environmental grounds. Attempts to develop a positive image of tropical timber products from countries that have invested in SFM and legality were simply seen as a “green wash”, with all tropical producer countries receiving the same label. As a result SFM in the tropics failed due to its high cost and lack of investment.

Acceptance of tropical timber products in China and India is also low as consumers in China increase their environmental awareness and India’s tropical timber industry is reliant on markets that demand certified and legal forest products.

There are low levels of investment in the tropical producer countries due to slower economic growth following the global economic crisis. This is further exacerbated by financial protectionism in developed economies, a rise in corruption and weak governance, and lack of trust in tropical producer countries. This reduced the level of investment in tropical planted forests (which are also viewed as a contributor to deforestation) and wood processing, as well as preventing the establishment of markets for ecosystem services from tropical forests.

A focus of investment in developed economies lead to improvements in technology for processing of non-tropical timber products, which means that they now match tropical timbers for appearance, durability, and other desired characteristics, but at a lower price. As a result other timber suppliers compete with the tropical timber supply.

Outcomes

Forest area and stock loss continues in Asia & Pacific, Latin America and Africa, with significant forest area loss in Brazil and Indonesia. This results in environmental degradation and a loss of forest community livelihoods. There is a small shift in tropical harvests away from producer countries to other tropical counties such as Viet Nam.

All forest product prices dip during the global economic crisis, and remain stagnant or declining in real terms following the crisis due to a weak economic recovery.

The weak economic recovery combined with increased trade barriers leads to slower than historical growth in wood product consumption. Consumption of tropical timber products by North America and Europe is declining. However, demand for tropical products continues to grow in the emerging economies in Asia & Pacific (China, India, Malaysia and Indonesia) and Latin America (Brazil). This is due to relatively higher economic growth in these regions and already higher consumption of tropical wood products. The rate of growth though is not as strong as historically. As a result tropical wood products continue to be a declining share of sawnwood and plywood consumption. African producer countries continue to have a higher share of tropical in consumption though, reflecting the already high share in this region. The share of tropical logs in producer country wood consumption also continues to decline driven by softwood and hardwood products being more competitive.

The Asia & Pacific region, and to a lesser extent Latin America, continues to experience relatively stronger growth in production of a number of wood products, approaching North American and European production of reconstituted panels (China, Malaysia, Thailand), wood pulp (China, Indonesia, Republic of Korea) and paper (China, Indonesia), and maintaining its dominance of secondary processed exports (China). China also closes the gap in hardwood sawnwood production.

Africa also experiences modest growth in forest product production, particularly of tropical solidwood products. The main producers are Nigeria for tropical sawnwood and Côte d'Ivoire for tropical plywood. Africa's share of global production remains small though within the short timeframe to 2020.

As has occurred historically the rate of growth in production of fibre-based (reconstituted panels, wood pulp, and paper and paperboard) and secondary processed (builder's carpentry, wooden furniture and other SPWP) products is relatively stronger than for solidwood products due to a stronger preference by consumers for fibre-based and secondary processed products. The strongest growth in production of these products continues to occur in Asia & Pacific (China for reconstituted panels, wood pulp, paper and paperboard and all SPWP and Malaysia and Thailand for reconstituted panels), increasing production by over 2.0% per year.

6. The Tropical Timber Market to 2020: Projections for Alternative Futures

The implications of the four alternative futures are described here in terms of how they will impact on the seven major historical trends in the tropical timber market (see *Historical Trends*) through to 2020. Historically the tropical timber market has been impacted by

- Continuing global forest loss, with most of this loss occurring in tropical producer countries, particularly in Africa and Latin America
- Little to no growth in global consumption of tropical sawnwood and plywood
- A shift in consumption of raw material and primary processed (sawnwood and plywood) forest products from tropical hardwoods to softwoods and non-tropical hardwoods, especially in Asia & Pacific and Latin America
- An increasing concentration of production and consumption of tropical logs, sawnwood and plywood in tropical producer countries, i.e. Indonesia, Brazil, Malaysia, China and India
- The rapid emergence of Asia & Pacific and Latin America as producers of more processed forest products, i.e. plywood, paper and paperboard, and secondary processed products
- A rapid growth in production of fibre-based products, i.e. reconstituted panels, wood pulp, paper and paperboard, and exports of secondary processed products, i.e. wooden furniture, builder's carpentry and joinery, and other SPWP, by tropical producer countries
- A long-term downward trend in forest product prices

Global and tropical forest loss

Global forest loss (area and stock) is predicted to be reversed by 2020 in all scenarios expect for continued stock loss in the *Forest Loss* scenario (Table 6.1 to Table 6.4). Consumer countries have historically been increasing their forest area and stock, and this is predicted to continue in all scenarios at an even more rapid pace. Tropical producer countries, however, have historically experienced forest loss. This is predicted to continue, though forest area loss will be slower, and is zero under the *Tackling Climate Change* scenario due to greater planted forest expansion. Forest stock loss in producer countries is predicted to continue, particularly in the *North & South* and *Forest Loss* scenarios due to less planted forest expansion and continued conversion of forest to agriculture.

Under all four scenarios forest area loss in the regions with historically high loss, Latin America, Africa, and Asia & Pacific[7], is predicted to slow or end by 2020. For the Asia & Pacific region this loss is greatest in the *North & South* and *Forest Loss* scenarios due to less expansion of planted forest area.

For the *Forest Livelihoods* and *Tackling Climate Change* scenarios forest loss is predicted to be reversed by 2020; 0.2% per year increase in Africa, and 0.9% to 1.1% per year increase in Asia & Pacific. The main countries to increase their forest area are China, India, Malaysia, and Democratic Republic of Congo. Indonesia and Brazil are predicted to continue to lose forest, though at a slower rate; less than 1% per year and 0.15% per year, respectively.

[7] Definitions of countries included in each of the regions used in this section are provided in *Appendix 4 Timber Market Projection Methodology*

Table 6.1 Country and regional forest area (000 ha) to 2020 under alternative futures. Sources: FAO (2005) 1995-2006, Model predictions 2020

	Actual			2020			
Region	1995	2000	2006	Forest Livelihoods	Climate Change	North & South	Forest Loss
Africa	265 212	258 337	251 353	253 722	253 729	256 442	256 442
Latin America	874 624	854 065	827 496	824 545	824 927	808 530	808 163
Asia & Pacific	676 979	672 434	677 687	709 907	715 865	691 942	687 860
North America	610 599	612 428	613 527	612 415	613 904	632 298	631 184
Europe	134 038	137 755	141 418	147 297	148 060	151 818	151 255
ROW	1 456 236	1 441 143	1 422 727	1 390 380	1 392 506	1 417 310	1 415 986
Producer	1 440 170	1 399 829	1 348 250	1 343 799	1 345 258	1 322 041	1 320 858
Consumer	820 817	832 896	859 838	900 877	906 527	905 746	901 916
World	4 017 688	3 976 162	3 934 208	3 938 267	3 948 990	3 958 341	3 950 889

Table 6.2 Country and regional forest area change (% per year) to 2020 under alternative futures. Sources: FAO (2005) 1995-2005, Model predictions 2006-2020

	Actual		Growth 2006-2020 (% per year)			
Region	1995-2000	2000-2006	Forest Livelihoods	Climate Change	North & South	Forest Loss
Africa	-0.4	-0.4	0.2	0.2	0.4	0.4
Latin America	-0.4	-0.5	-0.1	-0.1	-0.5	-0.5
Asia & Pacific	-0.1	0.1	0.9	1.1	0.4	0.3
North America	0.0	0.0	0.0	0.0	0.6	0.6
Europe	0.5	0.4	0.8	0.9	1.4	1.3
ROW	-0.2	-0.2	-0.5	-0.4	-0.1	-0.1
Producer	-0.5	-0.5	-0.1	0.0	-0.4	-0.4
Consumer	0.2	0.5	0.9	1.1	1.0	1.0
World	-0.2	-0.2	0.0	0.1	0.1	0.1

Table 6.3 Country and regional forest stock (million m^3) to 2020 under alternative futures. Sources: FAO (2005) 1995-2006, Model predictions 2020

	Actual			2020			
Region	1995	2000	2006	Forest Livelihoods	Climate Change	North & South	Forest Loss
Africa	52 008	51 006	50 278	51 404	51 636	52 456	52 515
Latin America	124 872	122 744	119 001	116 618	116 929	112 396	111 942
Asia & Pacific	54 459	53 579	51 842	47 427	48 560	44 416	43 130
North America	66 089	67 051	69 076	73 726	74 247	76 413	76 251
Europe	16 633	17 540	18 906	23 387	23 704	24 311	24 250
ROW	120 112	120 910	121 372	117 491	118 593	120 967	121 020
Producer	204 225	198 636	191 076	187 115	187 940	180 182	179 262
Consumer	76 730	79 216	81 620	84 754	85 926	88 136	87 327
World	434 173	432 830	430 475	430 054	433 669	430 958	429 107

Table 6.4 Country and regional forest stock change (% per year) to 2020 under alternative futures. Sources: FAO (2005) 1995-2005, Model predictions 2006-2020

	Actual		Growth 2006-2020 (%/yr)			
Region	1995-2000	2000-2006	Forest Livelihoods	Climate Change	North & South	Forest Loss
Africa	-0.3	-0.2	0.4	0.5	0.8	0.9
Latin America	-0.3	-0.4	-0.4	-0.4	-1.1	-1.2
Asia & Pacific	-0.3	-0.5	-1.8	-1.3	-3.1	-3.7
North America	0.2	0.4	1.3	1.4	2.0	2.0
Europe	0.9	1.1	4.3	4.5	5.0	5.0
ROW	0.1	0.1	-0.7	-0.5	-0.1	-0.1
Producer	-0.5	-0.6	-0.4	-0.3	-1.2	-1.3
Consumer	0.5	0.4	0.8	1.0	1.5	1.4
World	-0.1	-0.1	0.0	0.1	0.0	-0.1

Asia & Pacific forest area expansion is slightly higher under the *Tackling Climate Change* scenario due to the assumed greater expansion of planted forests and protected forest area in that region as a result of climate change policies such as Reducing Emissions from Deforestation and Degradation (REDD) and Clean Development Mechanism (CDM). This could lead to an additional forest area of 382 000 ha by 2020 under this scenario compared with the *Forest Livelihoods* scenario.

Comparing forest area changes across alternative futures, under the *Forest Loss* scenario, Latin American forest area would be 16.8 million ha lower (approximately the land area of Bangladesh) in 2020 compared with the *Tackling Climate Change* scenario, and Asia & Pacific forest area would be 28.0 million ha lower (slightly less than the land area of the Philippines).

Despite a slowing or reversal in forest area loss in Latin America and Asia & Pacific, across all four scenarios both regions are predicted to continue to have declining forest stock. This is due to continued growth in harvests in these regions associated with expansion of production of forest products. China experiences the largest absolute decline in forest stock in the Asia & Pacific region, though the decline is small in percentage terms; less than 1% per year. The largest contributor to forest stock loss in Latin America is Brazil, though as for China the decline is small in percentage terms; less than 1% per year

Growth in consumption of tropical forest products

Growth in global wood product consumption is generally greater than historical levels under the *Forest Livelihoods* and *Tackling Climate Change* scenarios, while it is lower than historical under the *North & South* and *Forest Loss* scenarios. By 2020 global consumption is greatest under the *Tackling Climate Change* scenario. This reflects the impact of both increased demand spurred by stronger economic growth following the global economic crisis, and increased wood supply from planted forest expansion, leading to lower forest product prices. Consumption is generally lowest (15% to 20% by 2020 compared with the *Forest Livelihoods* scenario) under the *Forest Loss* scenario due to the combined impact on demand of slower economic growth and higher forest product tariffs.

Global consumption of tropical sawnwood and plywood is predicted to remain stagnant through to 2020 under the *Forest Loss* scenario due to slower economic growth and the shift in consumer preferences away from tropical forest products in key existing (North America, Europe and Japan) and emerging markets (China and India) (Figure 6.1 and Figure 6.2). This leads to a continuing shift of consumption from tropical forest products to softwood sawnwood and plywood. A consequence of this shift is that consumption of tropical logs is predicted to remain flat through to 2020 under the *Forest Loss* scenario (Figure 6.3).

Tropical log consumption varies little across scenarios because greater consumption of wood to meet higher tropical forest product demand in the *Forest Livelihoods* and *Tackling Climate Change* scenarios is offset by reduced utilisation of tropical wood due to improved processing. This demonstrates the potential to grow consumption of tropical forest products without contributing to forest loss.

Global consumption of tropical sawnwood, and especially plywood, is predicted to grow under all scenarios except *Forest Loss*. This is especially the case under *Forest Livelihoods*. This is due to the combined effect of stronger global economic growth and a shift in consumer preferences to tropical timber products under this scenario. Relatively stronger growth in tropical plywood and sawnwood consumption, compared with softwoods and hardwoods, in the *North & South* scenario reflects the strong influence of the Asia & Pacific markets on demand for tropical forest products, compared with Europe and North America. Under the *North & South* scenario Asia & Pacific has relatively stronger economic growth than other regions and consumers in these regions, compared with Europe and North America, retain a strong preference for tropical forest products.

Figure 6.1 Historical (1995-2005) and predicted (2006-2020) softwood, tropical and non-tropical hardwood sawnwood consumption under four alternative futures. Each of the lines from 2006 to 2020 are for the four scenarios, with lines going from darkest (Forest Livelihoods) to lightest (Forest Loss) for each scenario

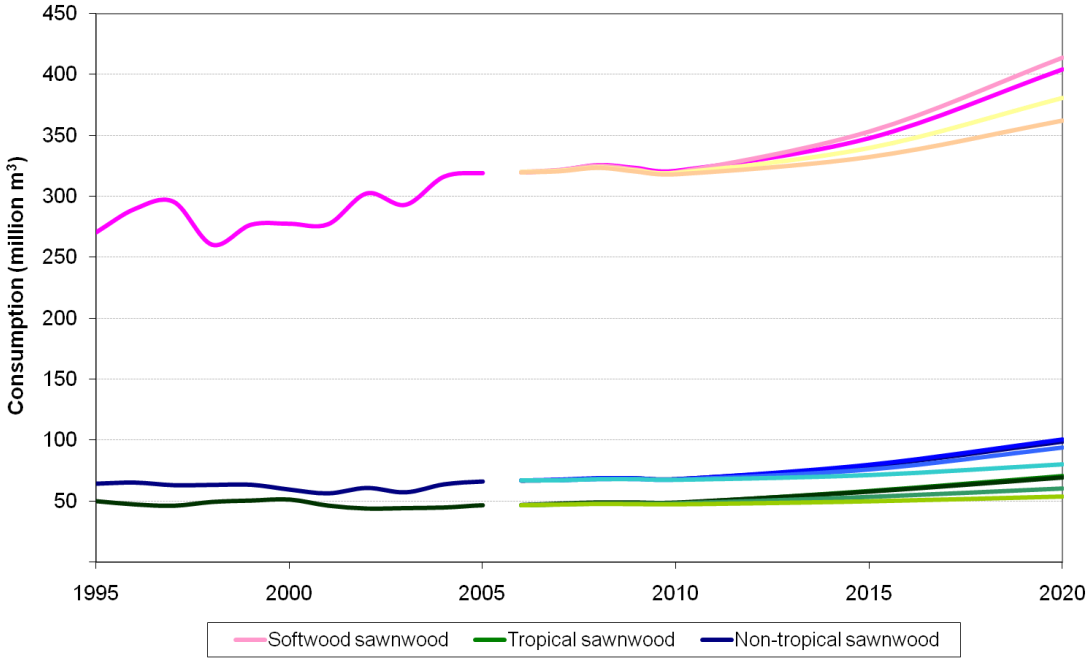
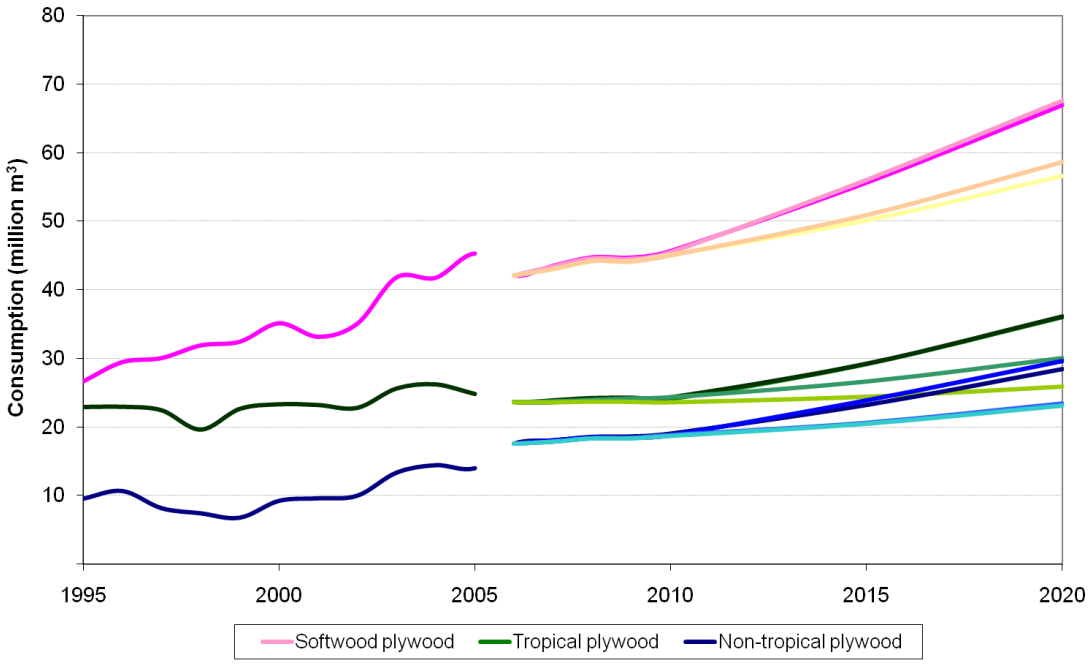


Figure 6.2 Historical (1995-2005) and predicted (2006-2020) softwood, tropical and non-tropical hardwood plywood consumption under four alternative futures.



As expected global consumption of fuelwood is predicted to grow most rapidly under the *Tackling Climate Change* scenario due to stronger demand for bioenergy as a climate change mitigation strategy (Figure 6.3).

Figure 6.3 Historical (1995-2005) and predicted (2006-2020) fuelwood, and softwood, tropical and non-tropical hardwood log consumption under four alternative futures.

