



**An Overview of World Tropical Hardwood Resources,
Forest Products Trade and Environmental Issues**

Shadia Duery
International Market Associate
Metafore
Portland, Oregon

Richard P. Vlosky
Director and Professor, Louisiana Forest Products Development Center
School of Renewable Natural Resources
Louisiana State University Agricultural Center
Baton Rouge, Louisiana

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Louisiana Forest Products Development Center
School of Renewable Natural Resources
Louisiana State University Agricultural Center

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Introduction

“The tropical forest (TF) is earth's most complex biome in terms of both structure and species diversity. It occurs under optimal growing conditions: abundant precipitation and year round warmth. There is no annual rhythm to the forest; rather each species has evolved its own flowering and fruiting seasons. Sunlight is a major limiting factor. A variety of strategies have been successful in the struggle to reach light or to adapt to the low intensity of light beneath the canopy” (SLW 1996).

Tropical and temperate tree species, genera and families differ dramatically. In addition, species diversity is much higher in the TF compared to temperate forests. For example, in temperate forests, typically 5-30 species share dominance versus the 40-100 different tree species one might find in one hectare of TF (Amazon Center for Environmental Education and Research 2005). This difference in diversity creates difficulty in forest management in the TF. In the temperate forest, clear-cut or even-aged management practices are often used to harvest trees. In contrast, TFs have very complex structures and interactions between species. Clear-cut tropical forests do not regenerate due to this structural complexity as well as the fragile soils with thin organic layers inherent in tropical forests. Because clear cutting is the most common harvesting practice, much of the world's TF have been permanently decimated.

Major Tropical Forest Regions

Tropical forests are found between 10° N and 10° S latitude at elevations below 3,000 feet (1000 meters) (**Figure 1**) Within this climatic zone, tropical forests are divided into four major regions as follows:

Neotropical Tropical Forest

Neotropical forests are found in Belize, Bolivia, Brazil, Caribbean islands, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Suriname, and Venezuela (Butler 2001).

South America accounts for 23 percent of global forests (Juslin and Hansen 2003). The TF of South America is mostly the Amazon rainforest; it is shared by 8 countries and accounts for 50 percent of global biodiversity. Brazil has the largest share and, not coincidentally, one of the largest deforestation rates in the world. Eighty percent of timber harvested in South American tropical countries comes from illegal logging practices (ITTO 2002). Their forest industry lacks new technology and forest regeneration rates are often less than 50 percent.

Central and South America have similar problems in their forest industries and in their forest management practices. Forest certification presents itself as a possible tool to control and reduce illegal logging.

Aftropical Tropical Forest

Aftropical forests are found in the following African countries: Angola, Benin, Burundi, Cameroon, Central African Republic, Comoros, Congo, Djibouti, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia, Madagascar, Malawi, Mozambique, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia, and

Zimbabwe (Butler 2001). Africa accounts for 17 percent of the world's forests, and most of these forests are tropical. Forest products are mainly used for subsistence purposes (87 percent for fuel wood) while trade in forest products accounts for only 2 percent of wood products manufactured on the continent. Deforestation rates are among the highest in the world (Juslin and Hansen 2003). Ghana and Côte d'Ivoire are the two major exporting countries of secondary forest products in Africa (FAO 2001).

Indomalayan Tropical Forest

This region includes tropical forests in Bangladesh, Bhutan, Brunei, Cambodia, China, India, Indonesia, Laos, Malaysia, Mauritius, Myanmar (Burma), Nepal, the Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam (Butler 2001).

This region contains two of the most populated countries in the world, China and India. Both countries have been experiencing a great economical development in the last decade. China has become one of the largest consumers of lumber in the world, and in order to supply to its own demand China has the largest plan for afforestation in the world. Malaysia and Indonesia are the largest producers of plywood in the world (Juslin and Hansen 2003).

Australian Tropical Forest

Australia, Papua New Guinea, and the Pacific Islands (including Hawaii) comprise this region (Butler 2001).

Tropical Hardwoods of the World

Forest products can be divided into timber and non-timber products. The focal point of this section is on timber or wood products. Some examples of non-timber forest products are nuts and rubber (from rubberwood tree sap). Timber species can be divided into softwoods and hardwoods. The difference between hardwoods and softwoods are the way the trees reproduce. Hardwoods are angiosperms meaning that they produce seeds that have a certain type of cover. Softwoods on the other hand gymnosperms meaning that they let the seed fall in the ground. The majority of the world's softwoods are located in the boreal forests of the northern hemisphere. Douglas-fir (*Pseudotsuga menziesii*), southern yellow pine (*Pinus taeda*), ponderosa pine (*Pinus ponderosa*), western white pine (*Pinus monticola*) sugar pine (*Pinus lambertiana*), western hemlock (*Tsuga heterophylla*), and the true firs (*Abies spp*) are the most important U.S. softwoods cut for lumber.