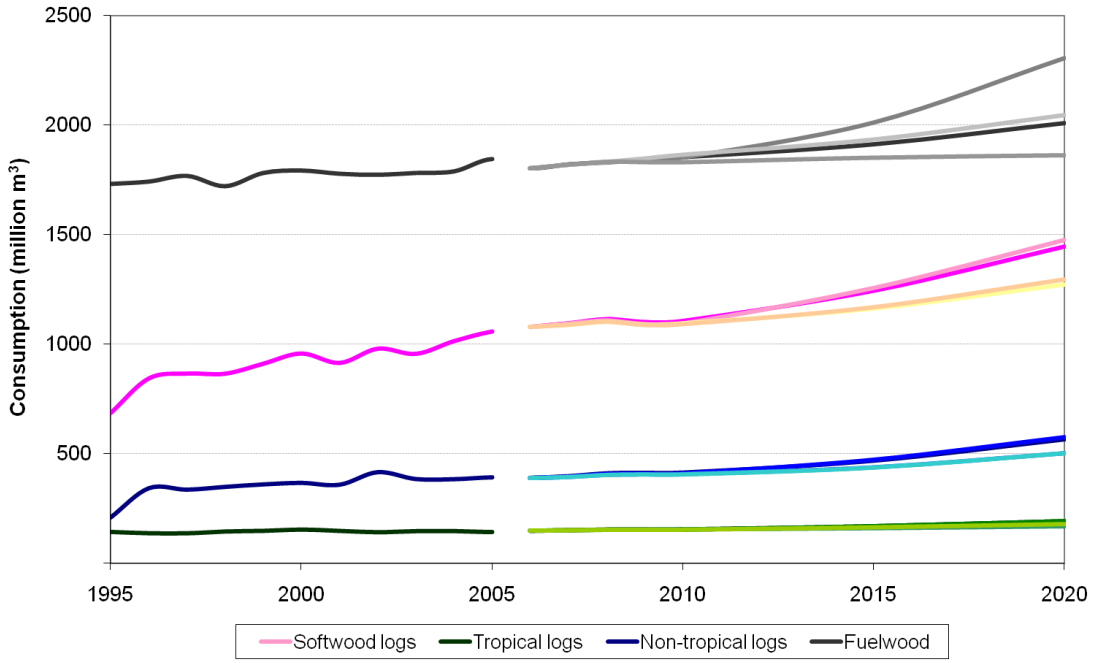
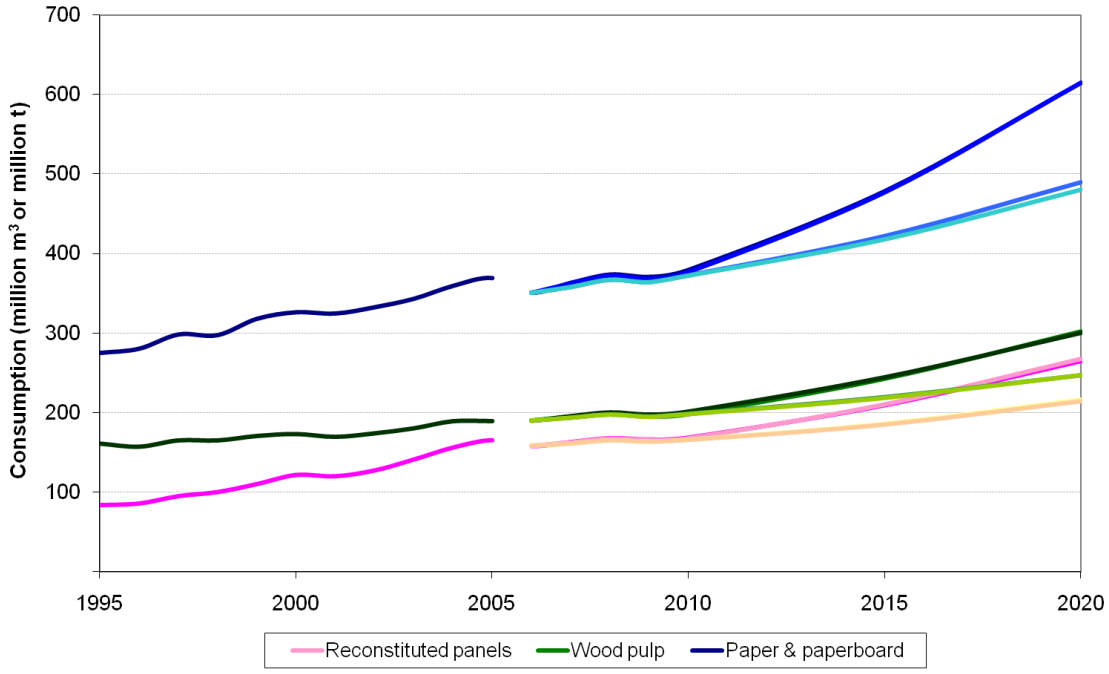


Figure 6.4 Historical (1995-2005) and predicted (2006-2020) reconstituted panel, wood pulp and paper and paperboard consumption under four alternative futures.



Global consumption trends also show that the historical shift from solidwood to fibre-based products (reconstituted panels, and paper and paperboard) is predicted to continue under all four scenarios, with growth in paper and paperboard especially strong in the *Forest Livelihoods* and *Tackling Climate Change* scenarios (Figure 6.4). This is due to the relatively stronger preference for fibre-based products compared with solidwood products, as reflected in the higher income elasticities of demand for fibre-based products (see *Appendix 4*).

Utilisation of tropical hardwoods in processed products

Tropical logs are less than 10% of global log consumption, though this belies considerable variation in shares across regions and countries (Table 6.5). Tropical logs are almost 100% of African log consumption, though across all producer countries they are approximately 50%. The share of tropical logs in wood consumption in Latin America and Asia & Pacific is 20% to 30%, while the share in North American and European consumption is negligible. The shares of softwood, tropical and hardwood in global log consumption are predicted to be largely unchanged from 2006 to 2020 across all four scenarios.

In producer countries the decline in the share of tropical log consumption continues. This decline is strongest in *Forest Livelihoods* and *Tackling Climate Change* scenarios due to improved processing in key producer countries (Malaysia, Indonesia, Brazil and China), and stronger growth in production and consumption of fibre-based products which utilise more softwood logs in production. This trend also occurs in the rest of the world, Latin America, Africa, and Asia & Pacific.

Table 6.5 Share (%) of softwood, tropical and hardwood in total log consumption, by region, historical (1995-2006) and predicted (2020) under the four alternative scenarios. Sources: ITTO and FAO for 1995 to 2006 and model predictions for 2020

		Actual			Share (%) in 2020			
Region	Commodity	1995	2000	2006	Forest Livelihoods	Climate Change	North & South	Forest Loss
Africa	Softwood	0.0	0.0	0.3	0.4	0.4	0.4	0.4
	Tropical	100.0	99.9	98.7	98.6	98.6	98.6	98.7
	Hardwood	0.0	0.0	1.0	1.0	1.0	1.0	0.9
Latin America	Softwood	36.3	41.2	41.0	44.3	43.7	43.2	40.9
	Tropical	35.2	29.2	26.9	23.2	23.6	24.0	27.3
	Hardwood	28.5	29.7	32.1	32.4	32.7	32.8	31.8
Asia & Pacific	Softwood	43.3	44.3	51.7	54.8	54.8	53.5	54.1
	Tropical	41.0	40.6	28.4	26.8	26.1	25.8	25.9
	Hardwood	15.7	15.1	19.9	18.4	19.1	20.7	20.0
North America	Softwood	78.7	71.8	73.7	71.2	71.7	71.1	71.2
	Tropical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Hardwood	21.3	28.2	26.3	28.8	28.3	28.9	28.8
Europe	Softwood	81.4	77.7	79.5	78.8	77.8	78.7	78.8
	Tropical	1.6	0.7	0.4	0.2	0.3	0.2	0.2
	Hardwood	17.0	21.6	20.1	21.1	21.9	21.1	20.9
ROW	Softwood	72.7	65.0	67.6	65.5	66.5	66.3	66.2
	Tropical	5.2	5.9	5.1	3.7	3.7	4.7	4.9
	Hardwood	22.1	29.1	27.3	30.8	29.8	29.0	28.9
Producer	Softwood	20.0	24.5	30.1	34.3	33.6	32.4	30.9
	Tropical	65.5	58.9	53.2	47.2	47.7	49.6	51.4
	Hardwood	14.5	16.7	16.8	18.5	18.7	18.1	17.7
Consumer	Softwood	80.2	76.8	75.8	75.3	75.1	74.6	74.8
	Tropical	3.1	2.2	1.9	2.4	2.1	2.0	2.4
	Hardwood	16.7	21.0	22.3	22.3	22.8	23.4	22.9
World	Softwood	66.0	64.7	66.7	65.6	65.8	65.5	65.5
	Tropical	13.9	10.5	9.2	8.7	8.5	8.7	9.0
	Hardwood	20.1	24.8	24.1	25.7	25.7	25.8	25.5

Tropical sawnwood is a slightly larger share of global sawnwood consumption, just over 10% (Table 6.6). As for logs, there is considerable variation across regions and countries. Reflecting its high tropical log consumption, almost 100% of African sawnwood consumption is tropical, compared with the producer country average of 50%. Interestingly, Latin America and Asia & Pacific differ in their shares, with Latin American sawnwood consumption including a larger share of tropical than Asia & Pacific. As for logs tropical sawnwood is a small share, less than 3%, of European and North American consumption.

At the global level, tropical sawnwood is predicted to increase its share of consumption marginally from 11% to 12% under the *Forest Livelihoods* and *Tackling Climate Change* scenarios, predominantly in the consumer countries due to the stronger preference for tropical sawnwood in these scenarios, and strong economic growth in key consumers such as China and India. The predicted growth in China's consumption of tropical sawnwood contributes to the reversal in Asia & Pacific's decline in tropical share of sawnwood consumption under the *Forest Livelihoods* and *Tackling Climate Change* scenarios (Table 6.6).

No change is predicted for European and North American shares of tropical in sawnwood consumption, despite an increased preference for tropical timber in these regions under the *Forest Livelihoods* and *Tackling Climate Change* scenarios. This is due to the already low level of tropical sawnwood consumption in these regions, combined with slower economic growth, compared with the emerging economies.

Table 6.6 Share (%) of softwood, tropical and hardwood in total sawnwood consumption, by region, historical (1995-2006) and predicted (2020) under the four alternative scenarios. Sources: ITTO and FAO for 1995 to 2006 and model predictions for 2020

		Actual			Share (%) in 2020			
Region	Commodity	1995	2000	2006	Forest Livelihoods	Climate Change	North & South	Forest Loss
Africa	Softwood	0.0	0.2	0.4	0.6	0.7	0.5	0.5
	Tropical	100.0	99.7	99.1	99.0	99.0	99.1	99.1
	Hardwood	0.0	0.1	0.5	0.3	0.3	0.4	0.4
Latin America	Softwood	24.7	43.7	43.1	46.6	47.2	46.1	39.9
	Tropical	75.3	51.2	54.8	51.1	50.9	52.1	58.1
	Hardwood	0.0	5.1	2.1	2.3	1.9	1.9	2.1
Asia & Pacific	Softwood	60.5	58.7	61.2	54.1	54.2	54.3	57.4
	Tropical	25.7	32.8	19.4	20.3	19.5	18.0	20.0
	Hardwood	13.8	8.5	19.4	25.6	26.3	27.7	22.6
North America	Softwood	79.1	78.3	81.6	81.9	82.1	81.7	82.1
	Tropical	0.2	0.2	0.2	0.2	0.2	0.2	0.1
	Hardwood	20.7	21.5	18.1	17.9	17.7	18.1	17.8
Europe	Softwood	82.8	85.1	90.7	91.5	90.6	91.5	92.3
	Tropical	4.1	3.1	2.3	1.9	2.4	2.1	1.5
	Hardwood	13.1	11.8	7.0	6.5	7.0	6.4	6.2
ROW	Softwood	68.4	66.8	66.2	67.8	68.1	66.9	66.5
	Tropical	8.0	11.5	11.2	8.5	8.7	10.6	10.8
	Hardwood	23.6	21.7	22.6	23.7	23.2	22.5	22.6
Producer	Softwood	15.2	27.2	39.6	45.7	45.8	44.6	38.3
	Tropical	84.3	69.0	56.5	50.7	50.4	51.7	58.3
	Hardwood	0.5	3.8	4.0	3.6	3.8	3.7	3.4
Consumer	Softwood	78.2	83.8	82.6	76.9	76.5	76.8	81.1
	Tropical	5.2	5.4	3.8	4.6	4.7	4.1	3.9
	Hardwood	16.6	10.8	13.6	18.5	18.8	19.1	14.9
World	Softwood	70.3	71.5	73.7	70.6	70.7	71.2	72.9
	Tropical	13.0	13.2	10.8	12.1	12.1	11.3	10.9
	Hardwood	16.7	15.4	15.5	17.3	17.2	17.6	16.2

Tropical plywood has a larger share of global plywood consumption; just under 30%, though historically this share has been declining (Table 6.7). The share of tropical in consumption varies greatly across regions and countries. The share of tropical is higher in consumer and producer countries than for other tropical products, 25% for consumers and 75% for producers, though the share has been declining in both groups of countries. Almost 100% of African plywood consumption is tropical, while 33% of Latin American and Asia & Pacific consumption is tropical. Tropical plywood is a larger share of North American and European plywood; 10% and 18% respectively, compared with sawnwood.

At the global level tropical plywood is predicted to experience a small decline in its share of plywood consumption under all scenarios, expect *Forest Loss*, where it loses share due to several factors. Firstly, there is a weaker preference for tropical wood products under this scenario in key emerging markets; China and India. China accounted for almost 25% of global tropical plywood consumption in 2005. India accounted for approximately 10% of tropical plywood and sawnwood consumption. Secondly, slower economic growth leads to slower growth in SPWP imports and hence less growth in exports of these products by key exporters such as China, which utilise tropical plywood in SPWP production. Thirdly, there is lower tropical wood supply due to continued forest loss from conversion of forest to agriculture and less planted forest expansion. Fourthly, no improvement in processing in tropical producer countries leads to relatively higher prices for tropical plywood compared with softwood plywood.

Table 6.7 Share (%) of softwood, tropical and hardwood in total plywood consumption, by region, historical (1995-2006) and predicted (2020) under the four alternative scenarios. Sources: ITTO and FAO for 1995 to 2006 and model predictions for 2020

		Actual			Share (% in 2020)			
Region	Commodity	1995	2000	2006	Forest Livelihoods	Climate Change	North & South	Forest Loss
Africa	Softwood	0.0	8.2	3.1	3.2	3.4	3.1	3.6
	Tropical	100.0	91.8	96.6	96.6	96.5	96.7	96.3
	Hardwood	0.0	0.0	0.3	0.2	0.1	0.1	0.1
Latin America	Softwood	42.2	57.6	58.3	57.1	57.4	57.9	59.8
	Tropical	62.3	31.4	35.6	32.6	32.9	34.6	33.1
	Hardwood	n.a.	11.0	6.1	10.3	9.7	7.6	7.1
Asia & Pacific	Softwood	22.4	31.0	39.7	41.8	42.1	41.4	45.7
	Tropical	62.4	57.3	39.2	34.3	33.8	35.7	31.3
	Hardwood	15.2	11.7	21.1	23.9	24.0	22.9	23.0
North America	Softwood	74.9	82.2	70.1	71.4	72.1	72.3	73.6
	Tropical	7.1	7.7	9.4	9.9	9.3	8.6	7.0
	Hardwood	18.0	10.1	20.4	18.8	18.6	19.1	19.4
Europe	Softwood	43.1	39.0	39.2	41.2	38.0	41.1	42.6
	Tropical	28.8	19.9	17.9	17.3	17.7	16.7	13.7
	Hardwood	28.1	41.1	42.9	41.6	44.4	42.2	43.7
ROW	Softwood	65.6	69.1	73.6	77.1	76.6	74.2	75.5
	Tropical	34.4	30.9	26.4	22.9	23.4	25.8	24.5
	Hardwood	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Producer	Softwood	14.3	29.7	21.1	22.4	22.2	20.8	24.8
	Tropical	87.1	63.5	76.2	73.4	73.7	76.0	71.8
	Hardwood	0.0	6.7	2.6	4.3	4.1	3.2	3.3
Consumer	Softwood	31.6	39.1	45.5	47.4	47.3	47.5	50.5
	Tropical	49.5	42.1	27.7	24.4	23.7	24.9	22.5
	Hardwood	18.9	18.8	26.8	28.2	29.1	27.6	27.1
World	Softwood	45.1	51.9	50.5	50.9	50.8	51.4	54.5
	Tropical	38.8	34.4	28.4	27.4	27.0	27.3	24.1
	Hardwood	16.1	13.6	21.1	21.7	22.2	21.2	21.5

A continued decline in the share of tropical plywood in Asia & Pacific and Latin America is predicted, with a shift to hardwood plywood. This is due to the stronger preference for hardwood plywood in producer countries in these regions, as reflected in the income elasticities of demand for tropical and hardwood plywood (see *Appendix 4*)

The share of tropical plywood in European and North American plywood consumption is predicted to be stagnant or decline, despite an increased preference for tropical timber. As for tropical sawnwood this is due to the already low level of tropical plywood consumption in these regions, combined with the relatively slower economic growth in the developed economies compared with the emerging economies.

Perhaps unexpectedly softwoods are predicted to be a declining share of log and solidwood consumption (Table 6.5 to Table 6.7). There are two separate reasons for this predicted trend. Under the *Forest Loss* and *North & South* scenarios the Russian log export tax is increased to its full extent. Due to Russia being the largest global exporter of softwood logs this increases the world price of softwoods relative to tropical and hardwood timber products encouraging a shift to the latter (Turner et al. 2008a). In the *Forest Livelihoods* and *Tackling Climate Change* scenarios the increased competitiveness of tropical timber products, through improved processing, combined with a stronger preference for tropical timber products in major markets such as China and India comes at the expense of consumption of softwood products.

Concentration of tropical timber production and consumption in tropical countries

The concentration of production and consumption of tropical timber products in tropical producer countries is predicted to remain, and in fact strengthen. This is because of stronger economic growth in many of these countries, particularly in Asia & Pacific (China, India, Malaysia and Indonesia), and improved processing in key Latin American (Brazil and Peru) and Asia & Pacific (Malaysia, Thailand, China and India) countries.

The major tropical log producers are predicted to remain Brazil, Indonesia, Malaysia and India, though Indonesia is predicted to surpass Brazilian harvests by 2020 in all four scenarios. The other significant trend is an increase in harvests from Papua New Guinea and Myanmar (Table 6.8).

Tropical producer countries have historically accounted for over 80% of global tropical sawnwood production, though that share has declined in Asia & Pacific and Latin America, with increased share going to tropical countries not in the ITTO producer group (the rest of the world in Table 6.10). Viet Nam is the major example (Table 6.9). Producer country share of tropical sawnwood production is predicted to increase slightly to 83% by 2020 under the *Forest Livelihoods* scenario due to improvements in country processing and strong economic growth in these countries. Under the *North & South* and *Forest Loss* scenarios production is predicted to continue to decline to 80%, with an increased share going to producers such as Viet Nam.

Changes in country rankings for tropical sawnwood and plywood production are strongly influenced by changes in competitiveness due to investment, or lack of investment, in improved processing. As such, the major tropical sawnwood producers are predicted to remain Brazil, Malaysia, India and Indonesia (Table 6.9). Under all four scenarios China is predicted to emerge as an important producer of tropical sawnwood, moving up the rankings. This is especially the case under the *North & South* scenario where China surpasses Indonesia as a producer due to China improving processing technology, while Indonesian processing is unimproved. This also explains the shift down the rankings of Cameroon in all scenarios except *Forest Livelihoods* where the country is able to invest in improved processing due to greater availability of global capital.