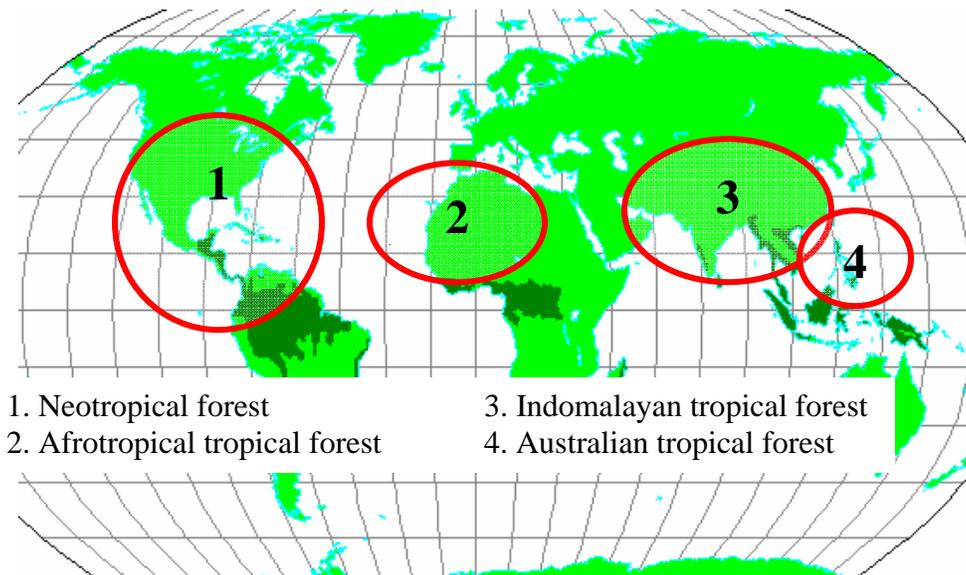


Figure 1. Tropical forests of the world

Source: SLW 1996

The focus of this paper is tropical hardwoods. Softwoods will not be discussed further in the paper. Hardwoods grow in non-tropical boreal and temperate forests in the northern and southern hemispheres as well as in tropical regions of the world. Tropical hardwoods are typically high in density and are mainly used for furniture, doors, and flooring.

Tropical Hardwood Trade Flows

Tracking global trade flows for tropical hardwood products is extremely difficult. The most used statistical sources are provided by FAOSTAT, part of the Food and Agriculture Organization of the United Nations (FAO), the International Tropical Timber Organization (ITTO), Eurostats, and United Nations-Economic Commission for Europe (UNECE). Regardless of reporting entity, major discrepancies exist between data reported by importing and exporting countries. The main causes for the discrepancies are non-standardization in the compilation of trade statistics, errors in data collection, differences in classification and measures, inconsistent conversions, and transshipments that are not accurately recorded. In addition, illegal harvesting and trade activity severely skew the data (Goetzl 2005). The 59 members of the International Tropical Timber Organization account for more than 90 percent of the reported world trade of tropical hardwood products (Hashiramoto et al. 2004). Because of this fact, ITTO data are primarily used in this study.

Supply of Tropical Hardwood Products

Tropical hardwood products originate from developing countries. In 1995, tropical hardwood exports accounted for US\$ 1,107 million, dropping to US\$ 695 million in 1999. Southeast Asia, Latin America, and Central Western Africa are the three main regions from which tropical hardwood products are exported. The trend in past years has been to reduce the export of tropical hardwood logs with a commensurate increase in semi-finished and finished

goods. Exporting countries are making this shift in an attempt to increase value-added to their forest resources. Only Africa continues to export tropical logs (ITTO 2004, Forest monitor 1995). The three primary tropical hardwood products exported are sawnwood, veneer, and plywood (ITTO 2004).

Demand for Tropical Hardwood Products

The United Nations Economic Commission for Europe/ Food Agricultural Organization/ Food Agricultural Organization (ECE/FAO) (2000) and International Trade Center 2001 state that the three primary regions that import tropical hardwood products are the U.S., European Union (EU), and Japan. Concurrent with exporter shifts to finished products exports, importing countries are changing the trend of importing primary products to importing secondary products from tropical countries (**Figure 2**). As EU and U.S. economic growth rates have slowed, prices for secondary tropical hardwoods have not increased in real terms over the past 5 years (International Trade Center 2001). During the Asian economic crisis of 1997-1998, trade of tropical hardwood products experienced a significant reduction but by 2000 had begun a slow recovery. The countries that were more affected by the crisis were Indonesia, South Korea, and Thailand. The Asian crisis was caused by a massive influx of western investment into the Asian economy. This investment created economic growth 2 to 8 percent of GDP. This investment also took place in Latin American economies. When the Mexican peso (currency) fell causing economic losses for the western investors, the uncertainties in these investments caused a snowball effect in the Asian economy as investors withdrew (Wikipedia 2006).

In addition to traditional markets in the U.S. EU, and Japan, other countries/regions are becoming important players in tropical timber trade. For example, China, Taiwan, and Korea import more than 100,000 m³ of one or more tropical hardwood products annually (ITTO 2004). China has become a dominant player in the market for tropical hardwood products and is one of the main importers of tropical logs. UNECE (2002) reports that China has become a significant exporter of tropical plywood to Europe using imported logs as the primary raw material. During 1997-2002, 75 percent of China's total volume of hardwood log imports was tropical logs mainly from Malaysia, Gabon, Papua New Guinea, Liberia and Myanmar (Hashiramoto et al. 2004). This figure increased to 80 percent in 2003.

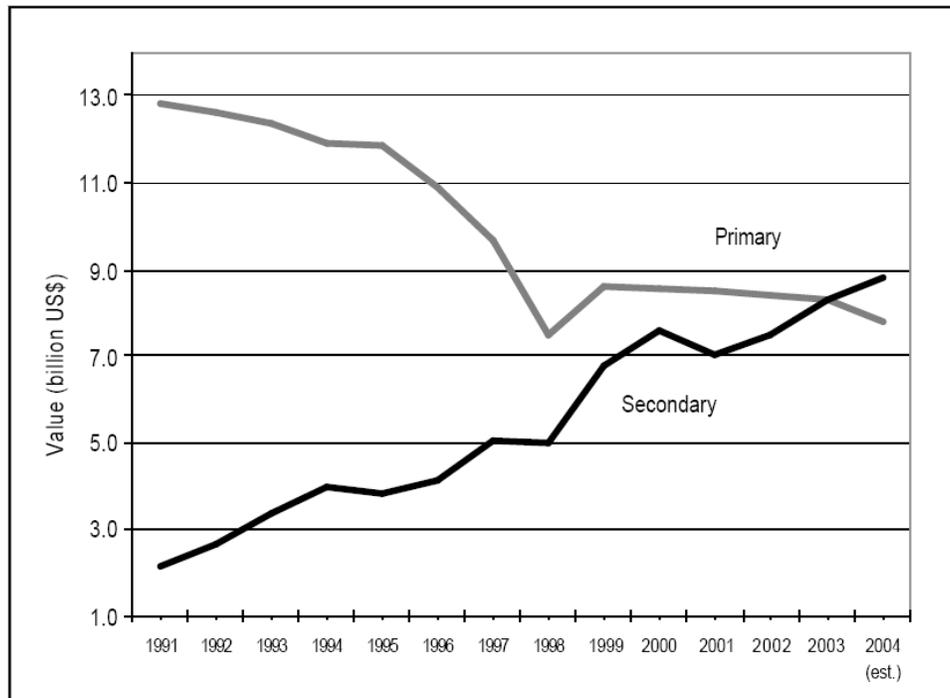


Figure 2. Import partner countries of primary and secondary tropical timber products that originate on ITTO member countries

Source: ITTO 2004

India has also become a major player in the importation of tropical timber. The country's growing economy is creating disposable income for wood product consumer purchases. In addition, infrastructure requirements have also created demand for tropical hardwood. India does not have an adequate domestic supply to meet demand for tropical timber. India's largest import sources are Malaysia, Myanmar, Indonesia, New Zealand, and in the last few years, Latin America and Africa. It is anticipated that India will become a major player in global markets for value-added tropical hardwood products. Its geographical location near the Middle-East, East Asia and Europe gives India a competitive advantage with regard to access to markets (Muthoo 2005).

Consumption of tropical hardwood products is influenced by global economies. One of the variables that influence markets for tropical hardwoods is the economic conditions in consumer countries (ITTO 2004). The major market countries/regions are China, U.S., Japan, the EU, and advanced-economies and new-industrialized-Asian-economies (NIE's). China has maintained steady economic growth over the past four years. Germany accounts for the largest economy of the EU. After the reunification of Germany the German economy contracted somewhat, resulting in an overall softening of the EU economy. The U.S. has had continued growth through 2004 (ITTO 2004).

New home construction is a significant demand sector for wood products. Wood accounts for 17 percent of building components in the U.S. (Trusty 2005). **Figure 3** shows that U.S. housing growth has increased dramatically since 1997 while **Figure 4** shows comparative single-family housing trends in Japan, the U.S. and the EU. The U.S. is by far the leading country in single-family housing starts. Single-family homes are predominantly wooden in these regions and therefore provide a good indicator of overall wood demand (ITTO 2004).

Table 1 shows the proportion of tropical product imports for major ITTO importers in 2004. Taiwan and Portugal obtain more than 50 percent of their logs from tropical suppliers. China and Portugal obtain 50 percent of their sawnwood imports from tropical sources. Taiwan and Hong Kong obtain more than 70 percent of their veneer imports from tropical countries. More than 80 percent of the plywood imported by Taiwan and the Republic of Korea comes from tropical forests. Most of the major producer countries, with the exception of Mexico, depend very much on tropical hardwood product imports for their primary hardwood product needs.

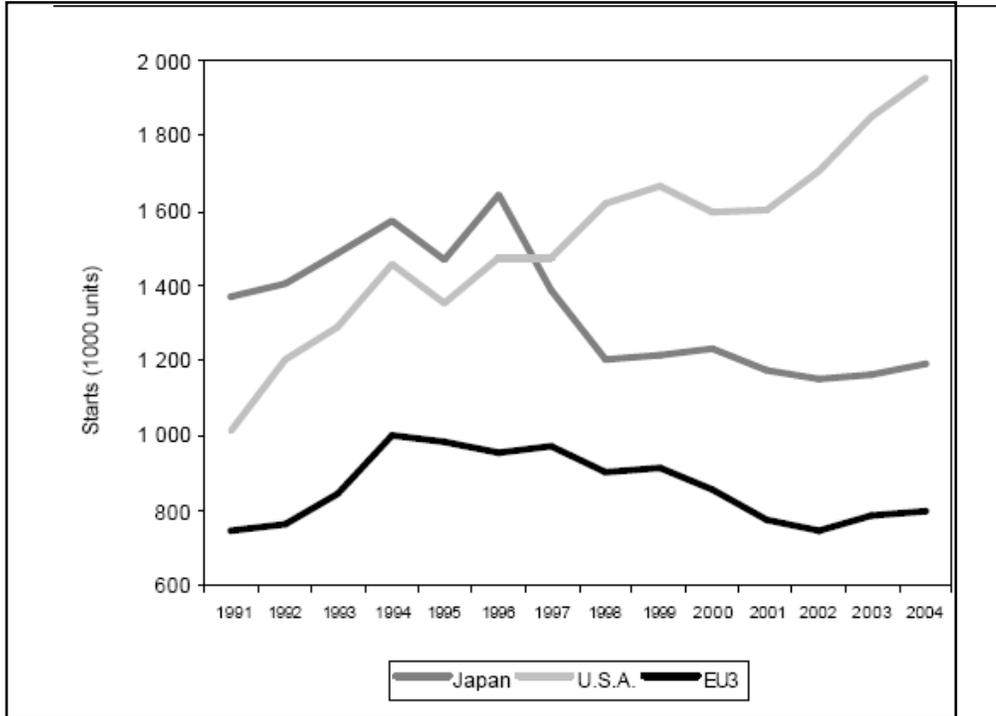


Figure 3. Total housing starts in Japan, the U.S. and the EU: 1991-2004
 Source: ITTO 2004