Table 6.8 The world top 11 producers of tropical logs, in 2005 and 2020 under the four scenarios; production (000 m^3) and share of global production (%). Source: FAO and ITTO for 2005, model predictions for 2020

	Actual		% of	Forest Livelihoods		% of	Climate Change		% of	North & South		% of	Forest Loss		% of
	Country	2005	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total
1	Brazil	26 600	18.3	Indonesia	43 056	22.4	Indonesia	41 749	21.9	Indonesia	33 426	19.8	Indonesia	34 656	19.4
2	Malaysia	24 219	16.7	Brazil	30 200	15.7	Brazil	30 170	15.8	Brazil	25 116	14.8	Brazil	30 233	16.9
3	Indonesia	22 590	15.6	India	21 870	11.4	India	21 744	11.4	Malaysia	20 604	12.2	Malaysia	20 604	11.5
4	India	20 312	14.0	Malaysia	20 604	10.7	Malaysia	20 604	10.8	India	18 629	11.0	India	17 921	10.0
5	Nigeria	7 100	4.9	Myanmar	7 383	3.8	Myanmar	7 386	3.9	Thailand	7 839	4.6	Nigeria	7 176	4.0
6	Thailand	5 100	3.5	Nigeria	7 156	3.7	Nigeria	7 281	3.8	Nigeria	7 151	4.2	Myanmar	7 031	3.9
7	Myanmar	4 047	2.8	Thailand	5 964	3.1	Thailand	6 308	3.3	Myanmar	6 615	3.9	Thailand	6 971	3.9
8	Viet Nam	3 454	2.4	PNG	5 243	2.7	PNG	5 073	2.7	Viet Nam	6 248	3.7	Viet Nam	6 734	3.8
9	Gabon	3 200	2.2	Gabon	4 794	2.5	Viet Nam	4 515	2.4	PNG	4 421	2.6	PNG	4 794	2.7
10	China	3 045	2.1	Viet Nam	4 612	2.4	Gabon	4 188	2.2	Gabon	3 829	2.3	Gabon	4 271	2.4
11	PNG	2 486	1.7	Cameroon	3 684	1.9	Cameroon	3 674	1.9	Cameroon	3 461	2.0	Cameroon	4 038	2.3
	Total	145 048	84.2	Total	192 402	80.3	Total	190 784	80.0	Total	169 240	81.2	Total	178 482	80.9

Table 6.9 The world top 10 producers of tropical sawnwood, in 2005 and 2020 under the four scenarios; production (000 m^3) and share of global production (%). Source: FAO and ITTO for 2005, model predictions for 2020

	Actual		% of	Forest Livelihoods		% of	Climate Change		% of	North & South		% of	Forest Loss		% of
	Country	2005	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total
1	Brazil	14 622	30.7	Brazil	25 580	35.3	Brazil	25 547	34.6	Brazil	21 045	33.2	Brazil	18 460	32.3
2	Malaysia	5 173	10.8	India	8 268	11.4	India	8 365	11.3	India	7 351	11.6	India	4 900	8.6
3	India	4 889	10.3	Indonesia	5 885	8.1	Indonesia	5 969	8.1	Malaysia	5 292	8.4	Indonesia	4 114	7.2
4	Indonesia	4 330	9.1	Malaysia	3 867	5.3	China	4 442	6.0	China	4 341	6.9	Malaysia	3 882	6.8
5	Viet Nam	3 232	6.8	Viet Nam	3 171	4.4	Malaysia	4 283	5.8	Viet Nam	3 523	5.6	Viet Nam	3 808	6.7
6	Thailand	2 850	6.0	China	3 003	4.1	Viet Nam	3 121	4.2	Indonesia	3 304	5.2	China	2 444	4.3
7	Nigeria	2 000	4.2	Myanmar	2 339	3.2	Myanmar	2 456	3.3	Nigeria	2 201	3.5	Myanmar	2 240	3.9
8	Myanmar	1 469	3.1	Nigeria	2 231	3.1	Nigeria	2 288	3.1	Thailand	2 184	3.4	Nigeria	2 210	3.9
9	Cameroon	1 000	2.1	Thailand	2 031	2.8	Thailand	2 014	2.7	Myanmar	1 911	3.0	Thailand	1 869	3.3
10	Madagascar	753	1.6	Cameroon	1 959	2.7	Peru	1 531	2.1	Peru	1 334	2.1	Cameroon	1 552	2.7
	Total	47 679	87.3	Total	72 517	84.2	Total	73 750	84.9	Total	63 366	86.9	Total	57 142	83.7

Table 6.10 Historical (1995-2006) and predicted (2020) regional shares of world production of tropical sawnwood. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Share of world production (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	4.4	8.6	9.5	10.0	8.6	8.5	11.4
Latin America	34.2	32.0	34.6	41.3	40.4	38.5	37.9
Asia & Pacific	51.7	46.6	42.2	36.4	38.7	39.5	35.2
North America	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Europe	1.5	1.3	0.3	0.2	0.5	0.2	0.2
ROW	8.1	11.5	13.5	12.1	11.8	13.3	15.2
Producer	87.3	83.8	82.8	83.3	81.4	79.5	80.0
Consumer	4.6	4.6	3.7	4.6	6.8	7.2	4.8

Table 6.11 Historical (1995-2006) and predicted (2020) regional shares of world production of tropical plywood. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Share of world production (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	2.5	4.4	4.7	5.4	4.4	4.2	5.0
Latin America	6.5	6.7	6.4	7.4	7.4	7.8	8.1
Asia & Pacific	85.7	83.9	82.8	83.1	83.9	83.6	81.4
North America	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Europe	2.7	2.4	1.9	0.7	1.0	0.9	1.4
ROW	2.6	2.7	4.2	3.3	3.4	3.5	4.1
Producer	71.5	75.6	65.9	68.4	67.1	66.0	57.8
Consumer	25.8	21.7	29.9	28.3	29.5	30.5	38.1

The tropical producer countries have historically accounted for 70% of global production of tropical plywood. This share is predicted to decline slightly under all scenarios with an increased share going to consumer countries in Asia & Pacific, specifically China (Table 6.11).

The top five producers of tropical plywood are predicted to remain China, Malaysia, Indonesia, India and Brazil (Table 6.12). Japan's production of plywood is predicted to decline to the point that it does not appear among the top 10 producers in any of the scenarios except *Forest Loss*, with the Philippines emerging as the seventh largest producer. Côte d'Ivoire is also predicted to emerge as an important producer of tropical plywood, though production levels are still predicted to be well below those of the top five producers.

Changes in country rankings for consumption of tropical logs are influenced by relative competitive advantage and the level of investment in processing. Rankings for tropical log consumption are largely unchanged across scenarios with Brazil, Indonesia, India, Malaysia and China remaining the largest consumers (Table 6.13). This reflects the fact that all five countries are predicted to remain competitive in tropical forest product processing under the *Forest Livelihoods* and *Tackling Climate Change* scenarios through investment in processing.

Country rankings for consumption of tropical sawnwood and plywood are influenced by differences across countries in their preferences for tropical wood products (as captured in the income elasticity of demand; see *Study Methodology*), their relative economic growth rates, and export of secondary processed products using tropical wood products. The major consumers of tropical sawnwood are higher economic growth economies (Brazil, India, China, Malaysia, Indonesia and Viet Nam) and important exporters of secondary processed products. As such these countries remain significant consumers (Table 6.14).

Table 6.12 The world top 10 producers of tropical plywood, in 2005 and 2020 under the four scenarios; production (000 m^3) and share of global production (%). Source: FAO and ITTO for 2005, model predictions for 2020

	Actual		% of	Forest Livelihoods		% of	Climate Change		% of	North & South		% of	Forest Loss		% of
	Country	2005	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total
1	China	5 811	23.5	China	9 640	26.2	China	9 652	26.3	Malaysia	8 886	28.9	China	8 899	33.5
2	Malaysia	5 676	23.0	Malaysia	8 397	22.8	Malaysia	7 757	21.2	China	8 566	27.8	Malaysia	6 026	22.7
3	Indonesia	3 975	16.1	Indonesia	6 444	17.5	Indonesia	6 853	18.7	India	3 942	12.8	Indonesia	2 815	10.6
4	India	2 400	9.7	India	4 398	12.0	India	4 451	12.1	Indonesia	2 876	9.3	India	2 173	8.2
5	Brazil	1 425	5.8	Brazil	1 766	4.8	Brazil	1 773	4.8	Brazil	1 683	5.5	Brazil	1 450	5.4
6	Japan	645	2.6	Gabon	592	1.6	Philippines	614	1.7	Côte d'Ivoire	467	2.0	Japan	446	1.7
7	Philippines	447	1.8	Ghana	588	1.6	Ghana	595	1.6	Ecuador	427	1.4	Philippines	430	1.6
8	Ghana	420	1.7	Philippines	545	1.5	Côte d'Ivoire	520	1.6	Philippines	370	1.2	Côte d'Ivoire	424	1.9
9	Korea, Rep.	420	1.7	Ecuador	531	1.4	Ecuador	519	1.4	Ghana	347	1.1	Ecuador	410	1.5
10	Ecuador	373	1.5	Côte d'Ivoire	504	1.6	Japan	416	1.1	Gabon	313	1.0	Ghana	402	1.5
	Total	24 693	90.1	Total	36 770	92.5	Total	36 649	92.5	Total	30 770	93.0	Total	26 604	91.2

Table 6.13 The world top 10 consumers of tropical logs, in 2005 and 2020 under the four scenarios; consumption (000 m^3) and share of global consumption (%). Source: FAO and ITTO for 2005, model predictions for 2020

	Actual		% of	Forest Livelihoods		% of	Climate Change		% of	North & South		% of	Forest Loss		% of
	Country	2005	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total
1	Brazil	26 603	18.6	Indonesia	43 059	22.4	Indonesia	41 752	21.9	Indonesia	33 428	19.7	Indonesia	34 658	19.4
2	Indonesia	22 495	15.7	Brazil	30 202	15.7	Brazil	30 173	15.8	Brazil	25 117	14.8	Brazil	30 235	16.9
3	India	21 491	15.0	India	23 042	12.0	India	23 314	12.2	India	20 535	12.1	India	18 864	10.6
4	Malaysia	18 577	13.0	China	21 220	11.0	China	17 971	9.4	Malaysia	18 180	10.7	China	18 386	10.3
5	China	11 402	8.0	Malaysia	14 890	7.7	Malaysia	16 084	8.4	China	15 615	9.2	Malaysia	16 569	9.3
6	Nigeria	7 062	4.9	Nigeria	7 098	3.7	Nigeria	7 234	3.8	Thailand	7 935	4.7	Nigeria	7 123	4.0
7	Thailand	5 163	3.6	Thailand	6 070	3.2	Thailand	6 438	3.4	Nigeria	7 093	4.2	Thailand	7 013	3.9
8	Viet Nam	3 466	2.4	Viet Nam	4 629	2.4	Viet Nam	4 537	2.4	Viet Nam	6 266	3.7	Viet Nam	6 748	3.8
9	Cameroon	2 123	1.5	Myanmar	3 516	1.8	Myanmar	3 661	1.9	Cameroon	3 145	1.9	Cameroon	3 722	2.1
10	Myanmar	1 228	0.9	Philippines	3 387	1.8	Philippines	3 613	1.9	Myanmar	2 816	1.7	Myanmar	3 277	1.8
	Total	143 196	83.5	Total	192 443	81.6	Total	190 826	81.1	Total	169 281	82.8	Total	178 523	82.1

Table 6.14 The world top 10 consumers of tropical sawnwood, in 2005 and 2020 under the four scenarios; consumption (000 m^3) and share of global consumption (%). Source: FAO and ITTO for 2005, model predictions for 2020

	Actual		% of	Forest Livelihoods		% of	Climate Change		% of	North & South		% of	Forest Loss		% of
	Country	2005	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total
1	Brazil	12 817	27.5	Brazil	22 503	32.4	Brazil	22 743	32.2	Brazil	17 933	29.8	Brazil	15 399	28.5
2	India	4 924	10.6	India	8 415	12.1	India	8 488	12.0	India	7 428	12.3	China	6 220	11.5
3	China	3 862	8.3	China	7 345	10.6	China	7 474	10.6	China	6 390	10.6	India	4 961	9.2
4	Malaysia	3 771	8.1	Viet Nam	3 241	4.7	Viet Nam	3 203	4.5	Viet Nam	3 676	6.1	Viet Nam	3 877	7.2
5	Viet Nam	3 377	7.3	Indonesia	3 228	4.7	Indonesia	3 197	4.5	Malaysia	2 736	4.5	Indonesia	3 116	5.8
6	Indonesia	2 739	5.9	Malaysia	2 832	4.1	Malaysia	2 929	4.1	Indonesia	2 453	4.1	Malaysia	2 808	5.2
7	Nigeria	1 958	4.2	Nigeria	2 211	3.2	Nigeria	2 257	3.2	Nigeria	2 190	3.6	Nigeria	2 192	4.1
8	Thailand	1 762	3.8	Thailand	2 110	3.0	Thailand	2 072	2.9	Thailand	1 886	3.1	Myanmar	1 701	3.1
9	Myanmar	1 070	2.3	Myanmar	1 962	2.8	Myanmar	1 965	2.8	Myanmar	1 735	2.9	Thailand	1 472	2.7
10	Peru	551	1.2	Peru	1 205	1.7	Peru	1 210	1.7	Peru	993	1.6	Peru	841	1.6
	Total	46 555	79.1	Total	69 394	79.3	Total	70 628	78.6	Total	60 244	78.7	Total	54 021	78.8

Table 6.15 The world top 12 consumers of tropical plywood, in 2005 and 2020 under the four scenarios; consumption (000 m^3) and share of global consumption (%). Source: FAO and ITTO for 2005, model predictions for 2020

	Actual		% of	Forest Livelihoods		% of	Climate Change		% of	North & South		% of	Forest Loss		% of
	Country	2005	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total	Country	2020	world total
1	China	6 076	24.5	China	9 780	27.1	China	10 050	27.9	China	8 706	28.9	China	8 971	34.6
2	Japan	4 094	16.5	Japan	4 442	12.3	India	4 397	12.2	Japan	4 199	14.0	Japan	3 237	12.5
3	India	2 350	9.5	India	4 340	12.0	Japan	4 360	12.1	India	3 828	12.7	India	2 144	8.3
4	USA	1 988	8.0	Korea, Rep.	3 625	10.0	Korea, Rep.	2 918	8.1	USA	2 212	7.4	USA	1 751	6.8
5	Korea, Rep.	1 792	7.2	USA	2 627	7.3	USA	2 461	6.8	Korea, Rep.	1 697	5.6	Indonesia	1 656	2.5
6	Indonesia	1 335	5.4	Indonesia	2 395	6.6	Indonesia	2 421	6.7	Indonesia	1 604	5.3	Korea, Rep.	1 305	5.0
7	Malaysia	892	3.6	Singapore	679	1.9	Philippines	752	2.1	Singapore	644	2.1	Singapore	590	2.3
8	Philippines	501	2.0	Philippines	669	1.9	Singapore	725	2.0	Malaysia	595	2.0	Malaysia	566	2.2
9	Singapore	500	2.0	Malaysia	613	1.7	Malaysia	635	1.8	Philippines	495	1.6	Philippines	464	1.8
10	Brazil	444	1.8	Ecuador	483	1.3	UK	565	1.6	Côte d'Ivoire	402	2.7	Ecuador	375	1.4
11	France	352	1.4	France	426	1.2	Ecuador	484	1.3	France	398	1.3	France	306	1.2
12	UK	332	1.3	Brazil	401	1.1	France	415	1.2	Ecuador	384	1.3	Côte d'Ivoire	306	2.6
	Total	24 801	84.6	Total	36 086	85.5	Total	35 965	85.0	Total	30 086	86.1	Total	25 920	82.2

Only for tropical plywood consumption do developed economies appear in the list of top 10 consumers; Japan, the United States, France and the United Kingdom (Table 6.15). However, comparatively stronger economic growth in Asia & Pacific countries, such as China, India, Republic of Korea, and Indonesia, especially in the *Forest Livelihoods* and *Tackling Climate Change* scenarios, and growth in exports of secondary processed products by China, India and Indonesia, mean that these countries pass the United States in the rankings and increase their share of global consumption.

Emergence of Asia-Pacific and Latin American producers

Except for tropical sawnwood and plywood, North America and Europe have historically been the largest producers of forest products. By 2006 Asia & Pacific had surpassed North American and European production of all plywoods, paper and paperboard, and secondary processed wood products. Most of this growth has occurred in China, and to a lesser extent in Indonesia, Malaysia and the Republic of Korea.

Asia & Pacific is predicted to experience the largest growth in production of a number of forest products. The region is predicted to surpass North American and European production of reconstituted panels by 2020 under all four scenarios, with the largest gains in share under the *Tackling Climate Change* and *North & South* scenarios (Table 6.16). The main countries to increase panel production are China, Malaysia and Thailand. The Asia & Pacific region is also predicted to close the gap with North America and Europe in hardwood sawnwood production under all scenarios, surpassing North America's share in the *North & South* scenario (Table 6.17). This increased production comes almost entirely from China.

Table 6.16 Historical (1995-2006) and predicted (2020) regional shares of world production of reconstituted panels. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Share of world production (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	0.1	0.2	0.1	0.1	0.1	0.1	0.1
Latin America	2.2	2.6	2.8	2.7	2.7	2.5	1.0
Asia & Pacific	16.0	14.6	22.7	29.9	31.0	30.9	29.7
North America	32.6	33.7	27.7	21.6	21.9	22.6	23.3
Europe	36.4	37.9	33.3	27.8	26.5	27.9	29.2
ROW	12.8	11.0	13.5	17.9	17.8	16.0	16.7
Producer	4.2	5.2	5.7	4.3	4.7	6.1	3.5
Consumer	57.7	60.3	62.2	66.3	63.4	64.8	66.3

Table 6.17 Historical (1995-2006) and predicted (2020) regional shares of world production of hardwood sawnwood. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Share of world production (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Latin America	0.0	1.6	0.5	0.7	0.8	0.8	0.5
Asia & Pacific	19.9	7.2	23.2	29.5	30.6	35.2	24.5
North America	47.6	54.7	44.5	33.2	33.7	34.4	40.1
Europe	11.4	12.7	6.6	5.7	5.6	5.1	6.1
ROW	21.1	23.8	25.0	30.8	29.3	24.5	28.7
Producer	0.3	2.1	1.1	1.6	1.8	1.7	1.1
Consumer	32.8	21.3	31.9	36.2	37.2	41.6	32.9

Table 6.18 Historical (1995-2006) and predicted (2020) regional shares of world production of wood pulp. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Share of world production (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	0.0	0.1	0.0	0.1	0.1	0.1	0.1
Latin America	4.0	4.6	5.6	8.7	8.2	7.9	7.8
Asia & Pacific	14.1	16.2	17.5	24.4	21.4	24.1	20.7
North America	52.0	45.8	42.0	26.7	34.1	27.9	29.7
Europe	22.7	24.6	25.3	26.0	23.1	26.2	27.4
ROW	7.2	8.7	9.5	14.2	13.1	13.8	14.2
Producer	6.1	8.1	9.6	15.3	14.4	13.9	13.7
Consumer	50.2	52.3	52.1	49.3	48.7	50.7	48.6

Table 6.19 Historical (1995-2006) and predicted (2020) regional shares of world production of hardwood plywood. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Share of world production (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latin America	0.0	0.2	0.4	1.6	1.4	1.0	0.9
Asia & Pacific	40.2	39.9	64.8	70.2	69.7	68.6	68.8
North America	37.3	31.4	19.6	16.1	14.8	17.2	17.3
Europe	22.5	28.5	15.1	12.2	14.1	13.2	13.0
ROW	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Producer	0.0	0.2	0.4	1.6	1.4	1.0	0.9
Consumer	65.9	74.4	83.6	87.5	87.6	88.2	88.3

Table 6.20 Historical (1995-2006) and predicted (2020) regional shares of world production of paper and paperboard. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Share of world production (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Latin America	3.8	3.7	4.0	6.5	6.5	5.5	5.4
Asia & Pacific	27.8	29.3	31.7	41.9	41.8	37.7	35.9
North America	37.1	33.0	29.0	18.3	21.3	20.8	21.3
Europe	26.2	27.9	28.0	23.5	20.7	26.5	27.5
ROW	5.1	6.1	7.2	9.7	9.6	9.4	9.8
Producer	7.3	8.4	8.9	14.1	14.2	12.2	11.7
Consumer	57.2	59.0	60.4	60.5	59.0	60.6	60.2

Asia & Pacific also increases its wood pulp production, particularly from China, Indonesia and Republic of Korea, further closing the gap with North America and Europe (Table 6.18), maintains its dominance in global plywood production, especially tropical (Table 6.11) and hardwood plywood (Table 6.19) from China, Malaysia and India, paper and paperboard production from China and Indonesia (Table 6.20), and secondary processed product exports, especially wooden furniture and other SPWP from China, Malaysia, Indonesia and India (Table 6.21 to Table 6.23).