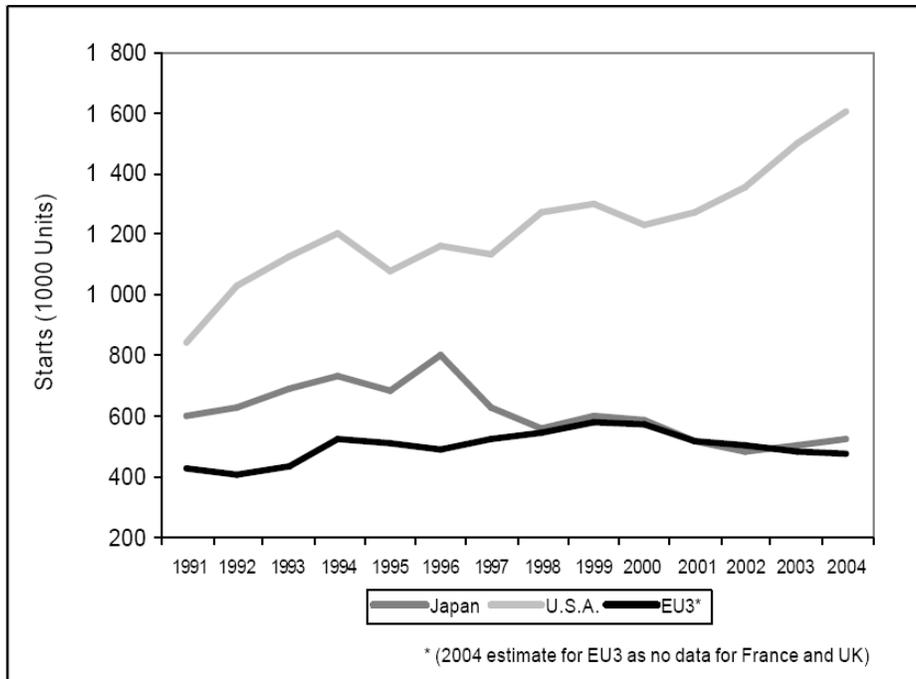


Figure 4. Single-family housing starts Japan, the U.S. and the EU: 1991-2004
 Source: ITTO 2004.

Table 1. Tropical proportion of total imports by major ITTO importers (2003)

ITTO	Proportion (%)			
	Logs	Sawnwood	Veneer	Plywood
Consumer Members				
Taiwan	81.4	38.3	88.4	80.1
Portugal	62.6	52.6	42.5	20.7
Hong Kong	45.4	47.7	75.4	78.9
China	30.0	51.4	54.8	51.2
France	25.7	11.0	56.1	26.5
Japan	14.1	5.5	32.3	78.1
U.K.	11.7	4.2	32.1	27.4
Netherlands	10.5	12.4	40.5	40.4
Republic of Korea	6.4	40.1	68.7	92.2
Italy	4.6	4.1	32.1	18.7
Germany	3.4	2.7	11.8	13.9
Spain	3.0	9.8	29.4	7.6
Denmark	1.2	5.9	46.6	23.5
Belgium	0.9	14.4	29.3	49.1
U.S.	0.1	0.7	6.2	29.5
Producer Members				
India	91.1	38.3	56.3	45.7
Malaysia	57.3	91.3	100	6.8
Mexico	12.2	1.7	18.5	35.4
Philippines	54.1	42.9	76.4	48.1
Thailand	86.3	85.8	74.2	97.2

Source: ITTO 2004.

Tropical Primary Wood Products Trade

Wood products are typically divided into primary and secondary products. Among the primary tropical hardwood products are logs, sawnwood, plywood, and veneer. Secondary wood products include wooden furniture and parts, doors, flooring, millwork and molding. The primary products discussed in this section are tropical roundwood, sawnwood, veneer, and plywood. The trade of these products is presented by production, consumption, imports, and exports.

Tropical Roundwood

Roundwood is the term given to logs extracted from the forest after debarking but before being squared by sawing or hewing. This stage is considered the first in the wood product manufacturing process.

1. Production

The total world production of tropical roundwood was approximately 136 million m³/year in 2003. The major producer countries are Brazil and Indonesia, followed by Malaysia and

India (ITTO 2004). Indonesia's major trading partner countries are Malaysia and China (Hashiramoto et al. 2004).

2. Consumption

The main producer countries are also the main consumer countries. Indonesia and Brazil are the main consumers followed by Malaysia, India, and China. These five countries account for 73 percent of total consumption (ITTO 2004).

3. Imports

The total world imports of tropical roundwood were 15.8 million m³ in 2003. China is the main importer of tropical roundwood (7.6 million m³) followed by India, Japan, Taiwan, and Portugal. China's growing economy and its zero percent tax on tropical roundwood is driving the imports skyward (ITTO 2004). China imported 7.3m³ in 2003, mainly from Malaysia, Gabon, Papua New Guinea, Liberia and Myanmar (Hashiramoto et al. 2004).

4. Exports

The total world exports of tropical logs were 13 million m³ in 2003. The main roundwood exporter country is Malaysia (5.5 million m³/ year in 2003) followed by Papua New Guinea, Gabon, Myanmar, and Liberia (ITTO 2004).

5. Prices

Table 2 shows a trend of escalating prices for tropical roundwood from 2002-2004. The main reason for the increase is the reduction in supply due to the log export restrictions in some countries to add domestic value reduce illegal logging.

Table 2 Average prices of ITTO countries exports of tropical logs (2002-2004)

Price	2002	2003	2004
	US\$/m ³		
Nominal	167	256	269
Minimum	128	187	197

Source: ITTO 2004

Tropical Sawnwood

The next step in wood processing is the manufacturing of sawnwood. Lumber is the main sawnwood product. Sawnwood production consists of the following stages: debarking logs, sawing boards from logs, squaring the edges, and cutting to length (trimming), drying (typically kiln or air), grading and packing (Juslin and Hansen 2003).

1. Production

Tropical sawnwood accounted for 5 percent of total sawnwood trade in 1999. It is expected to decrease and be replaced by sawn softwood coming from plantations and treated wood (International Trade Center 2001). The total world production of sawnwood from the 59 ITTO countries accounting for 90 percent of the tropical timber trade was 43 million m³/ year in 2003. Brazil is number one with 15.9 million m³ followed by Indonesia, India, Malaysia, and Thailand. Together these countries account for 80 percent of total production (ITTO 2004).

2. Consumption

The main consumer country is Brazil at 14.6 million m³ in 2003, followed by India, Indonesia, China and Malaysia. These five countries accounted for 71 percent of the total consumption (ITTO 2004).

3. Imports

The total world imports of sawnwood in 2003 were 10 million m³. China is the main importer of tropical sawnwood (2.8 million m³) followed by Thailand, Malaysia, Hong Kong, and Japan. These countries account for 40 percent of the total imports (ITTO 2004). Japan has increased its imports of sawnwood coming from Europe. This fact has reduced the market share of Canada, the U.S. and tropical countries. The increase in Thailand's tropical sawnwood imports is related to its growing furniture industry (Hashiramoto et al. 2004).

4. Exports

The total world exports of sawnwood were 7.1 million m³ in 2003. The main sawnwood exporter country at that time was Malaysia (2.5 million m³/ year in 2003) (Hashiramoto et al. 2004, ITTO 2004) followed by Brazil, Thailand, Cameroon, and Cote d'Ivoire (ITTO 2004)..The price of tropical sawnwood varies depending on the species.

Tropical Veneer

“Veneer is a thin sheet of wood of uniform thickness—commonly 0.5–1.0 mm (about 0.02–0.04 inch) and sometimes as much as 10 mm (about 0.4 inch). According to the method of production, it is classified as rotary-cut (cut on a lathe by rotating a log against a knife blade in a peeling operation), sliced (cut with a knife blade sheet by sheet from a log section, or flitch), or sawn (produced with a special tapered)” (Encyclopedia Britannica 2005).

1. Production

The total world production of tropical veneer was approximately 2.6 million m³ in 2003. The major producer countries are China, Malaysia, Philippines, Brazil, and Ghana. (ITTO 2004).

2. Consumption

The total annual consumption of tropical veneer was 3.7 million m³ in 2003. The main consumer countries are China, Philippines, Malaysia, India, and Brazil accounting for 55 percent of the total consumption (ITTO 2004).

3. Imports

The total world imports of tropical veneer were 1.3 million m³ in 2003. Korea was overwhelmingly the largest importer of tropical veneer with 228,000 m³ in 2003 followed by Taiwan, Malaysia, China, and the U.S. (ITTO 2004).

4. Exports

The total world exports of tropical veneer were less than 1 million m³ in 2003. The main veneer exporter country is Malaysia (462,000 m³ in 2003) followed by Gabon, Ghana, Cote d'Ivoire, and Brazil (ITTO 2004).

Tropical Plywood

Plywood is a panel product that is composed of odd number of plies or veneers glued together perpendicular to adjacent plies to increase strength. The face layer typically a higher grade than the back because it will be exposed in interior applications. Tropical plywood is used for primarily for decorative purposes.

1. Production

Global plywood production has been declining since 1998 with the introduction of competitively priced composite panels for structural applications (Hashiramoto et al. 2004). The total world production of tropical plywood, used mainly in non-structural applications, was approximately 15.7 million m³ in 2003. The major producer country is Indonesia (6.7 million m³) followed by Malaysia, China, India, and Brazil (ITTO 2004).

2. Consumption

The total annual consumption of tropical plywood was 13.2 million m³ in 2003. The leading consumer countries are Japan, China, India, Indonesia, Rep. of Korea, Indonesia, and Brazil followed by Malaysia, India, and China. These five countries account for 67 percent of the total consumption (ITTO 2004).

3. Imports

The total world imports of tropical plywood were 9 million m³ in 2003. Japan was the main importer of tropical plywood (4.6 million m³) followed by the Rep. of Korea, U.S., Taiwan, and China (ITTO 2004).

4. Exports

The total exports of tropical plywood were 10.2 million m³ in 2003 worldwide. The main tropical plywood exporter country is Indonesia (5.1 million m³/ year in 2003) followed closely by Malaysia, and then Brazil, China, and Belgium (ITTO 2004).

Table 3 gives a summary of the 2003 production, consumption, imports, and exports of the tropical roundwood and tropical primary wood products. **Table 3** shows that 32 percent of the roundwood production goes to produce sawnwood, 2 percent to veneer, and 12 percent to plywood. Around 10-12 percent of the produced tropical roundwood is actually traded (imported or exported); the rest is consumed in the country where it is produced. There is a trend of increasing percentage of product exported from sawnwood to veneer to plywood.

Table 3. Summary of tropical primary wood products world trade (2003)

Product	Production (10⁶ m³)	Consumption (10⁶ m³)	Imports (10⁶ m³)	Exports (10⁶ m³)	% Exported
Roundwood	136.0	--	15.8	13.0	10
Sawnwood	43.0	--	10.0	7.1	17
Veneer	2.6	3.7	1.3	1.0	38
Plywood	15.7	12.3	9.0	10.2	65

Source: ITTO 2004

Tropical Secondary Wood Products Trade

The major consumer countries of tropical secondary wood products are the U.S., Europe, and Japan. There is a trend towards a reduction in imports of primary products and an increase in imports of secondary products. The main producers and exporters of these products are Malaysia, Brazil, Thailand, Mexico, Viet Nam and the Philippines (Hashiramoto et al. 2004). It is difficult to find secondary tropical hardwood product trade data because of the lack of standardization and gaps in data from tropical countries. This has resulted in extremely inaccurate counts and statistics.

Table 4 shows the broad international trade categories of secondary wood products used by ITTO. Wooden furniture categories account for 60 percent of the total trade value. Overall, from producer to consumer countries there is an increase in secondary tropical hardwood products trade and a reduction in primary tropical hardwood products trade.

Table 4. Secondary products of tropical species categories and international trade nomenclature classification

Secondary Tropical hardwood Product Category	Description
Wooden furniture and parts	Seats with wooden frames
	Furniture of wood
Builders' woodwork	Builders' joinery and carpentry
Other secondary tropical hardwood products	Packaging, cable drums, pallets, etc.
	Coopers' products and parts
	Wood products for domestic/ decorative use, excluding furniture
	Other manufactured wood products
Moldings	Continuously shaped or profiled wood
	(e.g. moldings, unassembled strips and friezes for parquet flooring, beaded wood, dowels, etc.)
Furniture and parts	Furniture of other material like bamboo

Source: ITTO 2004

Major Trade Flows of Secondary Tropical Hardwood Products

The five largest global importers of STWP are the U.S., Germany, the UK, Japan, and France. Most Japanese imports come from China. Chinese STWP imports have decreased because of the increase in Chinese production of STWP. **Table 5** shows the major trade flows among the major players in secondary tropical hardwood products. The main importer countries and regions are the EU, U.S. and Japan, and the main exporter countries are Indonesia, Malaysia, and Brazil. **Table 5** shows how the three major importers of STWP follow a trend of increasing their imports of secondary tropical hardwood products and reducing their imports of primary tropical hardwood products.