Table 6.21 Historical (1995-2006) and predicted (2020) regional shares of total net-exports of builder's carpentry. Sources: COMTRADE 1995 to 2006, model predictions for 2020

	Share of total net-exports (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	0.5	0.3	0.2	0.1	0.2	0.2	0.1
Latin America	22.0	12.4	10.2	10.4	11.8	10.8	3.3
Asia & Pacific	120.8	88.7	42.1	50.4	49.6	42.8	38.8
North America	0.0	0.0	23.5	13.9	12.2	21.0	32.7
Europe	-43.3	-1.4	23.9	25.1	26.1	25.2	25.1
ROW	0.0	0.1	0.1	0.1	0.1	0.0	0.0
Producer	127.5	85.3	35.6	35.3	37.1	26.7	14.8
Consumer	-27.5	14.7	64.3	64.6	62.8	73.2	85.2

Table 6.22 Historical (1995-2006) and predicted (2020) regional shares of total net-exports of other secondary processed wood products. Sources: COMTRADE 1995 to 2006, model predictions for 2020

	Share of total net-exports (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	1.8	1.3	0.6	0.2	0.1	0.6	0.3
Latin America	7.4	10.5	15.8	15.8	16.0	16.3	3.3
Asia & Pacific	44.6	43.5	64.1	78.7	77.7	77.2	79.6
North America	0.0	0.0	1.0	0.5	0.3	1.2	1.3
Europe	46.3	43.1	17.7	4.1	5.2	4.7	15.4
ROW	0.0	1.6	0.8	0.7	0.7	0.1	0.2
Producer	28.1	30.3	39.0	37.3	37.0	28.0	14.0
Consumer	71.9	68.1	60.2	62.0	62.3	71.9	85.8

Table 6.23 Historical (1995-2006) and predicted (2020) regional shares of total net-exports of wooden furniture. Sources: COMTRADE 1995 to 2006, model predictions for 2020

	Share of total net-exports (%)						
	Actual			Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995	2000	2006	2020	2020	2020	2020
Africa	0.4	0.3	0.3	0.3	0.2	0.3	0.3
Latin America	7.0	7.4	7.0	6.4	6.7	6.3	3.5
Asia & Pacific	9.8	38.2	61.1	67.8	64.3	68.8	70.1
North America	0.0	0.0	2.5	2.1	2.6	2.6	2.7
Europe	82.8	52.1	21.4	16.7	19.9	16.5	17.0
ROW	0.0	1.9	7.7	6.8	6.3	5.5	6.3
Producer	17.5	25.8	29.0	27.0	25.9	25.5	22.3
Consumer	82.5	72.4	63.4	66.2	67.8	68.9	71.4

Africa is also predicted to experience strong growth in forest product production, though the region's share of global production will remain small within the short timeframe to 2020. The region's largest gains in global share of production are for tropical forest products, reflecting the regions focus on tropical log consumption. Tropical sawnwood production increases its share from 9.5% in 2006 to between 8.5% and 11.4% by 2020 (Table 6.10) and tropical plywood from 4.7% in 2006 to between 4.2% and 5.4% by 2020 (Table 6.11).

An unexpected result is that Africa is predicted to increase its share of global tropical sawnwood production most under the *Forest Loss* scenario, the scenario with the least favourable circumstances for tropical timber products (lower economic growth, higher import tariffs, and weaker preferences for tropical timber products). This is due to less competition in

production from Latin America and Asia & Pacific under this scenario because there is less improvement in processing in these regions. It is also important to remember that while Africa increases its share of global production of these products in the *Forest Loss* scenario, it experiences only a small increase in volume produced due to lower global consumption arising from slower economic expansion.

Under the *Forest Loss* scenario Latin America, specifically Brazil, is predicted to lose a significant share of the exports of builder's carpentry (Table 6.21) and other SPWP (Table 6.22) due to a decline in exports of these products under this scenario (Table 6.29 to Table 6.31). This is due to a combination of lower global import demand and China's gaining a greater share of exports of this demand.

Growth in production of fibre-based and secondary processed products

As has occurred historically the rate of growth in fibre-based product production (reconstituted panels, wood pulp, and paper and paperboard) and secondary processed products is more rapid than for traditional solidwood products (Table 6.24 to Table 6.31). This is particularly the case in Asia & Pacific (greater than 5.5% per year) and Latin America (greater than 6.0% per year). The key producers in Asia & Pacific are China for reconstituted panels, wood pulp, paper and paperboard, and all SPWP, Malaysia and Thailand for reconstituted panels and wooden furniture, and Indonesia for wood pulp, paper and paperboard and other SPWP. The key producer in Latin America for fibre-based products and SPWP is Brazil.

The continued growth in production of fibre-based products is due to stronger growth in demand for reconstituted panels, paper and paperboard and secondary processed products (as captured by higher income elasticities of demand; see *Study Methodology*) and expansion of planted forest area in Asia & Pacific and Latin America countries. In the *Forest Livelihoods* and *Tackling Climate Change* scenarios production of these products, especially reconstituted panels and SPWP, is also boosted by improvements in processing, particularly in countries in Latin America and Asia & Pacific.

Africa is also predicted to experience stronger growth in production of fibre-based products, compared with solidwood products, with growth rates comparable to those of Asia & Pacific (Table 6.21 to Table 6.25). The growth in wood pulp and paper and paperboard is predicted to occur in Nigeria. However, this growth is from a much smaller base than for the Asia & Pacific region.

Table 6.24 Historical (1995-2006) and predicted (2020) regional growth rates of world production of softwood sawnwood. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Growth rate (% per year)					
	Actual		Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995-2000	2000-2006	2006-2020	2006-2020	2006-2020	2006-2020
Africa	-	-	5.4	5.5	2.2	2.7
Latin America	11.6	1.8	4.5	4.7	3.0	-0.7
Asia & Pacific	-6.8	4.9	0.7	1.3	0.6	-0.8
North America	-1.4	1.4	2.0	1.8	1.8	1.8
Europe	3.4	2.5	0.1	0.3	0.0	0.1
ROW	1.1	3.2	2.3	2.7	1.2	1.0
Producer	9.4	8.8	4.6	4.7	3.2	-0.1
Consumer	0.5	2.2	0.2	0.5	0.1	0.0

Table 6.25 Historical (1995-2006) and predicted (2020) regional growth rates of world production of softwood plywood. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Growth rate (% per year)					
	Actual		Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995-2000	2000-2006	2006-2020	2006-2020	2006-2020	2006-2020
Africa	-	-	3.8	3.8	3.2	3.1
Latin America	19.5	5.3	4.5	4.0	3.8	2.8
Asia & Pacific	6.8	13.3	2.9	3.0	2.1	1.9
North America	1.6	-2.9	1.3	1.3	0.7	0.9
Europe	1.8	4.8	2.6	3.0	1.4	2.8
ROW	5.5	8.3	3.8	4.1	1.3	3.3
Producer	19.7	9.1	4.1	3.8	2.8	1.8
Consumer	5.1	10.3	2.9	2.9	2.0	2.1

Table 6.26 Historical (1995-2006) and predicted (2020) regional growth rates of world production of reconstituted panels. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Growth rate (% per year)					
	Actual		Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995-2000	2000-2006	2006-2020	2006-2020	2006-2020	2006-2020
Africa	29.3	-16.8	6.7	5.9	5.6	5.6
Latin America	9.3	4.9	3.2	3.3	1.4	-4.7
Asia & Pacific	4.6	10.2	5.3	5.6	4.2	3.8
North America	6.7	1.1	1.8	2.0	0.7	0.9
Europe	6.8	2.0	2.3	2.0	0.9	1.2
ROW	3.6	6.8	5.3	5.4	3.3	3.5
Producer	9.6	5.2	1.6	2.3	2.6	-1.3
Consumer	6.9	4.3	3.9	3.7	2.4	2.5

Table 6.27 Historical (1995-2006) and predicted (2020) regional growth rates of world production of wood pulp. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Growth rate (% per year)					
	Actual		Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995-2000	2000-2006	2006-2020	2006-2020	2006-2020	2006-2020
Africa	32.5	-0.1	5.9	4.9	5.8	5.9
Latin America	3.2	4.3	5.9	5.6	4.0	4.0
Asia & Pacific	3.3	2.4	5.3	4.5	3.9	2.9
North America	-1.2	0.0	0.0	1.7	-1.0	-0.5
Europe	2.3	1.7	3.3	2.5	2.0	2.3
ROW	4.0	2.6	5.7	5.2	4.2	4.4
Producer	5.8	3.7	6.1	5.8	4.2	4.1
Consumer	1.6	1.2	2.7	2.7	1.6	1.3

Table 6.28 Historical (1995-2006) and predicted (2020) regional growth rates of world production of paper and paperboard. Sources: ITTO and FAO 1995 to 2006, model predictions for 2020

	Growth rate (% per year)					
	Actual		Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995-2000	2000-2006	2006-2020	2006-2020	2006-2020	2006-2020
Africa	31.5	-0.4	5.0	4.1	5.0	5.0
Latin America	1.9	2.4	6.9	6.9	4.3	4.0
Asia & Pacific	3.3	2.3	5.6	5.6	3.4	2.9
North America	0.5	-0.6	0.6	1.7	0.0	0.0
Europe	3.5	1.2	2.6	1.7	1.9	2.0
ROW	5.4	3.6	5.7	5.6	4.0	4.1
Producer	4.8	2.0	6.8	6.9	4.3	3.9
Consumer	2.9	1.5	3.7	3.6	2.2	2.1

Table 6.29 Historical (1995-2006) and predicted (2020) regional growth rates of total net-exports of builder's carpentry. Sources: COMTRADE 1995 to 2006, model predictions for 2020

	Growth rate (% per year)					
	Actual		Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995-2000	2000-2006	2006-2020	2006-2020	2006-2020	2006-2020
Africa	6.4	11.6	-2.0	3.0	1.9	-6.1
Latin America	6.2	11.4	2.1	3.2	2.0	-6.0
Asia & Pacific	10.7	3.5	3.2	3.4	1.7	1.0
North America	-	-	-1.5	-2.1	0.9	3.8
Europe	n.a.	n.a.	2.3	2.8	1.9	1.9
ROW	-	21.5	2.0	2.0	-5.9	-5.9
Producer	9.1	1.7	1.9	2.5	-0.3	-4.3
Consumer	n.a.	35.3	2.0	2.1	2.5	3.4

Table 6.30 Historical (1995-2006) and predicted (2020) regional growth rates of total net-exports of other secondary processed wood products. Sources: COMTRADE 1995 to 2006, model predictions for 2020

	Growth rate (% per year)					
	Actual		Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995-2000	2000-2006	2006-2020	2006-2020	2006-2020	2006-2020
Africa	3.5	-5.5	-3.3	-5.8	3.2	-2.1
Latin America	14.3	12.3	3.9	4.0	3.2	-7.8
Asia & Pacific	8.0	12.0	5.2	5.2	4.3	4.2
North America	-	-	-1.2	-5.3	3.8	4.3
Europe	7.2	-6.2	-5.9	-4.2	-5.9	1.8
ROW	-	-3.0	2.9	2.9	-8.4	-7.5
Producer	9.7	10.1	3.6	3.6	0.8	-4.1
Consumer	7.5	4.7	4.1	4.2	4.2	5.1

Table 6.31 Historical (1995-2006) and predicted (2020) regional growth rates of total net-exports of wooden furniture. Sources: COMTRADE 1995 to 2006, model predictions for 2020

	Growth rate (% per year)					
	Actual		Forest Livelihoods	Climate Change	North & South	Forest Loss
Region	1995-2000	2000-2006	2006-2020	2006-2020	2006-2020	2006-2020
Africa	9.0	5.8	1.9	1.9	1.9	1.9
Latin America	13.3	6.3	2.7	3.3	2.2	-1.9
Asia & Pacific	35.1	14.0	3.9	3.9	3.7	3.6
North America	-	-	2.0	3.8	3.2	3.2
Europe	4.7	-5.4	1.5	3.0	1.2	1.1
ROW	-	27.4	2.4	2.2	0.7	1.3
Producer	18.8	8.9	2.8	2.8	2.1	0.9
Consumer	10.2	5.4	3.5	4.0	3.5	3.5

Forest product price trends

In all four scenarios, forest product prices are predicted to dip slightly during the global economic crisis due to lower global demand. Beyond the crisis prices are predicted to increase in the *Forest Livelihoods* and *Tackling Climate Change* scenarios, particularly for hardwood logs and sawnwood, and paper and paperboard (Figure 6.5 to Figure 6.9). The growth in prices under these scenarios is due to three factors. Firstly, the stronger predicted growth in forest product demand associated with more robust economic growth and preferences for tropical timber products (Figure 6.1 to Figure 6.4). Secondly, the relatively stronger influence of economic growth in demand for hardwood sawnwood and paper, as shown in the higher income elasticities of demand for these products (see *Study Methodology*). Thirdly, the reduction in forest available for supply due to expansion of protected forest area for provision of ecosystem services, particularly in the tropics.

Prices for tropical logs, sawnwood and plywood are predicted to grow less than those for softwood and hardwood products under the *Forest Livelihoods* and *Tackling Climate Change* scenarios. This reflects the impact of improved processing technology (lower input-output coefficients and manufacturing costs) in the major tropical producer countries. This reduces the demand for tropical logs and lowers the cost of processed products. One outcome of this is that tropical product prices move closer to those of softwoods, particularly for sawnwood.

Prices are predicted to be stagnant or declining in the *North & South* and *Forest Loss* scenarios because of weaker growth in demand (Figure 6.1 to Figure 6.4) associated with slower economic growth following the global economic crisis.

Prices for softwood sawnwood and plywood, reconstituted panels, wood pulp and SPWP vary less across the alternative scenarios for two reasons. Firstly, these products are produced using softwoods. Secondly, softwood log supply is less impacted by the factors considered in this study to influence forest area change; expansion of tropical planted forests, increased protected tropical forest, and less tropical forest degradation. This reflects the smaller proportion of global softwood harvests in tropical countries; less than 13% of global harvests.

The increase in bioenergy demand under the *Forest Livelihoods* and especially the *Tackling Climate Change* scenarios (Figure 6.3) is predicted to lead to strong growth in the price of fuelwood. This is a continuation of a trend that emerged during the early part of the decade as demand for bioenergy grew, particularly in Europe. In the *Tackling Climate Change* scenario the fuelwood price is predicted to reach that of softwood logs. This suggests there is potential for lower value softwood logs to be diverted from pulp use to bioenergy.

Figure 6.5 Historical (1995-2005) and predicted (2006-2020) softwood, tropical and non-tropical log and fuelwood prices under four alternative futures. Each of the lines from 2006 to 2020 are for the four scenarios, with lines going from darkest (Forest Livelihoods) to lightest (Forest Loss) for each scenario

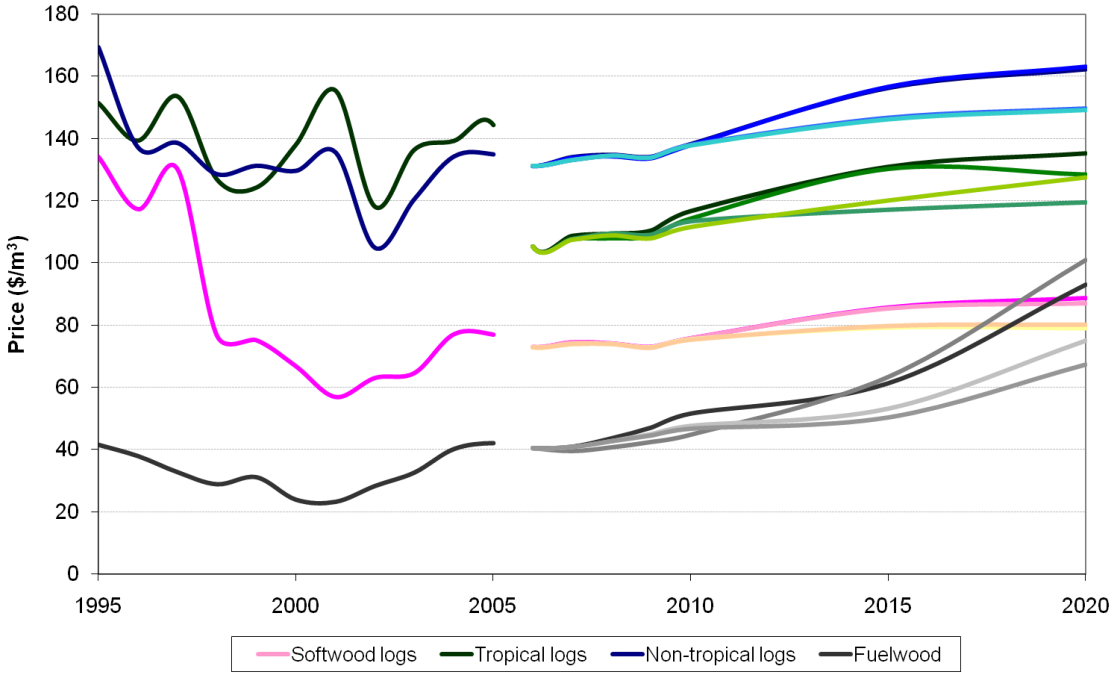


Figure 6.6 Historical (1995-2005) and predicted (2006-2020) softwood, tropical and non-tropical sawnwood prices under four alternative futures.

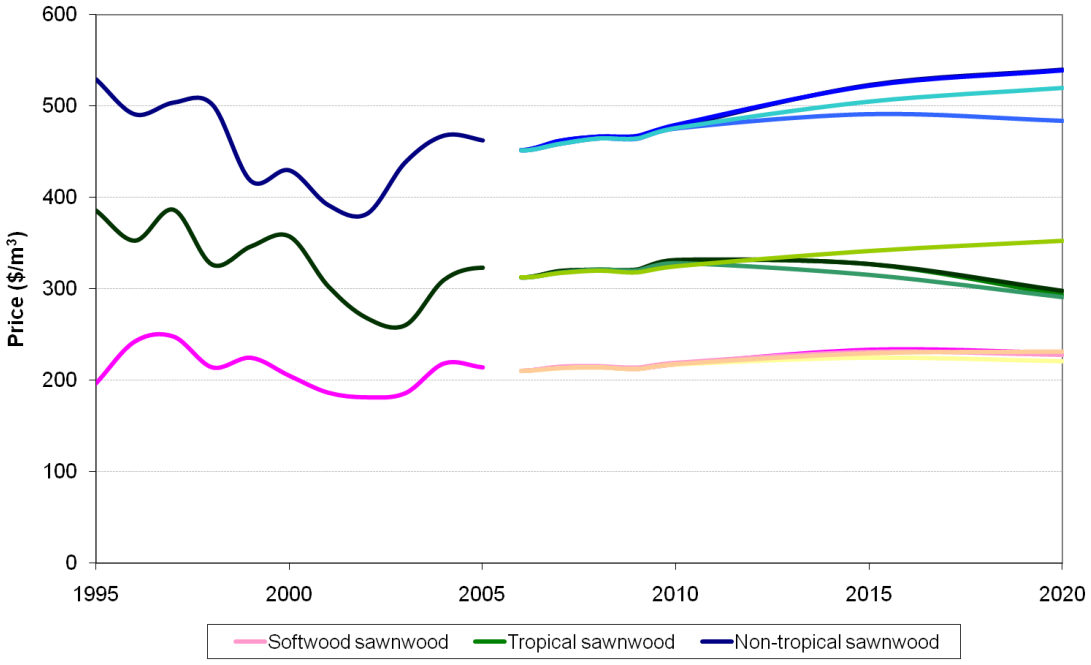


Figure 6.7 Historical (1995-2005) and predicted (2006-2020) softwood, tropical and non-tropical plywood prices under four alternative futures.

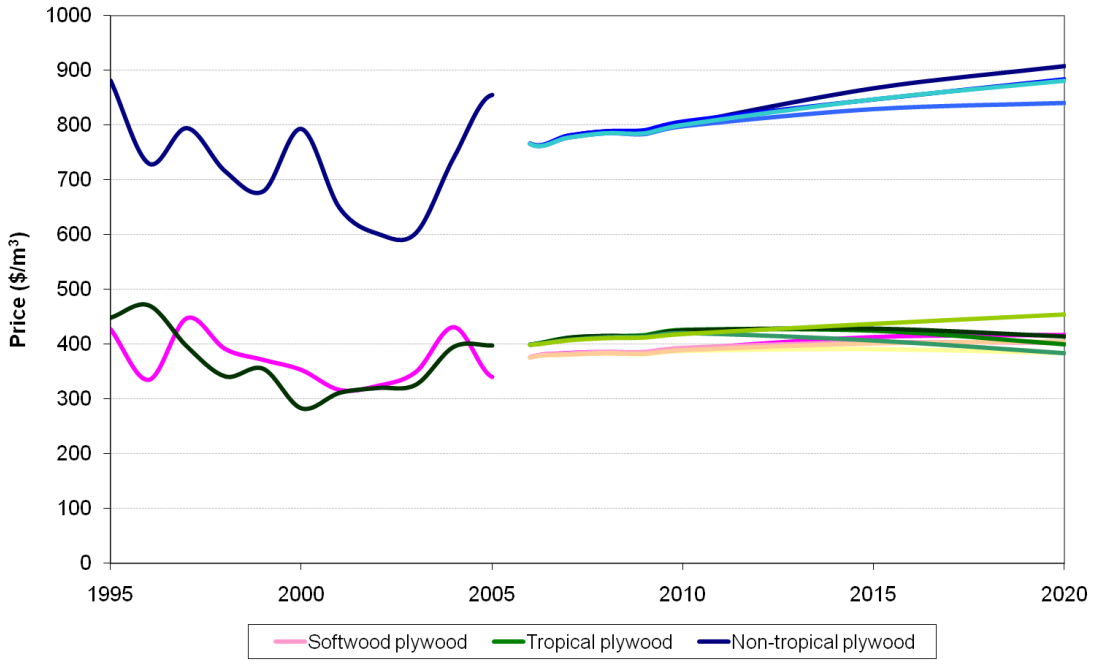


Figure 6.8 Historical (1995-2005) and predicted (2006-2020) reconstituted panel, wood pulp and paper and paperboard prices under four alternative futures.

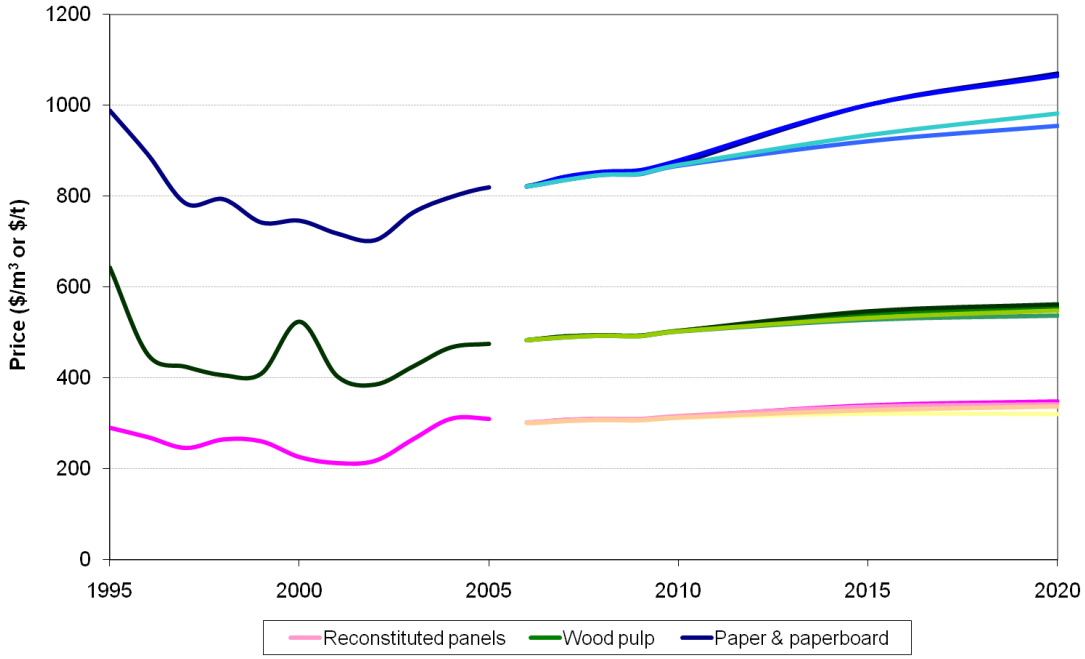
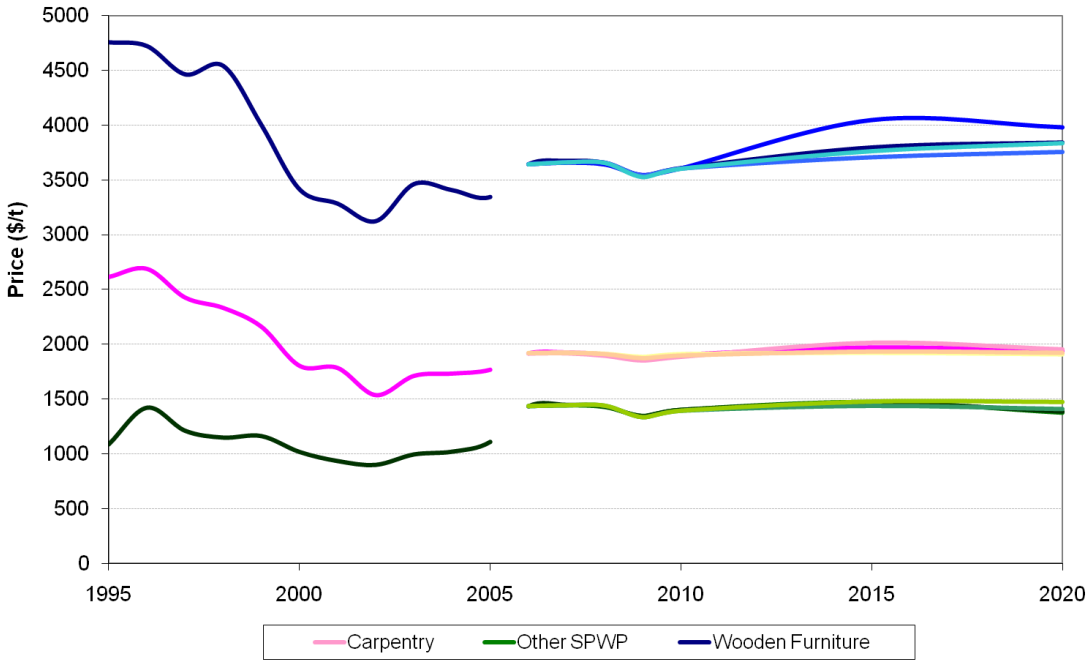


Figure 6.9 Historical (1995-2005) and predicted (2006-2020) carpentry, other secondary processed wood products, and wooden furniture prices under four alternative futures.



7. Conclusions

This study developed four plausible alternative futures (or scenarios) for the tropical timber market to 2020. The first two scenarios, *Tropical Timber – Symbol of Tropical Forest Livelihoods* and *Tropical Forests – Tackling Climate Change*, have similar potential outcomes and are predicated on a strong recovery from the global economic crisis. They differ, however, in their key drivers. The former is driven by recognition of the role of the tropical timber trade in forest protection and community livelihoods, the latter by recognition of the role of tropical forests in mitigating climate change. The other two scenarios are variants on a retraction of the market for tropical timber products, precipitated by a weak recovery from the global economic crisis and varying degrees of trade and financial protectionism. The first, *North & South*, is based on an alignment of the BRIIC (Brazil, Russia, India, Indonesia and China) and developing economies as a new political and trading bloc. The second, *Tropical Timber – Symbol of Tropical Forest Destruction*, is based on a declining global acceptance of tropical timber products, driven by increasing trade protectionism couched in environmentalism. The outcomes of these alternative futures for the tropical timber trade and tropical forests were then determined using an economic model of the global forest sector.

Identifying alternative futures recognises that the future is never known with certainty, and that strategic planning should be undertaken accordingly (Schwartz 1996). It is critical in strategic planning to be prepared to put into action plans that will succeed under as many of the futures as possible. It is also critical to recognise that because the future is uncertain we can influence which of the futures unfolds as history. To this end the alternative futures developed here serve four purposes.

Firstly, they provide an insight into how key influences on the tropical timber market will impact on the tropical timber trade and forests, depending on which influences come into play (Schwartz 1996). For example, a strong recovery of country economies from the global economic crisis will support the provision of capital for increased investment in SFM and payment for ecosystem services from tropical forests.

Secondly, the alternative futures provide the context for assessing how strategies developed today, such as under the ITTO Action Plan (ITTO 2008), will play out under each of the futures (Schwartz 1996). For example, multilateral tariff reduction will result in more beneficial outcomes for the tropical timber trade in futures where there is a supportive environment for investment in sustainable forest management, plantation forests and wood processing in tropical producer countries (*Forest Livelihoods* and *Tackling Climate Change*), than futures where the investment environment is less supportive (*North & South* and *Forest Loss*). If a strategy looks good in only one scenario then it is high risk, especially if there is little control over the likelihood of that scenario occurring (Schwartz 1996).

Thirdly, desirable futures can be identified, and the key drivers for these influenced in to increase the likelihood of that future. For example, the positive outlook for the tropical timber market and tropical forests under the *Forest Livelihoods* scenario is influenced by several interlinked key drivers that can be directly influence by ITTO member countries. These drivers are; (i) strengthening of forest governance in tropical producer countries, (ii) investment in improved processing in tropical producer countries, (iii) harmonisation of certification and timber procurement schemes, and (iv) relating to consumers the importance of tropical timber products in supporting forest community livelihoods and tropical forest protection.

Fourthly, a set of leading indicators can be identified from the key drivers under each of the alternative futures, and trends arising from these. These indicators can then be monitored to identify as soon as possible which of the four alternative futures is emerging as history unfolds (Schwartz 1996). For example, close attention to the strength of the recovery from the global economic crisis, especially in Europe, the United States and BRIIC economies will indicate which of the *Forest Livelihoods* or *North & South* scenario is emerging. In reality the tropical timber market in 2020 will contain elements of each of the four alternative futures, though one future is likely to dominate.

Finally, an important strength of the approach to producing forecasts of the tropical timber market used here is that all the assumptions in the economic model of the global forest sector are explicit. Furthermore, all the projections can be reproduced and the assumptions deemed unrealistic changed. By making the software and the data available it is hoped that many such experiments with alternative scenarios would be conducted. In so doing scientific economic analysis can be merged with the art of scenario planning to arrive at increasingly richer and useful projections of the tropical timber market.

Recommendations

In order for ITTO member countries to benefit from the outlook for the tropical timber market to 2020 presented in this report, the following recommendations are made based on the discussion above of how to make use of the alternative futures in decision making.

ITTO

i) Assess the ITTO Action Plan 2008-2011 (ITTO 2008) against the four alternative futures to determine whether or not the actions will achieve the desired outcomes under all of the alternative futures. Where actions are unlikely to lead to expected outcomes under two or more of the alternative futures, actions should be adapted to make them more robust if the desired future does not arise
ii) Use the alternative futures, and drivers, trends and outcomes for these, to inform the development of the next ITTO Action Plan. This should particularly help in setting priorities for actions that (a) increase the likelihood of the most desirable futures for the tropical timber market and tropical forests (*Forest Livelihoods* or *Tackling Climate Change*) in 2020, and (b) achieve their desired outcome under all alternative futures.
iii) The findings from this study suggest that important drivers under the influence of the ITTO that would lead to a favourable future for the tropical timber market and tropical forests are:
    a) Continuing to support actions that improve the investment environment for processing, planted forests and SFM in tropical producer countries, particularly continuing efforts to strengthen forest governance
    b) In conjunction with the first, continuing actions to support increased human capability in tropical producer countries for implementing REDD and provision of other ecosystem services from tropical forests and for improving processing, particularly log and timber conversions
    c) Actions to demonstrate and promote to consumers in all markets (especially Europe, North America, Brazil, China, and India) the positive environmental and social benefits of tropical timber products. These benefits include mitigating climate change, improving forest community livelihoods, increasing the value of tropical forests relative to non-forested uses of the land, and sustainably produced products
    d) Continuing to provide supporting data on tariff and non-tariff barriers to tropical timber products in both producer and consumer countries to support negotiation of equitable bilateral and multilateral trade agreements
iv) Support at least three (one from each producer region) tropical producer countries in undertaking their own country level scenario planning exercises, including quantitative analysis of the scenarios using the economic model developed as part of this study. This will improve the country specific results of the current study and enable development of capability in producer countries to undertake an outlook for the tropical timber industry in their own country. Critical to ensuring ownership of the scenarios developed is that key stakeholders within these countries lead and undertake the scenario planning process themselves
v) Provide support to tropical producer countries, where appropriate, to make use of the four alternative futures and economic model developed as part of this study to assess forest and trade policy development in their own countries

vi) Gather data to support decision-making under the four alternative futures. Areas where data could be improved, but for which information on emerging trends critically influences the future that unfolds are:
   a) Ecosystem services from tropical forests and demand for these. This could build on the existing criteria and indicators work and also support work demonstrating the environmental and social benefits from tropical timber products. This data is essential to understanding the supply of ecosystem services from tropical forests, and how this matches up with potential demand for these services.
   b) Processing technology in tropical producer countries, especially a comparison of conversion efficiencies and manufacturing costs among products and countries. This will help improve production statistics for tropical timber products, and enable monitoring of improvements in processing, as well help in any future develop of the economic model used in this study

vii) Develop a set of leading indicators that can be used by the ITTO, tropical timber producer and consumer countries, and forest industry to determine as soon as possible which of the four alternative futures is closest to that actually unfolding. These leading indicators include
   a) Economic growth in major markets, especially Europe, the United States, Brazil, India, and China
   b) Trends in the proliferation of tariff and non-tariff barriers affecting tropical and non-tropical timber products
   c) Trends toward alignment of forest certification and timber procurement schemes in tropical timber consuming countries
   d) Trends in the growth of payment for ecosystem services in tropical timber producing countries, such as tropical forest area under biodiversity offsets, watershed protection, forest certification, Clean Development Mechanism, REDD and sustainable forest management
   e) Trends in consumer perceptions of the environmental and social credentials of tropical timber products in major markets, especially in the emerging markets of China and India
   f) Trends in tropical producer country processing efficiency, including conversion efficiency and manufacturing cost

Governments in tropical timber producing countries

i) Consider the use, where appropriate, of the four alternative futures and economic model developed as part of this study to assess forest sector and trade policies and actions that could impact on tropical timber markets and tropical forests. This would help to inform policy development and ensure policies achieve desired outcomes under each of the alternative futures.

ii) The findings from this study suggest that a critical driver under the influence of the governments of tropical timber producing countries that would lead to the *Forest Livelihoods* or *Tackling Climate Change* futures is improvement in the investment environment for processing, planted forests and SFM, including continuing efforts
   a) To strengthen forest governance
   b) Increase country human capability in the forest sector
   c) Address policies that may act as barriers to investment in timber processing, SFM and planted forests
   b) Participate with tropical timber consuming countries and non-governmental organisations in consultative processes for developing timber procurement and certification to ensure a move toward harmonisation of these schemes

Governments in tropical timber consuming countries

i) Consider the use, where appropriate, of the four alternative futures and economic model developed as part of this study to assess forest sector and trade policies and actions that could impact on tropical timber markets and tropical forests. This would help to inform

policy development and ensure policies achieve desired outcomes under each of the alternative futures.

ii) The findings from this study suggest that important drivers under the influence of the governments of tropical timber consuming countries that would lead to the *Forest Livelihoods* or *Tackling Climate Change* futures are
   a) Undertake activities to demonstrate and promote to consumers in their respective countries the positive environmental and social benefits of tropical timber products, including climate change mitigation, contribution to improving forest community livelihoods, and sustainably produced products.
   b) Continue to work with tropical timber producing countries and non-governmental organisations in consultative processes for developing timber procurement and certification that move toward harmonisation of these schemes and demonstrate the social and environmental benefits of tropical timber products
   c) Support bilateral and multilateral trade agreements that address tariff and non-tariff barriers to tropical timber products in both producer and consumer countries

Forest industry and trade

iii) Consider the use, where appropriate, of the four alternative futures and economic model developed as part of this study to assess strategies that could impact on their markets. This would help to inform strategy development and ensure strategies achieve desired outcomes under each of the alternative futures.

iv) The findings from this study suggest that a key driver under the influence of the tropical forest industry that would lead to the *Forest Livelihoods* or *Tackling Climate Change* futures are activities to achieve, demonstrate and promote to consumers in all markets the positive environmental and social benefits of tropical timber products, including climate change mitigation, biodiversity protection, contribution to forest community livelihoods, and sustainably produced products

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Appendix 1 Demographic and Economic Trends

Profile	Unit	Country	2009	2014	2019
Population	(000 persons)	Indonesia	226,305	235,211	242,416
		Malaysia	28,005	30,571	33,028
		China	1,326,290	1,336,686	1,339,480
		India	1,147,104	1,222,025	1,293,783
		Russia	143,410	141,446	138,093
		Brazil	191,819	202,446	211,537
		Japan	127,790	126,900	124,921
		United States	308,389	323,641	338,765
Proportion 15-64 years	(%)	Indonesia	67.2	68.7	69.6
		Malaysia	65.5	67.0	67.8
		China	73.3	73.5	71.8
		India	62.9	64.1	65.1
		Russia	70.3	70.3	68.7
		Brazil	69.7	70.1	69.9
		Japan	64.9	62.1	60.7
		United States	67.3	66.4	65.1
Households	(000s)	Indonesia	60,406	63,620	66,337
		Malaysia	6,662	7,410	8,127
		China	411,749	420,168	478,165
		India	240,983	258,430	275,075
		Russia	53,396	52,878	51,794
		Brazil	56,163	59,975	63,827
		Japan	49,524	50,695	51,393
		United States	122,436	130,991	139,833
Avg household income[1]	(US$)	Indonesia	5,454	6,214	7,008
		Malaysia	14,491	15,493	16,351
		China	4,459	5,980	6,855
		India	2,241	2,547	2,843
		Russia	14,072	17,116	19,691
		Brazil	24,734	26,771	28,558
		Japan	54,684	56,619	59,442
		United States	78,779	79,715	80,229
Proportion households earning >$US30,000	(%)	Indonesia	1	2	2
		Malaysia	10	12	13
		China	0	1	1
		India	0	1	1
		Russia	8	13	19
		Brazil	20	22	23
		Japan	69	72	76
		United States	65	65	65
GDP	(US$ billion)	Indonesia	474	572	675
		Malaysia	224	269	313
		China	4,243	5,742	7,313
		India	1,344	1,661	1,994
		Russia	1,541	1,892	2,164
		Brazil	1,634	1,890	2,129
		Japan	5,114	5,283	5,499
		United States	13,960	15,026	15,941

[1] All values are 2007 real US$
Source: Global Demographics (2009)

Appendix 2 Scenario Development Methodology

Scenarios are a valuable tool for evaluating alternative decisions in a tangible real-world context. They use a multi-disciplinary approach to present information in a way that encourages cause-and-effect thinking. Scenarios have two main purposes: anticipating and understanding risk, and discovering new strategic options.

Scenario planning acknowledges that the future is unpredictable; the scenarios are distinct, plausible pictures of the world in which the tropical forest industry may opreate. During World War II the US Air Force used scenarios to help its generals imagine possible enemy actions in different circumstances. The technique was later introduced to Royal Dutch Shell in the 1970s by Pierre Wack. The widespread adoption of scenario planning began in the early 1990s, with the publication of Peter Schwartz's "The Art of the Long View" (Schwartz 1996).

Scenario planning has become an accepted methodology in future studies because other approaches used to anticipate the future, from computer-based forecasting models to Delphi surveys, though scientifically rigorous, fail to predict what will happen in a rapidly changing and turbulent environment. Forecasts are not always wrong but because they tend to be constructed on the assumption that tomorrow's world will be much like today's they fail to offer guidance when it is most needed, during times of change. In contrast, scenarios do not pinpoint future events; instead, they highlight the major forces that could push the future in different directions. This facilitates learning about the future by increasing awareness of long-term interactions between the most important driving forces.