The United States imports the largest quantity of secondary tropical hardwood products (STWP) in the world (Hashiramoto et al. 2004, ITTO 2004). Imports in 2003 were US\$ 16.5 billion, accounting for 34 percent of global imports. In 2002, 23 percent of U.S. imports came from ITTO producer countries (Mexico, Indonesia, Brazil, Malaysia, and Thailand) that accounted for 90 percent of the tropical hardwood trade. Additional imports came from non-ITTO members such as China, Canada, and the EU (mainly Italy). U.S. imports have quadrupled

in the last ten years. Increasing single housing starts is the primary reason for the growing demand for wood products, including STWP (ITTO 2004). The European Union exceeded the imports of the U.S. in 2003, importing US\$ 19.2 billion. The leading importing members of the EU are Germany, the UK, France, the Netherlands and Belgium, accounting for 70 percent of total EU imports. A major portion of the EU imports originate in EU countries (Germany and Italy), with the remainder coming from China, Brazil, Indonesia, and Malaysia. Germany is the largest importer country, contributing US\$ 4.4 billion in 2002 and consistently importing from Eastern European countries.

Table 5. Direction of trade of secondary tropical hardwood products for main partners, 2002 (million US\$)

Exporter	China	EU	ITTO	Indonesia	Malaysia	Brazil	ITTO
Importer			Consumers				Producers
EU	1,146		11,916	1,010	309	310	2,119
	719		13,985	629	305	279	1,347
U.S.	5,069	2,071	11,497	747	576	656	3,787
	2,935	2,126	9,464	514	522	570	2,805
Japan	1,059	430	1,725	280	171	4	903
	944	424	1,584	321	200	7	917
ITTO Cons.	8,991	14,806		2,264	1,295	1,020	7,493
	5,650	17,371		1,873	1,270	904	6,861

(Source: ITTO 2004)

Table 6 shows the change in import value from 1995 to 1999 of secondary tropical hardwood products in Japan, the U.S., and the EU. The EU is the only one that has increased its import value in primary and secondary tropical hardwood products from 1995 to 1999. The U.S. has reduced its import value of secondary tropical hardwood products and has not changed the import value of primary tropical hardwood products. Japan has radically increased its import value of primary tropical hardwood products and reduced its import value of secondary tropical hardwood products.

Table 6. Import value of primary and secondary processed tropical timber products by the European Union, Japan and United States of America (1995-1999)

		US\$ million					Percent change 1995/1999
	Primary	1995	1996	1997	1998	1999	
Japan	Secondary	3.0	2.5	2.5	2.6	N/A	-12
	Primary	1.3	1.4	1.6	1.6	1.7	+35
United States of America	Secondary	4.5	4.6	4.4	3.8	2.0	-57
	Primary	0.8	0.9	0.8	0.6	0.8	NC
European Union	Secondary	0.8	0.8	0.8	0.8	0.9	+13
	Primary	1.3	1.4	1.5	1.7	2.1	+57

(Source: FAO 2001 citing ITTO)

Environmental issues

The clearing of tropical forests has been occurring for many centuries. Deforestation is primarily the result of logging or burning for subsistence agriculture. The National Aeronautics and Space Agency (NASA) (1998) stated that at the current rate of destruction, within 100 years tropical forests will no longer exist. There is no question that deforestation results in unstable and vulnerable watersheds (Revenge et al. 1998). Deforestation also has a huge impact on the carbon cycle. The loss of forests releases carbon dioxide into the atmosphere. Since CO₂ is a greenhouse gas, the result will be an increase in global temperatures (NASA 1998).

“Global deforestation has caused mounting environmental concern, and pressures from environmental non-governmental organizations (NGOs) have been actively channeled to affect timber trade and the opinions of individual consumers concerning wood products (particularly in the U.S. and EU)” (International Trade Center 2001).

Deforestation

Deforestation can be seen from many dimensions; (1) forces that influence deforestation, (2) immediate causes of deforestation, (3) contributing factors, and (4) the consequences in terms of habitat destruction. In the end they all convey in the same results. Pearce and Brown (1994) identify two main forces affecting deforestation:

- “Competition between humans and other species for the remaining ecological niches on land and in coastal regions. This factor is substantially demonstrated by the conversion of forest land to other uses such as agriculture, infrastructure, urban development, industry and others” (Pearce and Brown 1994).
- “Failures in the workings of economic systems to reflect the true value of the environment. Basically, many of the functions of tropical forests are not marketed and, as such, are ignored in decision-making. Additionally, decisions to convert tropical forests are themselves encouraged by fiscal and other incentives” (Pearce and Brown 1994).

One of the largest contributors to the deforestation in the tropical rainforest is population growth and the lack of land tenure. The impact of these factors is compounded by (1) poor forest management practices (clearcuts) by commercial and illegal loggers, (2) the increasing demand for both farm and grazing land, and (3) the need for fuel and timber for construction directly correlated with population growth. **Figure 5** shows that the major cause of deforestation of tropical forests is land clearing by subsistence cultivators.