Scenarios are also useful in organising a large amount of seemingly unrelated information in a logical manner, so as to stimulate discussion about the choices that lie ahead. Scenarios are therefore a way of understanding the driving forces that could move a sector one-way or the other. They focus less on predicting outcomes and more on understanding the forces that will eventually compel an outcome (Wack 1985).

The scenario process begins with identifying the focal issue or decision. Once the focal issue has been determined (in this case the long term outlook for tropical timber markets), it is important to gather information and views from across a broad range of stakeholders. This phase is used to identify the major trends and the forces that might act together to push the future in a certain direction. Two main processes were used to uncover the driving forces that might emerge in the next 10 to 15 years and impact on the tropical timber sector:

1. Expert interviews
2. A literature review around key issues based on the STEEP (**s**ocial, **t**echnological, **e**nvironmental, **e**conomic and **p**olitical) process.

Expert interviews

Based on their experience and knowledge stakeholders in the tropical timber market have a mental model of the sector. Uncovering the ideas and assumptions of key players in the tropical timber sector is therefore a vital step in uncovering key issues, concerns, and potential opportunities for the future of the tropical timber market. Individual interviews are the preferred method for eliciting these views and insights (Schwartz 1996; van der Heijden 1996). Van der Heijden (1996) provides nine questions that allow stakeholders to consider the future of the tropical timber market and tropical forestry and provide their views from various perspectives.

The first question is designed to review the personal journey taken by the stakeholder to come to be in their professional position today. Questions 2 to 4 are designed to generate a list of the main uncertainties and concerns in the area being studied, in this case tropical forestry and the tropical timber market. Question 5 allows the interviewee to express the most positive outcome to their concerns and uncertainties, while question 6 takes an opposite

approach, requesting the interviewee explain what they would consider a bad potential outcome to their concerns and uncertainties. Questions 7 to 9 are follow-up questions, asking for pivotal events that are important to remember, and what may constrain or aid the good events from occurring.

The nine questions used in this study were tailored to the tropical timber and forestry sector:

1. How did you come to be involved in the tropical forest industry?

2. What do you see as being the critical issues for the future of the tropical timber market and tropical forestry?

3. If you could ask somebody who was able to foretell the future of this industry, what **three questions** would you ask them?

4. What do you see as being a desirable outcome in relation to these issues? What is the one thing you hope will occur?

5. On the other hand, what would you worry about? What would be an undesirable outcome? What would be your worst nightmare?

6. Why have these issues arisen? Can you pinpoint any events, either good or bad, that have led to the current situation?

7. What's the one lesson/ outcome from the tropical timber trade and tropical forestry's history that we must remember moving forward?

8. What are the actions that need to be carried out in the short-term/ immediately in order to achieve a favourable outcome? What will ensure it will happen?

9. What things, both inside and outside the tropical forest market and tropical forestry, are limiting what can be achieved? What will prevent the favourable outcome from occurring?

Potential interviewees were initially identified from a list of 'likely candidates' using ITTO contacts and networks. Individuals interviewed were also asked to nominate further potential interviewees. Potential interviewees were identified from all regions (Africa, Latin America, Asia & Pacific, North America and Europe) and the entire value-chain from forest management to tropical timber product consumers. Personal recommendation ensured that those seen by their peers as holding a key perspective, as well as those thought by their colleagues as worthy of contacting were selected.

As an initial stage of the information gathering process, 46 key stakeholders were contacted by email and invited to respond to the above set of questions either by phone interview or via email. 24 participants responded with their views (Table 2.A.1).

Table 2.A.1 List of individuals interviewed

Name	Position	Organisation	Region	Area
Alhasan Attah		Ghana Timber	Africa	Timber trade and markets
Amha bin Buang	Assistant Director, Economic Information and Market Intelligence	ITTO	Asia & Pacific	Timber trade and markets
Jeremy Broadhead		FAO	Asia & Pacific	Forestry
Chris Brown	Consultant	FAO	Asia & Pacific	Forestry, wood processing
Michael Buckley		Turnstone Communications	Asia & Pacific	Timber trade and markets
Ramon Carillo	Project Manager, Forest Industry	ITTO	Latin America	Wood processing
Carlos Carneiro	Forest Programmes Adviser	FAO	Latin America	Forestry
Jessica Casaza		FAO	Latin America	Forestry
Jorge Meza		FAO	Latin America	Forestry
Ben Donkor		Ghana Timber	Africa	Timber trade and markets
Pat Dugan		Bagong Pagasa Foundation, Philippines	Asia & Pacific	Forestry
Pat Durst		FAO	Asia & Pacific	Forestry, wood processing
Richard Eba'a Atyi		Cameroon UNECE project	Africa	Forestry
Lauren Flejzor	Coordinator, Market Information Services	ITTO	Global	Timber trade and markets
B.C.Y. Freezailah	Chairman	Consultant	Asia & Pacific	Forestry, wood processing
Alberto Goetzl		Seneca Creek	North America, global	Wood processing, timber trade and markets
Mahboob Hasan	Finance/Administrative Officer	ITTO	Global	Forestry
Steven Johnson	Editor & Communications Manager	ITTO	Global	Forestry, wood processing, timber trade & markets
John Leigh	Conservation Officer, Reforestation and Forest Management	ITTO	Latin America	Forestry
Hwan Ok Ma	Projects Manager, Reforestation and Forest Management	ITTO	Asia & Pacific	Forestry
Eduardo Mansur	Assistant Director, Reforestation and Forest Management	ITTO	Latin America	Forestry

Name	Position	Organisation	Region	Area
Frances Maplesden	Statistician, Economic Information and Market Intelligence	ITTO	Asia & Pacific	Timber trade and markets
Polycarpe Masupa Kambale	Projects Manager, Reforestation and Forest Management	ITTO	Africa	Forestry
Mario Mengarelli		FAO		
CTS Nair		FAO	Global	Forestry
Alastair Sarre	Consultant		Asia & Pacific	Forestry
Markku Simula	Consultant	ARDOT	Global, Europe	Timber trade and markets
James Singh	Commissioner of Forests	Guyana Forestry Commission	Africa	Forestry, wood processing timber trade and markets
Anna Mohase		Guyana Forestry Commission		Forestry, wood processing timber trade and markets
Pradeepa Bholanath		Guyana Forestry Commission		Forestry, wood processing timber trade and markets
Tetra Yanuariadi	Projects Manager, Forest Industry	ITTO	Asia & Pacific	Wood processing

The interview process and analysis followed the method prescribed by van der Heijden (1996). Analysis of the responses allowed a range of common issues and concerns to emerge (Appendix 3), as well as the key assumptions and most (and least) desired future paths. This enabled a starting point for a review of the literature on the driving forces behind these key issues.

Review of future trends and drivers

Driving forces behind future trends are often obvious and well understood by some, and less so to others (Schwartz 1996). It is therefore necessary to obtain a more objective view of the underlying aspects of the driving forces that have emerged from the interview process. To achieve this, an analysis of published literature around each key issue can allow a deeper understanding of the issues, as well as eliciting not only the obvious trends and drivers, but also emerging 'weak signals' which may rise in prominence and impact on the focal issue. Such weak signals are important to capture, as the opportunities available in the future are usually determined not from a consensus view of what will happen, but from initially unexpected and dynamic events (Schwartz 2003; Slaughter 1996; Saul 2006).

Undertaking an extensive review of the literature for all key issues arising from the interviews would be an immense task, so a technique has been developed that allows a strategic 'scan' of the literature to look for likely forces related to society, technology, environment, economic, and political (STEEP) aspects.

STEEP allows the large volumes of information to be more readily organised, while considering the key forces from areas which usually make a difference to the 'expected' story (Schwartz 1996).

The following key issues identified from the stakeholder interviews were investigated using this STEEP literature review, included:

i) Consumer country perceptions of tropical timber products

ii) Values placed on tropical natural forests

iii) Political stability, rule of law, and governance in tropical producer countries

iv) The nature of investments in tropical producer country forest management and processing

v) The global economic crisis

vi) The role of plantation forests in meeting countries' future timber needs

vii) The emergence of new trading and political regions

Scenario development

Once the main driving forces have been identified from the interviews (Appendix 2) and STEEP literature review, it should be apparent that some are pre-determined—in other words, they are completely outside our control and will be the same in all scenarios. An example is the Baby Boomer cohort in Western economies. Many other driving forces are uncertain. All uncertainties seem unique to start with, but can usually be grouped.

A workshop was used to start to structure the main information (van der Heijden 1996, 2002) and to cluster and rank the key driving forces and uncertainties into a set of orthogonal axes (Schwartz 1996). Critical uncertainties are those that are central to the focal issue of the exercise and are impossible to predict. Those forces deemed to be most important as well as most uncertain are selected as potential divergent future paths to base scenarios around.

The report author (Turner) along with a Resource Economist (Richard Yao), Market Researcher (Karen Bayne), Resource Modeller (Thomas Adams) and Climate Change Analyst (Tim Payn) participated in a scenario development workshop, which employed the following method:

1. The main driving forces, key assumptions and major uncertainties that were seen by each participant as important elements from the stakeholder interviews and literature were listed
2. Driving forces and assumptions were clustered into the main future trends and drivers for each key issue
3. The top three uncertainties or questions around each key issue were selected by each workshop participant
4. The top twenty uncertainties were listed, and scoring used to determine which were both important and uncertain to the future of the tropical timber market. This process revealed six critical uncertainties:
    - Can plantations be successfully developed in the tropics?
    - Will governance and corruption in lesser developed countries improve?
    - Will a BRIC forest trading bloc emerge?
    - Will consumer markets accept tropical timber products?
    - Will a significant green market develop or will consumers still seek price first?
    - How will land use change?
5. Orthogonal axes were; the strength of forest governance, the strength of the green market, and trade protectionism
6. The following potential scenario plots emerged from a discussion of these major uncertainties and orthogonal axes:
    - Tropical timber products no longer used in ITTO consumer countries
    - Tropical timber products accepted by ITTO consumer countries
    - Climate change sparks adoption of mitigation strategies, such as clean development mechanism
    - Implications from a BRIIC trading bloc
    - Environmental services established voluntarily
    - Environmental services established as necessity
7. Further revision and detail added to the scenarios produced a final ‘set’ of four scenarios, which are outlined in Section 4. *Alternative Futures*

Appendix 3 Drivers Identified in Interviews

Social

- Decreasing acceptability of tropical timber in Western markets arising from
  - consumer resistance to harvesting of natural forests
  - lack of effort by producers to negate this
  - biased reporting on tropical timber trade
  - a misinformed public
  - knowledge, education and awareness by public in consumer countries
  - perceptions around certification
- Continued acceptability of tropical timber in Asia, particularly China
- Producer country reliance on their forests for timber, food, non-timber forest products and addressing poverty leading to
  - High proportion of GDP from forest export earnings
  - Deforestation concerns in tropical producer countries
  - Different values placed on forests by tropical producer countries, e.g. Philippines versus consumer countries, e.g. New Zealand, the United States
  - Population and consumption growth, particularly for fuelwood
  - Wages and worker welfare in producer countries
- Consumer willingness to pay for sustainable forest management
  - Desire for sustainable forest management over price alone (varies by consumer country)
- Non-West reaction to Western 'regime' instructions for sustainable forest management (welcoming and abiding by FAO or push-back against)

Technological

- Efficiencies in timber processing and utilisation
  - a technological divide between developed and developing countries
  - change in processing capacities and processes
  - technology requirements for smaller diameter logs as forest resource is degraded and wood supply shifts to plantations
  - timber preservation
  - technology obsolescence in tropical producer countries
  - moving away from primary production to value added
  - potential for innovation in producer countries
  - quality of the timber resource and methods of quality control
- Need for investment in infrastructure
- The future of tropical plantations
- Adoption of Western techniques
- Animal-powered extraction versus mechanised extraction methods

Economic

- Competing values for land
  - timber versus carbon versus conservation markets
  - non-timber forest product market development
  - forests and timber versus alternative land uses
    - Higher costs to implement sustainable forest management, compared with alternative land uses and plantations
    - Financing of and investment in tropical forest management
    - Biofuel markets

        - Plantation incentives and disincentives compared with other land uses
- Competition in the tropical timber market (among producer countries and with consumer countries), particularly reduced competitiveness of the industry relative to
    - Land use
    - Non-tropical timbers
    - Non-timber products
    - Differentiation of tropical timber compared with competing products, e.g., bamboo
- Population and demographic changes, particularly economic and demographic growth of Brazil, Russia, India and China (BRIC)
- Impacts of the global economic crisis
- Lack of marketing plans and business development within tropical producer countries

Environmental

- Tropical forest deforestation and degradation
    - How to sustain future supplies of tropical timber, particularly from natural forests?
    - Biodiversity and ecosystem change from plantations and changing land use
    - Tropical forest restoration and recovery
    - Species extinction
- Role (and influence) of environmental NGO
    - Forest certification standards that are too high
    - What certification schemes will win out? FSC alone or will others be mutually recognised?
- Effects of climate change on tropical forests
- "Forest" definition, e.g., inclusion of oil palm plantations

Political

- Political constraints in tropical producer countries
    - Illegal activities and 'smuggling'
    - Political stability, corruption, and ability to control and regulate forest operators
    - Lack of political will to enforce sustainable forest management
    - tropical producer country government priorities of poverty alleviation, health and education ahead of environment and forests
    - "Fit" of legal system to practices and producer nation conditions
    - Forest ownership and land tenure

- Policies affecting the tropical timber trade
    - Log export bans and harvesting restrictions in tropical producer countries
    - Timber concessions
    - Likely success of policies such as Forest Law Enforcement, Governance and Trade, Reducing Emissions from Deforestation and Degradation, and carbon trading
    - Investment and incentive schemes for sustainable forest management in tropical producer countries
- Role of China in the tropical timber trade is key
- Pressure and influence of the West in land-use, forest management and protection, and investment in tropical countries. A form of neo-colonialism?

Appendix 4 Timber Market Projection Methodology

Rationale for the modelling approach

There are a number of international forest sector models; the Global Forest Products Model (GFPM; Buongiorno et al. 2003), CINTRAFOR Global Trade Model (CGTM; Cardellichio et al. 1989), Global Fibre Supply Model (GFSM; Bull et al. 1998), EFI-Global Trade Model (EFI-GTM; Kallio et al. 2004) and Global Trade Analysis Project (GTAP; Mcdougall et al. 1998). Most forest sector models, however, have a strong regional focus with either exogenous trade, e.g. the Timber Assessment and Market Model (TAMM; Adams & Haynes 1996), Timber Supply Model (TSM; Sedjo and Lyon 1990, Sedjo and Lyon 1996) or a few endogenously determined regional trade flows, e.g. studies by Manurung & Buongiorno (1997) of Indonesian log export bans and by Binkley et al. (1994) of the British Columbia forest sector. The regional focus of most forest sector models is perhaps a reflection of the historical development of most models for analysis of national level forest policies, and the sources of funding for model development.

Forest sector models vary not only in the modelling techniques used, but also the level of detail. Most models have a particular regional, sectoral, and/ or commodity focus. For example, the TAMM focuses on North American wood supply, disaggregating North America into twelve wood supply regions, and the solidwood sector into hardwood and softwood sectors. This reflects the conception of TAMM as a model for assessing the ability of United States wood supply to meet future demand. The focus of each model influences the sorts of policy issues that the model may be used for. The GFPM and CGTM with their global coverage of the forest sector are suited to analyzing the distributional effects of policies that have an international influence, such as trade liberalization or climate change policies. Models with global coverage may also capture the unintended consequences of national level policies on other regions of the world, or the mitigation of forest sector policy impacts in a country due to opposing responses in other regions (Cardellichio & Adams 1990; Perez-Garcia 1995).

An important aspect of forest sector models is the description of the elements of wood supply including forest stock, forest area, and harvest volumes. Both the links between these elements and, the linkages between wood supply and forest product demand are important. Forest sector models differ greatly in their description of wood supply. Computable general equilibrium models such as the GTAP tend to have the simplest wood supply specification due to the inclusion of all sectors of the economy making these models large. The ability to increase the realism of wood supply dynamics in spatial partial equilibrium models containing complex trade flows is also limited by model size (Cardellichio & Adams 1990). In these models a simple growth-drain approach (e.g. CGTM), or exogenously determined wood supply shift (e.g. Zhu et al. 1998) is used to model wood supply. Of the forest sector models discussed only the TSM endogenously determines regeneration effort as well as harvest levels. This complex specification of the wood supply sector in the TSM is, in part, achieved by simplifying the rest of the sector and the description of trade flows, due to the high computational demands of inter-temporal optimization (Sohngen & Sedjo 1996).

Given the large number of policy issues spatial equilibrium models such as the CGTM and GFPM have been applied to they appear to have some advantages over the other approaches. The utility of spatial equilibrium models for policy analysis is a reflection of the model structure's flexibility in accommodating a range of scenarios, by including appropriate constraints or by changing the objective function. The ability to include additional constraints in spatial equilibrium models also allows consideration of a-priori knowledge which limit the deviation of the model results from some set value (Taylor & Howitt 1993). The trade inertia bounds in the CGTM and the GFPM, which limit the period-to-period change in interregional trade flows, are an example of such constraints. Constraints of this kind are useful when performing policy analysis as they can be used to generate a "realistic" base scenario (Reichelderfer 1993). For example, in applying the GFPM to forecast the impact of regional trade agreements on the New Zealand forest sector, constraints were used to restrict New Zealand's expansion of pulp capacity, reflecting the limited potential for development of new

pulp mills (Turner et al. 2001). Disadvantages of such a-priori constraints to consider, are that poor judgment in setting them will result in poor decisions (Reichelderfer 1993), they may reduce the consistency of model results with the models' competitive behaviour assumption (Cardellichio & Adams 1990; Taylor & Howitt 1993) and they complicate the interpretation of model results (Cardellichio & Adams 1990).

Countries and products

The modified version of the Global Forest Products Model developed for this study deals with 180 countries (Table 4.A.1), each of which produces, consumes, imports, or exports at least one of 19 wood products (Table 3.1). The source of the base year, 2006, production, consumption, trade, and price data for these countries and products is the International Tropical Timber Organization (ITTO 2009f) for industrial roundwood (logs), sawnwood and plywood data from member countries, COMTRADE (UN 2009) for carpentry, wooden furniture and other secondary processed wood product imports and exports, and Food and Agriculture Organization online database FAOStat (FAO 2009a) for remaining countries and products.

These data are collected from individual country statistics, which it is recognised, contain potential inaccuracies. However, the ITTO, UN and FAO are the only source of internationally comparable country data. Furthermore, the calibration of the Global Forest Products Model base year data (Buongiorno et al. 2001, Turner et al. 2005b) addresses some of the inaccuracies in the data. While most trade data are left unchanged by the calibration procedure, the production data are modified to ensure feasibility and consistency. For example, consumption cannot be negative. Furthermore, the amounts of materials used in a country and the amounts of products manufactured must be consistent with a-priori knowledge regarding the inputs needed per unit of output.

Because domestic price data are scarce for most countries, the market-clearing price in countries that were net exporters of a product was the world average export unit value[8]. For net importers, the price was the world export price plus the freight cost and import tariff for a particular country (Buongiorno et al. 2003). Also needed for the base year were country forest stock and forest area, from the Forest Resources Assessment 2005 (FAO 2005), and GDP per capita, from the World Development Indicators database (World Bank 2009).

From the base year, the model made projections of forest resources, and forest product prices and quantities to 2020. To make these projections the model required parameters describing the four main components of the wood-based sector: final demand, raw material supply, manufacturing activities, and international trade. Demand for final products and supply of raw materials are represented by econometric equations, which relate demand and supply volumes to product prices and gross domestic product. Manufacturing activities are represented by input-output coefficients and manufacturing costs covering labour, energy and capital. Transport cost depends on freight rates and import tariffs.