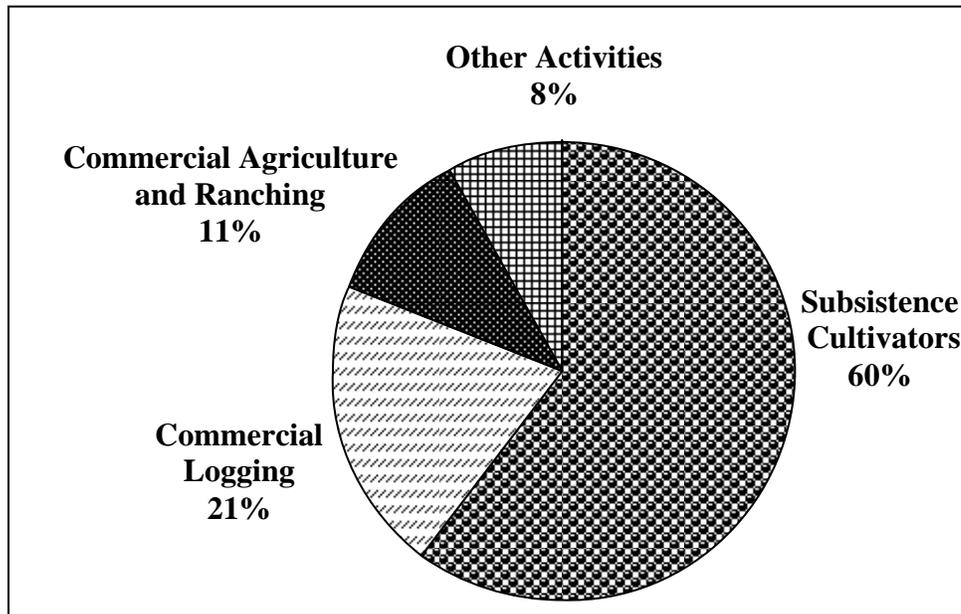


Figure 5. Major causes for tropical deforestation

Source: Butler 2001.

Tropical forests located in developing countries share similar issues. The forests are mainly owned by the state, and the state lacks funding to manage and protect the forest. As a result the forest is vulnerable to attack. When a resource is unprotected the population at large takes from the resource as much as they can because the resource is a common good. The problem is not the lack of laws and regulations; laws written but not enforced are worthless.

Geist and Lambin (2002) state that tropical deforestation can be better understood by multiple factor analysis than by single factor analysis; the causes are a combination of multiple variables. Their research showed that the results of a multiple factor analysis in one area cannot be applied to another area because of the complexity of the interrelationships of the factors.

Forests, as a general rule, are not only a place for the extraction of wood products; they are also the habitat where more than half of the world's biodiversity is found. At the moment almost half of the world's original forest cover is gone (NASA 1997). Briant et al. (1997) affirm that tropical deforestation can be also seen from the habitat threat perspective and state that deforestation can be analyzed in terms of internal and external causes.

Internal Causes of Tropical Deforestation

1. Logging

Logging accounts for 21 percent of the causes of tropical deforestation, it also opens roads that facilitate the access to hunt and gather materials from the forest.

2. Energy Development, Mining, and New Infrastructure

As an example, discovery of a natural gas reservoir in the middle of the forest results in opening long transects of forest (roads) to access said reservoirs. Another example is mining that requires water and use of highly toxic chemicals such as mercury (a major pollutant of the aquifers).

3. Land Clearing for Agriculture Expansion and Subsistence Agriculture

Many countries have tried to move the poorest segments of the population within cities to the forestland by promising them land for farming (SLW 1996). Forest soils lack proper nutrients for agriculture because the nutrients are in the biomass of the trees, not in the soils. Clearing the forest has become a cyclical deforestation pattern: clear the land, plant some crops for a couple of years, and when the soils do not have more nutrients to support the crops change the land use to grasslands, followed by clearing another piece of forest to start the cycle again (NASA 1998).

4. Excessive Vegetation Removal

Examples in this category include use of the forest as a free source of firewood and building materials. In Africa, the forest has clearly been reduced by over extraction.

External Causes of Tropical Deforestation

1. Growing Economies Consumption

Growing economies have increased trading in forest products (NASA 1998). However, to have a market share countries need to be competitive with respect to costs of production. Tropical countries cannot compete without appropriate technology for timber extraction. By trying to reduce their production costs, poor countries engage in unsustainable practices such as clearcutting, or extraction of only a few valuable sought after timber species.

2. Population Growth and Demand for New Land

Population growth in developing countries creates an increasing demand on their tropical forests. This growing population increases the demand for food, and forests are cleared to accommodate food production systems. At the same time, the growth in population increases the demand for forest products like wood fuel, timber, and paper.

3. Poor Economic Policies

When a cost benefit analysis is done to rationalize replacement of a tropical forest by an alternative use, the value of non-timber tangible and intangible products, such as biodiversity and eco-tourism, are not properly factored into the calculation.

4. Short Sighted Political Decisions

Politicians repeatedly make short-term decisions, i.e. opening certain wildlife refuges for commercial exploitation such as harvesting the natural resources of that site. The pressure to create new jobs overshadows any future consequences of this type of decision.

Tropical Deforestation Measures

Forest covers 30 percent of the world's area, and only 6 percent of that area is tropical forest. Deforestation is measured by the amount of forest that is lost each year. Satellite imaging is the most accurate measurement currently in use. Comparisons of images over time are used to calculate rates of change between images. **Table 7** shows tropical deforestation rates by regions and countries that have the largest tropical forest areas. The distribution of the world's forest area by region is as follows: Africa (7 percent), Asia (9 percent), Oceania (5 percent), and South America (23 percent). In South America, Brazil has the largest forest area, 14 percent of the world's forest area.

Sixty-four percent of Brazil's total area is covered with tropical forest, with an annual rate of change from 1990 to 2000 of -0.4 percent. The region with the largest forest annual rate of change from 1990 to 2000 is Africa with -0.8 percent, followed by South America -0.4 percent, Oceania -0.2 percent, and Asia -0.1 percent. The countries with the largest forest annual rate of change from 1990 to 2000 are Sudan with -1.4 percent and Indonesia with -1.2 percent, followed by Democratic Republic of the Congo with -0.4 percent and Brazil with -0.4 percent. The majority of the tropical forest is located within these nine countries. Brazil has almost 14 percent of the world forest (**Table 7**) and also has one of the largest deforestation rates in the world. The Associated Press (2005) stated that "Deforestation in the Amazon rain forest in 2004 was the second worst ever, figures released by the Brazilian government ... Satellite photos and data showed that ranchers, soybean farmers and loggers burned and cut down a near-record area of 10,088 square miles of rain forest in the 12 months".