As there are no internationally comparable production data for secondary processed wood products (carpentry, wooden furniture and other SPWP), only their net imports and exports were modelled (Turner et al. 2008b). The demand equations of net importing countries relate imports to GDP and price. The supply equations of next exports countries are represented by input-output coefficients and manufacturing costs describing how sawnwood and wood-based panels are used in producing secondary processed products for export (Turner et al. 2008b).

Each of the four components has a static and a dynamic element. The static part describes each year's competitive equilibrium, where the price of each product in each country is solved so that consumption equals production plus imports minus exports. The dynamic element is governed by endogenous changes, determined within the model, or exogenous changes, determined outside of the model. The remainder of the chapter discusses the methods, data, and parameters that make up each of the four components of the Global Forest Products Model.

[8] The value of world exports divided by the volume of world exports for a product.

Table 4.A.1 Countries and regions represented in the modified Global Forest Products Model used for this study

Country	Country	Country	Country
AFRICA	**EUROPE**	**REST OF THE WORLD**	**REST OF THE WORLD**
Cameroon*	Austria	Senegal	Saudi Arabia
Central African Rep. *	Belgium	Sierra Leone	Singapore
Congo, Rep. *	Denmark	Somalia	Sri Lanka
Congo, Dem. Rep. *	Finland	South Africa	Syrian Arab Republic
Côte d'Ivoire*	France	Sudan	Turkey
Egypt	Germany	Swaziland	United Arab Emirates
Gabon*	Greece	Tanzania, United Rep of	Viet Nam
Ghana*	Ireland	Tunisia	Yemen
Liberia*	Italy	Uganda	Cook Islands
Nigeria*	Netherlands	Zambia	French Polynesia
Togo*	Norway	Zimbabwe	New Caledonia
LATIN AMERICA	Poland	Bahamas	Samoa
Guatemala*	Portugal	Barbados	Solomon Islands
Honduras*	Spain	Belize	Tonga
Mexico*	Sweden	Cayman Islands	Albania
Panama*	Switzerland	Costa Rica	Bosnia and Herzegovina
Trinidad and Tobago*	United Kingdom	Cuba	Bulgaria
Bolivia*	**REST OF THE WORLD**	Dominica	Croatia
Brazil*	Algeria	Dominican Republic	Czech Republic
Colombia*	Angola	El Salvador	Hungary
Ecuador*	Benin	Haiti	Iceland
Guyana*	Botswana	Jamaica	Iran, Islamic Rep of
Peru*	Burkina Faso	Martinique	Iraq
Suriname*	Burundi	Netherlands Antilles	Israel
Venezuela, Boliv. Rep.*	Cape Verde	Nicaragua	Macedonia, The Fmr Yug Rp
ASIA & PACIFIC	Chad	Saint Vincent/Grenadines	Malta
Cambodia*	Djibouti	Argentina	Romania
China	Equatorial Guinea	Chile	Slovakia
India*	Ethiopia	French Guiana	Slovenia
Indonesia*	Gambia	Paraguay	Serbia
Japan	Guinea	Uruguay	Montenegro
Korea, Rep.	Guinea-Bissau	Afghanistan	Armenia
Malaysia*	Kenya	Bahrain	Azerbaijan, Republic of
Myanmar*	Lesotho	Bangladesh	Belarus
Nepal	Libyan Arab Jamahiriya	Bhutan	Estonia
Philippines*	Madagascar	Brunei Darussalam	Georgia
Thailand*	Malawi	Cyprus	Kazakhstan
Australia	Mali	Jordan	Kyrgyzstan
Fiji Islands*	Mauritania	Korea, DPR	Latvia
New Zealand	Mauritius	Kuwait	Lithuania
Papua New Guinea*	Morocco	Laos	Moldova, Republic of
Vanuatu*	Mozambique	Lebanon	Russian Federation
NORTH AMERICA	Niger	Mongolia	Tajikistan
Canada	Réunion	Oman	Turkmenistan
USA	Rwanda	Pakistan	Ukraine
	Sao Tome and Principe	Qatar	Uzbekistan

* ITTO producer countries

Final demand

Demand for final products (fuelwood, other industrial roundwood, softwood sawnwood, tropical sawnwood, hardwood sawnwood, softwood plywood (including veneer), tropical plywood, hardwood plywood, reconstituted panels, paper and paperboard, and imports of carpentry, other SPWP and wooden furniture) is represented by econometric equations. These equations relate the demand for each product to national income, measured by real gross domestic product, and real product price, in U.S. dollars. The price and income elasticities of demand, the percentage change in quantity demanded (or imported for secondary processed products) for a one percent change in product price or country income, are in Table 4.A.2. For this study the equations for fuelwood, other industrial roundwood,

reconstituted panels, and paper and paperboard were based on estimates reported in Buongiorno et al. (2003). Equations for SPWP import demand were based on estimates reported in Turner et al. (2008b). Equations for sawnwood and plywood split into softwood, tropical and hardwood were estimated for this study using the method described in Turner & Buongiorno (2004) applied to data from the ITTO for 1995 to 2007 for the 64 member countries.

The Global Forest Products Model determines real product price changes endogenously, that is simultaneously with the quantities supplied, demanded, and traded. Country income changes, represented by the rate of growth of real gross domestic product are exogenous, reflecting assumptions regarding the future economic growth of each country. These economic growth rates are one of the important trends that varied across the four future scenarios for the tropical timber market (see *Representing Alternative Futures in the Model*). They were used to represent the global economic crisis and differences among countries in economic recovery from the crisis.

Table 4.A.2 Price and income elasticities of demand for final products. Source: Modified from Buongiorno et al. (2003, Table 4.5), Turner et al. (2008b), and author's estimates

Commodity	Consumer[1]		Producer[2]	
	Price	Income	Price	Income
Fuelwood	-0.10	n.a.	-0.10	n.a.
Other industrial roundwood	-0.37	0.06	-0.37	0.06
Softwood sawnwood	-0.77	0.70	-1.67	0.96
Tropical sawnwood	-2.00	1.07	-0.52	0.61
Hardwood sawnwood	-1.62	0.91	-2.43	1.12
Softwood plywood	-0.74	1.08	-0.22	0.78
Tropical plywood	-1.77	0.97	-0.92	0.69
Hardwood plywood	-1.00	0.94	-3.74	2.08
Reconstituted panels	-0.98	1.20	-0.98	1.20
Paper and paperboard	-0.67	1.20	-0.67	1.20
Carpentry[3]	-1.05	1.60	-1.05	1.60
Other SPWP[3]	-1.00	1.90	-1.00	1.90
Wooden furniture[3]	-1.36	1.70	-1.36	1.70

[1] Canada, United States, Japan, Rep. of Korea, Australia, New Zealand, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom, [2] rest of the world, [3] elasticities for these products are for import demand

Raw material supply

The supply, or harvest, of wood (fuelwood, softwood, tropical and hardwood industrial roundwood, and other industrial roundwood) is also represented by econometric equations (Turner et al. 2006). These equations relate wood supply to each country's income per capita, measured by real gross domestic product per capita, forest stock, and wood price. The price, income per capita, and forest stock elasticities, the percentage change in quantity supplied for a one percent change in each explanatory variable, are in Table 4.A.3.

Table 4.A.3 Equation parameters for fuelwood and softwood, tropical and hardwood industrial roundwood supply in the modified version of the Global Forest Products Model used for this study

Commodity	Price	Forest stock	GDP per capita
Fuelwood	1.00	n.a.	n.a.
Other industrial roundwood	1.00	1.50	n.a.
Softwood industrial roundwood	1.31	1.00	1.20
Tropical industrial roundwood	1.00	0.80	1.20
Hardwood industrial roundwood	1.31	1.00	1.20

Wood price changes are determined endogenously by the Global Forest Products Model so that they balance supply and demand. The growth rates of country income per capita are

exogenous, based on assumptions regarding future economic and demographic growth. These income per capita growth rates are one of the important trends that varied across the four future scenarios for the tropical timber market (see *Representing Alternative Futures in the Model*). In the Global Forest Products Model they reflect the increase in wood supply due to improvements in infrastructure and technology. Forest stock changes are determined endogenously by the Global Forest Products Model, and reflect the harvest capacity of a country.

The forest stock of a country is predicted with a growth-drain equation, where next year's stock equals the current stock plus the annual changes in forest stock due to forest area change and to forest growth or decay on a given area, minus harvests. Stock change due to growth or decay is a function of forest density, stock per unit area. Forest area change in this implementation of the Global Forest Products Model is exogenous. Rates of forest area change are one of the important trends that varied across the four future scenarios for the tropical timber market (see *Representing Alternative Futures in the Model*). These were used to represent differences in planted forest expansion and conversion of forest to agriculture under the four scenarios.

The supply of waste paper is related to national income, measured by real gross domestic product, and its real price, in U.S. dollars. Reflecting the availability of recovered paper, there is an upper bound on waste paper supply, which is determined by a country's paper consumption and recycling rate. This upper bound shifts over time due to endogenous changes in paper consumption, and exogenous changes in the maximum recycling rate determined by growth in income per capita.

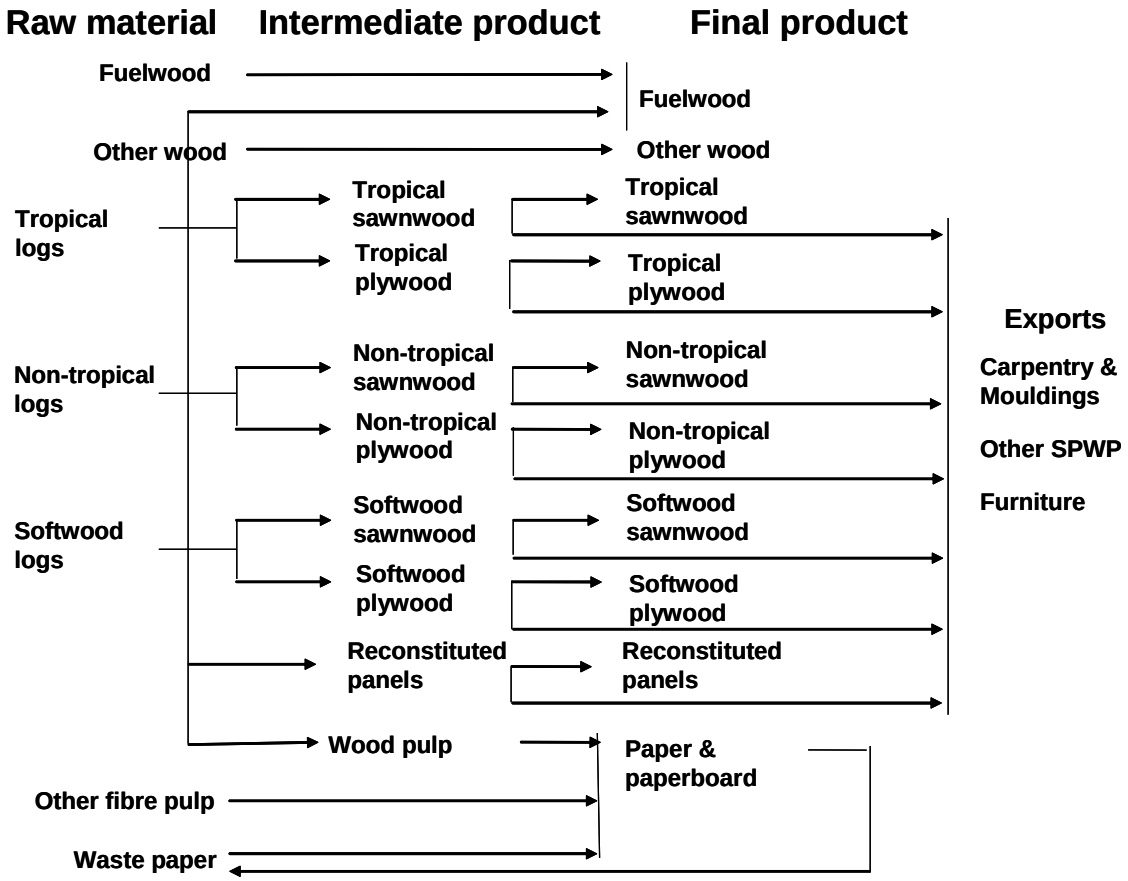
Manufacturing activities

The manufacture of forest products; softwood, tropical and hardwood sawnwood, softwood, tropical and hardwood plywood (including veneer), reconstituted panels, wood pulp, paper and paperboard, carpentry, other SPWP and wooden furniture, is represented by input-output coefficients and associated manufacturing costs. Input-output coefficients describe how raw materials are utilised in production, i.e. the amount of input per unit of output (Fig. 4.A.1). These differ among forest products and countries. These data were estimated with the methods described in Buongiorno et al. (2001) and Turner et al. (2008b). The manufacture of reconstituted panels and wood pulp from different wood inputs (softwood, tropical or hardwood) were described as separate manufacturing processes.

The manufacturing cost is the cost of the inputs – labour, energy, capital, etc. – not explicitly recognized in the model. The manufacturing cost is an increasing function of the level of production, described by an elasticity. For most manufacturing activities a one percent increase in production results in a 0.10 percent increase in the cost of manufacture, apart from the cost of wood and fibre inputs. In the projections, costs of manufacture were another of the important trends that varied across the four future scenarios for the tropical timber market (see *Key Trends in the Alternative Scenarios*). Changes in these costs were used to represent investment in improved processing technology.

In the projections, manufacturing technology, represented by the input-output coefficients is another of the important trends that varied across the four future scenarios for the tropical timber market (see *Representing Alternative Futures in the Model*). Changes in these coefficients were used to represent technological advances in wood processing.

Figure 4.A.1 Commodities in the modified Global Forest Products Model and their linkages through manufacturing



International trade

The Global Forest Products Model predicts trade flow volumes, between each country and the world market, for all forest products, except other industrial roundwood, for which there is no trade data. Predicted trade flows are influenced by the cost of transportation, which includes the cost of freight and import and export tariffs. Freight costs are those reported in Turner and Buongiorno (2001). Import and export tariff data for 2006 were from the APEC[9], UNCTAD TRAINS[10] databases and ITTO (2009).

The freight cost was kept constant (in real terms) during the projections from 2006 to 2020. Import and export tariff changes from 2006 to 2020 were another of the important trends that varied across the four future scenarios for the tropical timber market (see *Representing Alternative Futures in the Model*). Changes in tariffs were used to represent variation in the extent of free trade across the four scenarios.

Changes in trade from year-to-year were limited by trade inertia bounds. These bounds simulate inertia in trade patterns; it takes time for new markets to be established, or existing markets to expand. The larger the bounds the more rapid was the permissible change in trade. However, the actual trade within those bounds was the result of the market forces (demand and supply for all the country and products) represented by the model.

[9] www.apectariff.org
[10] www.unctad.org/trains

Representing alternative futures in the model

Key trends in the alternative scenarios

The four alternative scenarios (*Forest Livelihoods, Tackling Climate Change, North & South,* and *Forest Loss*) were represented in the Global Forest Products Model by implementing the seven key trends under the scenarios (Table 4.A.4). These trends are:

- Recovery from the global economic crisis, which is represented by GDP and GDP per capita growth rates
- Regional political and trade blocks, which are represented by preferences for tropical timber products and level of tariffs on forest products, including implementation of the Russian log export tax
- Bioenergy demand, which is represented by the rate of growth in fuelwood demand
- Investment in improved processing, which is represented by input-output factors (wood input required for production) for logs to processed products and the cost of manufacture
- The profitability of sustainable forest management, which is represented by the rate of forest area change and impact of harvesting on forest stock loss
- Expansion of planted forests, which is represented by the rate of forest area change and growth in forest stock
- Demand for ecosystem services, which is represented by the expansion of protected forest area and rate of tropical forest conversion to agriculture

The rate of recovery from the global economic crisis, the extent of regional political and trade blocks, and growth in bioenergy demand are demand side trends. They influence the extent to which demand for forest products in general, and tropical forest products and fuelwood in particular, will grow in the future. Demand for forest products is increased with a stronger recovery from the economic crisis, less regionalisation and stronger growth in bioenergy demand. The last, however, may reduce wood available for other forest products due to forest and harvests going to production of fuelwood. All three of these trends differ among countries.

Increased investment in improved processing is a demand and supply side driver. It influences the supply of processed forest products, but also the demand for wood through the change in wood input required for production. Increased investment in improved processing leading to improved conversion rates, i.e. lower input-output factors, and lower manufacturing costs increases the supply of processed products and decreases consumption of logs. Changes in processing differ among countries.

The uptake of sustainable forest management, growth in demand for ecosystem services, and expansion of planted forests are supply side trends. They influence the expansion of forest area and the extent to which forest is available for wood supply. The first two, by reducing forest degradation and protecting forests from conversion to agriculture reduce wood supply in the short run, but can increase it in the longer term by allowing expansion of forest stock. The last clearly increases potential wood supply. All three of these trends differ among countries.

Table 4.A.4 Trends, variables describing trends, and their values under the four alternative future scenarios for the tropical timber market

			Scenario			
Trend	Variables	Source	Forest Livelihoods	Tackling Climate Change	North & South	Forest Loss
Global economic crisis	GDP growth post-2008	World Bank, IPCC	A1B	A1B	A2	A2
Regional blocks	Preference for tropical timber	Author estimates	High	No change	Country dependent	Country dependent
	Import tariffs	Author estimates	Half of current by 2020	No change	150% of current by 2020	Double current by 2020
	Russian log export tax		Kept at 6.5%	Kept at 6.5%	Increased to 80%	Increased to 80%
Bioenergy demand	Fuelwood demand	IPCC Scenarios	A2	A1B	A2	Half of A2
Investment in processing	Conversion factors	Author estimates from various[1]	-2% per year from 2010 (Group 1-3)[7]	-2% per year from 2010 (Group 1-2)	-2% per year from 2010 (Group 1)	No change
	Manufacturing costs	Author estimates from various[2]	-1% per year from 2010 (Group 1-3)	-1% per year from 2010 (Group 1-2)	-1% per year from 2010 (Group 1)	No change
Profitable sustainable forest management	Forest area change	IPCC	A1B adjusted for vulnerable forest	A1B adjusted for vulnerable forest	A2	A2
	Harvest drain on forest stock	Author estimates from various[3]	80% by 2020 (Group 1-3)	80% by 2020 (Group 1-2)	80% by 2020 (Group 1)	No change
Planted forest expansion	Forest area change	FAO[4]	Business-as-usual	Business-as-usual + 50%	Business-as-usual	Pessimistic
	Forest stock growth	FAO[4]	Business-as-usual	Higher productivity	Business-as-usual	Business-as-usual
Ecosystem service demand	Protected forest area	Author estimates from varous[5]	40% of forest area by 2020 (Group 1-3)	40% of forest area by 2020 (Group 1-3)	No change	No change
	Conversion to agriculture	Author estimates from varous[6]	60%-90% reduction in conversion from 2010 (Group 1-3)	60%-90% reduction in conversion from 2010 (Group 1-3)	No change	No change

[1] Yin (2000)
[2] Bernstein (1994), Vahid & Sowlati (2007), Li et al. (2008), Helvoigt & Adams (2009)
[3] Boltz et al. (2003)
[4] Carle & Holmgren (2008)
[5] FAO (2005), ITTO (2009)
[6] Eliasch (2008), Grieg-Gran (2008), Miles et al. (2008), FAO (2000, 2005)
[7] see Table 4.A.5 for description of Group 1-3 countries

The extent to which some of the seven trends will occur in tropical producer countries is mediated by the extent to which the country's political and economic environment supports the changes. This is particularly the case for supply side trends; investment in processing, sustainable forest management, planted forest expansion and provision of ecosystem services from tropical forests. To reflect country differences in support for forest protection and investment the ITTO producer countries were grouped into four categories (Table 4.A.5).

Table 4.A.5 International Tropical Timber Organisation producer and consumer country groupings based on extent to which political and economic environment supports forest protection and industry investment

(1) Strongly Supportive	(2) Supportive	(3) Weakly Supportive	(4) Limited or No Support
Malaysia	Ghana	Papua New Guinea	Cambodia
Thailand	Vietnam	Guatemala	Ecuador
China	Vanuatu	Nigeria	Philippines
India	Trinidad & Tobago	Honduras	Venezuela
Brazil	Indonesia	Suriname	Myanmar
Mexico	Guyana	Gabon	Cote d'Ivoire
Peru	Colombia	Liberia	Togo
Costa Rica	Bolivia	Cameroon	Congo, Dem Rep
	Panama	Congo, Rep	Central African Republic
	Fiji		Sierra Leone
			Equatorial Guinea

These categories are subjective groupings of countries based on the extent to which they have a political and economic environment that supports protection of forests and investment in the forest industry. Countries were allocated to these groups based on their rankings in the World Bank (2008) "Ease of Doing Business", Transparency International (2009) "Corruption Perceptions Index"[11] and level of forestry institutions and capacity for REDD monitoring, verification and reporting (Hardcastle & Baird 2008). The first is a measure of the attractiveness of the regulatory and economic environment for investment in a country. The second an indicator of the quality of governance structures, while the third measured the quality of country institutions in forestry and political support for protecting forests.

Countries in the first group, "Strongly Supportive" have excellent institutional support and capacity, strong forest governance, and a supportive regulatory and economic environment for investment. As such these countries were assumed to be able to attract investment and establish policies to improve wood processing, expand planted forests, support sustainable forest management and develop markets for ecosystem services, including REDD.

Countries in the second group "Supportive" have good institutional support and capacity, good forest governance, and a supportive regulatory and economic environment for investment. As such these countries were assumed to be able to attract investment and establish policies to support the forest sector. However, their ability to attract investment is limited under the scenarios where economic growth is weaker, i.e. the *North & South* and *Forest Loss* scenarios.

Countries in the third group, "Weakly Supportive", have some institutional support and capacity, modest forest governance, and a weak regulatory and economic environment for investment. As such these countries were assumed to be able to attract investment for tropical forestry and processing only in the most favourable circumstances for investment, i.e. the *Forest Livelihoods* scenario.

Countries in the fourth group, "Limited or No Support" have limited institutional support and capacity, weak forest governance and weak regulatory and economic investment

[11] www.transparency.org

environments. As such these countries may struggle to attract investment and establish and implement policies to develop their forestry sector. As a result they are assumed to be unable to attract investment for forestry and processing under any of the scenarios.

Modelling the key scenario trends

The seven trends from the four scenarios are described by 13 variables. The following sections describe how these 13 variables were estimated and implemented in the Global Forest Products Model.

GDP and GDP per capita growth

The recovery from the global economic crisis was represented by two variables, country GDP and GDP per capita growth rates. Country GDP and GDP per capita growth rates through the global economic crisis (2008-2010) were from the World Bank (2009a,b). All scenarios included these projections of the economic impact of the global economic crisis.

Post-2010 economic growth was based on Intergovernmental Panel on Climate Change (IPCC) scenarios for GDP and population growth adjusted by Raunikar et al. (2009) (Table 4.A.6 and Figure 4.A.2). Two IPCC scenarios were used. Scenario A2 represents a slow down in globalization due to a rise in regional interests. This is similar to the scenario of a prolonged economic crisis due to increased protectionism (the *North and South* and *Forest Loss* scenarios). Associated with this IPCC scenario are slower economic growth, stronger population growth leading to lower income per capita, slower growth in bioenergy demand, and less forest loss.

IPCC scenario A1B represents continuing globalization. This is similar to the scenario of a rapid recovery from the economic crisis (the *Forest Livelihoods* and *Tackling Climate Change* scenarios). Associated with this IPCC scenario are higher economic growth, lower population growth, more rapid growth in biofuel production, and greater forest loss

Figure 4.A.2 Historical (1995 to 2005) and forecast (2006 to 2020) gross domestic product by region. Sources: World Bank (2009b) for 1995 to 2005, World Bank (2009a) for 2006 to 2010, Raunikar et al. (2009) for 2011 to 2020

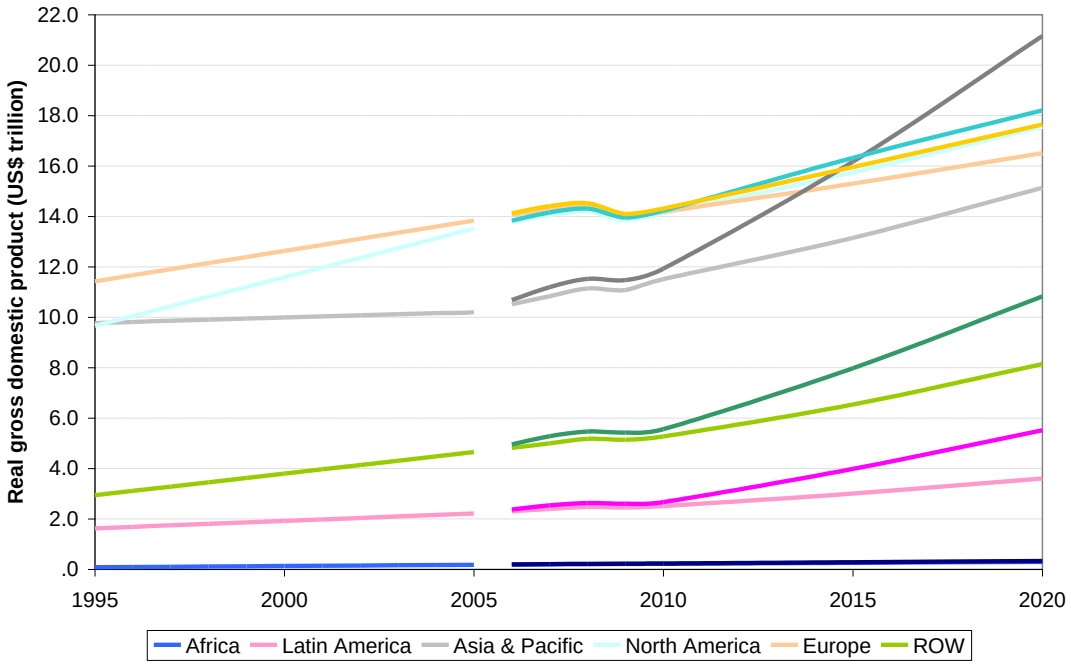


Table 4.A.6 Observed and predicted annual rates of growth (%) of IPCC projections used as exogenous variables in the GFPM simulations. Source: Raunikar et al. (2009)

	Observed	Predicted 2006-2060	
Region	1992-2006	Scenario A1B	Scenario A2
	Population		
ALM[1]	2.29	1.05	1.62
Asia[2]	1.25	0.29	1.00
OECD90[3]	0.58	0.26	0.43
REF[4]	0.13	-0.07	0.46
World	1.33	0.50	1.09
	Gross domestic product		
ALM	4.93	5.41	3.69
Asia	6.83	5.70	3.59
OECD90	2.21	1.90	1.50
REF	1.15	4.85	3.10
World	2.95	3.71	2.35
	Forest area		
ALM	-0.16	-0.02	-0.01
Asia	-0.22	0.10	0.10
OECD90	0.01	0.01	0.11
REF	-0.24	-0.04	-0.01
World	-0.14	0.00	0.03
	Bioenergy demand		
ALM	1.68	3.84	2.45
Asia	-1.89	1.94	1.04
OECD90	-5.52	5.56	2.71
REF	2.54	1.99	1.76
World	-1.26	3.36	1.83

[1] Africa, Latin America, Middle East
[2] Except Middle East
[3] OECD countries in year 1990
[4] Central and Eastern Europe and Newly Independent States of the former Soviet Union

Import tariffs and preferences for tropical timber products

Regional political and economic blocks were represented by regional differences in preferences for tropical timber products, global import tariff levels, and the extent to which the Russian log export tax is increased.

Regional differences in preferences for tropical timber products were represented by modifying the income elasticities of demand for tropical timber products in shown in Table 4.A.2 (Table 4.A.7). These elasticities describe the extent to which country economic growth leads to a growth in demand for tropical timber products. For the *Forest Livelihoods* scenario these income elasticities were increased for developed consumer countries in Asia & Pacific (Japan, Republic of Korea, Australia and New Zealand), North America, and Europe. For the *Tackling Climate Change* scenario income elasticities were unchanged. For the *North & South* scenario income elasticities of demand were lower in the developed consumer economies (Table 4.A.7). For the *Forest Loss* scenario income elasticities were lower for the developed consumer economies and key emerging economies; India and China.

Tariff changes across scenarios were based on author's estimates. They were unchanged in the *Tackling Climate Change* scenario, halved from 2010 to 2020 in the *Forest Livelihoods* scenario, 50% higher from 2010 to 2020 in the *North & South* scenario, and doubled from 2010 to 2020 in the *Forest Loss* scenario.

Table 4.A.7 Long-run price and income elasticities of demand for sawnwood and plywood products for ITTO producer and consumer countries. Shaded income elasticities of demand for tropical sawnwood and plywood were adjusted between scenarios

Scenario			Sawnwood			Plywood		
			Softwood	Tropical	Hardwood	Softwood	Tropical	Hardwood
Forest Livelihoods	Producer	Price	-1.67	-0.52	-2.43	-0.22	-0.92	-3.74
		Income	0.96	0.61	1.12	0.78	0.69	2.08
	Consumer	Price	-0.77	-2.00	-1.62	-0.74	-1.77	-1.00
		Income	0.70	1.20	0.91	1.08	1.40	0.94
Tackling Climate Change	Producer	Price	-1.67	-0.52	-2.43	-0.22	-0.92	-3.74
		Income	0.96	0.61	1.12	0.78	0.69	2.08
	Consumer	Price	-0.77	-2.00	-1.62	-0.74	-1.77	-1.00
		Income	0.70	1.07	0.91	1.08	0.97	0.94
North & South	Producer	Price	-1.67	-0.52	-2.43	-0.22	-0.92	-3.74
		Income	0.96	0.61	1.12	0.78	0.69	2.08
	Consumer	Price	-0.77	-2.00	-1.62	-0.74	-1.77	-1.00
		Income	0.70	0.20	0.91	1.08	0.20	0.94
Forest Loss	Producer[1]	Price	-1.67	-0.52	-2.43	-0.22	-0.92	-3.74
		Income	0.96	0.20	1.12	0.78	0.20	2.08
	Consumer	Price	-0.77	-2.00	-1.62	-0.74	-1.77	-1.00
		Income	0.70	0.20	0.91	1.08	0.20	0.94

[1] for Brazil and India only

The Russian log export tax was assumed to remain at 6.5% ad valorem in the *Forest Livelihoods* and *Tackling Climate Change* scenarios. It was increased to its maximum level (Eastin & Turner 2009) in the *North & South* and *Forest Loss* scenarios (Table 4.A.8).

Table 4.A.8 Russian log export tax. Source: Eastin & Turner (2009)

	Softwood logs		Hardwood logs	
	Tax rate (%)	Minimum tax (€/m^3)	Tax rate (%)	Minimum tax (€/m^3)
May 2006	6.5	4	6.5	4
July 1, 2007	20	10	20	24
April 1, 2008	25	15	25	24
January 1, 2009	80	50	40	50

Bioenergy demand

The scenarios for changes in demand for bioenergy were based on the IPCC scenarios for growth in bioenergy production as reported in Raunikar et al. (2009) (Table 4.A.6). In the Global Forest Products Model these changes in demand were applied to the demand for fuelwood.

For the *Forest Livelihoods* and *North & South* scenarios bioenergy demand growth was based on the IPCC scenario A2, i.e. slow growth in bioenergy demand. For the *Tackling Climate Change* scenario bioenergy demand growth was based on IPCC scenario A1B, i.e. strong growth in bioenergy demand brought about by climate change policies. For the *Forest Loss* scenario bioenergy demand growth was half that used in the *Forest Livelihoods* and *North & South* scenarios.

Manufacturing costs and technical change

Regional estimates of cost efficiency for pulp industries from Yin (2000) were used to represent changes in manufacturing costs for wood fibre based industries. That study found the highest cost efficiency for pulp producers in Latin America and Finland and the lowest cost efficiency for producers in Asia and Oceania. It was assumed that over the 10-years to 2020 the latter would adopt technologies to reach the cost efficiency of Latin America, while Latin America would improve cost efficiency, though at a slower rate

For the *Forest Livelihoods* scenario manufacturing costs were reduced by 1% per year for countries in Asia & Pacific and African regions that have supportive investment environments (Table 4.A.5), and countries with less supportive investment environments in Latin America. Manufacturing costs were reduced by 0.5% per year for Latin American countries with strongly supportive investment environments.

For the *Tackling Climate Change* scenario manufacturing costs were reduced by 1% per year for Asia & Pacific and Latin America & African region countries with supportive investment environments. Manufacturing costs were reduced by 0.5% per year for Latin American countries with strongly supportive investment environments.

For the *North and South* scenario manufacturing costs were reduced by 1% per year for strongly supportive countries in Asia & Pacific and African regions, and by 0.5% per year for Latin America, countries with strongly supportive investment environments. For the *Forest Loss* scenario manufacturing costs were unchanged

To represent productivity growth, i.e. a decrease in input-output coefficients, estimates of total factor productivity changes from North American studies were used (Bernstein 1994, Vahid & Sowlati 2007, Li et al. 2008, Helvoigt & Adams 2009)[12] (Table 4.A.9).

In the *Forest Livelihoods* scenario manufacturing coefficients (conversion factors) were reduced by the changes in Table 4.A.9 for tropical timber producing countries with supportive investment environments (Table 4.A.5). These represent the reduction in wood inputs required to produce a cubic metre of wood product.

In the *Tackling Climate Change* scenario input-output coefficients were reduced by the changes in Table 4.A.9 for tropical timber producing countries with strongly supportive and supportive investment environments (Table 4.A.5). In the *North & South* scenario input-output coefficients were reduced by the changes in Table 4.A.9 for tropical timber producing countries with a strongly supportive investment environment (Table 4.A.5). Input-output coefficients were unchanged for tropical timber producing countries in the *Forest Loss* scenario.

Table 4.A.9 Indicative estimates of productivity growth by forestry sector, used in the scenarios

Product	Productivity Growth (%/yr)	Source
Sawnwood	2.5	Bernstein (1994), Vahid & Sowlati (2007), Li et al. (2008), Helvoigt & Adams (2009)
Plywood	3.0	Vahid & Sowlati (2007)
Reconstituted panels	4.0	Vahid & Sowlati (2007)
Wood pulp	0.5	Yin (2000)
Paper and paperboard	0.5	Yin (2000)
Secondary processed products	3.5	Authors estimate

[12] No studies from tropical producer countries were found in a search of the academic literature

Forest area change

Forest area in each scenario was influenced by a number of factors; expansion of planted forests, adoption of sustainable forest management, and emergence of markets for ecosystem services from tropical forests. Base forest area change estimates were from the IPCC scenarios reported in Raunikar et al. (2009) (Table 4.A.6). Base *Forest Livelihoods* and *Tackling Climate Change* forest area change were based on the IPCC A1B scenario, while those for the *North & South* and *Forest Loss* scenarios were based on the IPCC A2 scenario.

Planted forest expansion

Scenarios for annual planted forest expansion and annual productivity changes from Carle & Holmgren (2008) were applied from 2010 to 2020. For the *Forest Livelihoods* and *North & South* planted forest expansion was based on Carle & Holmgren's (2008) business-as-usual scenario, which is a continuation of the current area change, without planted forest productivity increases.

The *Forest Loss* planted forest area change was based on Carle & Holmgren's (2008) pessimistic scenario with had half the area change predicted under the business-as-usual and no productivity increases.

Tackling Climate Change planted forest expansion was based on Carle & Holmgren's (2008) business-as-usual scenario with an assumed 50% greater rate of expansion of planted forest area due to climate change policies, and a productivity increase. To represent the increase in planted forest productivity country forest stock growth was adjusted upward based on two separate components of the increase

(i) The increased proportion of total forest area in more productive planted forests
(ii) Increased productivity of planted forest from Carle & Holmgren (2008). This adjustment was applied as a proportion of country total forest area in planted forest.

Adoption of sustainable forest management

The impact of increased adoption of sustainable forest management was represented as a change in the ratio of forest inventory (stock) drain to harvest. The change in this ratio was based on a comparison of studies of financial and ecological impacts of conventional and reduced-impact logging in South America (Boltz et al. 2003). In that study conventional logging was found to lead to 20% to 40% more damaged trees compared with conventional logging.

For the *North & South* and *Forest Loss* scenarios the ratio of inventory drain to harvest was unchanged. For the *Forest Livelihoods* and *Tackling Climate Change* scenarios the ratio of inventory drain to harvest was 80% by 2020, i.e. 1 m^3 harvested (including harvest losses) results in a 0.8 m^3 reduction in forest stock, in countries with political and economic environments that support investment in sustainable forest management (Table 4.A.5)

Emergence of markets for ecosystem services

The emergence of markets for ecosystem services from tropical forests, e.g. REDD, was represented by

(i) an increase in the proportion of forest area and stock that is protected, and hence not available for harvest, and

(ii) a lower rate of conversion of forest to agriculture as a result of higher potential returns to land in forest.

Under the *Forest Livelihoods* and *Tackling Climate Change* scenarios for countries with political and economic environments that support forest protection and investment the protected forest area was assumed to increase to 40% of total forest area by 2020, gradually increasing from the current reported protected forest area (FAO 2005) from 2010. 40% protected forest area is slightly higher than that currently protected in India and China (FAO 2005). For the *North & South* and *Forest Loss* scenarios there was no change in the proportion of forest area protected.

The other impact of the emergence of ecosystem service markets represented was a reduction in tropical forest converted to livestock and cropping. This was reflected in a reduction in deforestation rates from the IPCC Scenario A1B (Table 4.A.6) based on an estimate of the proportion of potential forest loss due to conversion to livestock and rice cropping. This proportion was derived from estimates of regional tropical forest area vulnerable to conversion to increasingly valuable agricultural products (pasture to oil palm) (Grieg-Gran 2006, Miles et al. 2008, Eliasch 2008) and the assumption that ecosystem service markets could increase returns to land in forest to $400 per ha (Table 4.A.10). This return cannot be known with any certainty until estimates of the potential demand and supply of tropical ecosystem services are made.

The last row in Table 4.A.10 shows the proportion of vulnerable forest area that would potentially not be converted to livestock or cropping (rice) were ecosystem service markets to increase returns to forest to $400 per ha. This proportion was used to adjust the deforestation rates assumed in the IPCC A1B scenario.

For the *Forest Livelihoods* and *Tackling Climate Change* scenarios countries with political and economic environments that support forest protection and investment (Table 4.A.5) had a reduction in forest conversion to agriculture. For the *North and South* and *Forest Loss* scenarios there was no change in the assumed rate of forest conversion to agriculture.

Table 4.A.10 Cumulative proportion (%) of tropical forest area vulnerable to conversion to increasingly valuable (from logging to oil palm) uses and the reduction in vulnerable forest converted to livestock and cropping (rice) by region. Author estimates from Miles et al. (2008) and FAO (2000)

Land use	Africa	Americas	Asia	Australia, Oceania, Hawaii	Total
Oil palm	74.4	74.3	73.8	5.8	71.8
Soybean	61.9	49.4	68.1	5.8	54.8
Sugarcane	58.0	48.4	67.7	4.8	53.0
Maize	54.2	46.3	67.3	4.8	50.7
Rice	53.4	46.0	67.1	4.7	50.3
Pasture	43.4	36.9	66.0	4.7	42.5
Logging	26.1	14.3	34.2	2.6	20.8
None	4.7	6.6	19.2	2.0	7.9
Reduction (%)	*71.8*	*61.8*	*91.0*	*80.9*	*70.0*