Table 7. World deforestation rates by continents and major countries (1999-2000)

		Land area	Forest	Continent	World	Forest	Forest	Forest
		Total	Total	Forest %		% of land area	Change	Annual rate of change
		1999	2000			2000	1990-2000	1990-2000
#	Country/area	(million ha)	(million ha)			% of land	('000 ha)	(%)
	Africa	2,978	650			21.8	-5,262	-0.8
1	Dem. Rep. of the Congo	227	135	21	4	60	-532	-0.4
2	Angola	125	70	11	2	56	-124	-0.2
3	Sudan	238	62	10	2	26	-959	-1.4
				41	8			
	Asia	3,085	548			17.8	-364	-0.1
4	China	933	164	30	4	18	1,806	1.2
5	Indonesia	181	105	19	3	58	-1,312	-1.2
6	India	297	64	12	2	22	38	0.1
				61	9			
	Oceania	849	198			23	-365	-0.2
7	Australia	768	155	78	4	20	-282	-0.2
8	Papua New Guinea	45	31	16	1	68	-113	-0.4
				94	5			
	South America	1,755	886			51	-3,711	-0.4
9	Brazil	846	544	61	14	64	-2,309	-0.4
				51	23			
	World	13,064	3,870		34	30	-9,391	-0.2

Source: Food and Agriculture Organization of the U.N.: The State of the World's Forests 2003

Illegal Logging

“Illegal logging occurs when timber is harvested, transported, processed, bought or sold in violation or circumvention of national or sub-national laws” (Toyne et al. 2002). Illegal logging and illegal trade is a problem that occurs in more than 70 countries of the world including developed and developing countries. The World Bank calculated that illegal logging results in losses of US\$ 5 billion to the governments plus US\$ 10 billion to producing countries per year (2002) (Toyne et al. 2002).

Illegal logging has the capacity to depress world prices from 7 to 16 percent depending on the wood product (American Forest and Paper Association 2004).

A crucial component of the deforestation issue, illegal logging is the end result of inadequate law enforcement in tropical countries. The ITTO found in 2002 that 80 percent of the logging in tropical countries comes from illegal logging practices.

Illegal logging is not only a problem in tropical producer countries but also in consumer countries that do not ensure the legality of the wood product they procure. This results in detrimental repercussions in the short and long term. It propagates corruption, leads to loss of habitat, and leaves forest soils completely unprotected and vulnerable to erosion flooding. Long-term hazards include the release of CO₂ into the atmosphere, with resultant impacts on climate, and ultimately complete loss of the forest resources within that country (Brack 2005).

Developed nations like the G8 (the largest eight economies in the world) have the power to choose what type of products they purchase. There are already some efforts in the EU to ban products that do not come from legitimate activities (Brack 2005). The U.S. has also implemented an initiative to ban the procurement of products coming from illegal logging practices. One of the U.S. proposals is the use of forest management certification as a tracking tool to ensure the legality of the source. Another is to develop and enhance sustainable building partnerships by asking the U.S. State Department to enforce the laws and help track the source of manufactured products. Another way to help eliminate or reduce illegal logging is to encourage foreign investment in legal logging operations (Metafore 2003).

Illegal logging can be fought only by working in partnership with producer and consumer countries. Illegal logging affects developed countries because it provides wood products at a price that reflects distorted costs and consequently lowers the prices of wood products in developed countries. Metafore 2003 states that to fight illegal logging there are three main points that need to be attacked. The first is to promote legal forestry, the second is to protect areas of focus (natural reserves), and the third is to improve the tracking system along the supply chain.

Summary

The tropical forest is found between 10° N and 10° S latitude at elevations below 3,000 feet or 1000 meters. Tropical forests provide habitat for almost 50 percent of global biodiversity. The main regions encompassing the tropical forests are located in Central West Africa, Central and South America, and Southeast Asia, mostly in developing countries. The primary product extracted from tropical forests is hardwood timber.

The three main regions that consume tropical hardwood products are the EU, U.S., and Japan. The tropical hardwood products that are traded are divided into primary and secondary wood products. Among the primary tropical hardwood products, the most important are logs, sawnwood, plywood, and veneer. Among the secondary tropical hardwood products are wooden furniture and parts, builder's woodwork, and molding. China and India have become major importers of primary tropical hardwood products. The U.S., the EU, and Japan have decreased

their imports of primary tropical hardwood products and increased their imports of secondary tropical hardwood products over the last decade. The main producer countries are Indonesia, Malaysia, and Brazil.

Tropical forests are more than simple producers of timber products. They are the habitat for 50 percent of the world's biodiversity. Tropical forests suffer from major deforestation. The primary activities responsible for deforestation in the tropics include subsistence cultivation (60 percent), commercial logging (21 percent), commercial agriculture and ranching (11 percent), and other activities (8 percent). The two forces that drive deforestation are (1) competition between humans and other species for the remaining land and (2) market failures including lack of land tenure and lack of market value for environmental benefits. The countries with the highest tropical deforestation rates from 1990 to 2000 are Sudan -1.4 percent, Indonesia -1.2 percent, Democratic Republic of the Congo -0.4 percent, and Brazil -0.4 percent.

“Illegal logging occurs when timber is harvested, transported, processed, bought or sold in violation or circumvention of national or sub-national laws” (Toyne et al. 2002). Illegal logging is a problem that hurts the economies of developed and developing countries. The World Bank calculated that in 2002 illegal logging cost US\$ 5 billion to governments plus US\$ 10 billion to producing countries. One way to reduce illegal logging is to promote legal forestry. Another is to protect on areas of focus (conservation areas). The third is to improve the tracking system along the supply chain.

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