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PRODUCTION AND TRADE IN TROPICAL HARDWOODS: AN ASIAN-PACIFIC CASE STUDY

Trends and Issues Related to Competition with Temperate Hardwoods and Softwoods

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FOREWORD

Trade patterns in the world's timber markets are continually changing as conditions surrounding both the resource and the markets change. Many influences are involved, and they affect both hardwoods and softwoods in a variety of ways.

On the resource side, the effects of tropical degradation and deforestation and measures to arrest the loss are being felt widely. In response to these pressures, many tropical countries are attempting to improve management of their indigenous forests and to develop man-made plantations of fast-growing tropical species. In addition, a growing number are increasingly emphasizing supply of more highly processed products rather than unprocessed or semiprocessed ones. At the same time, developed countries have established extensive areas of softwood plantations, often to supply what is seen as a growing deficit in former hardwood markets. These changes are affecting supply sources, the products being supplied, and the materials they are being made from, with implications for market shares, prices, and profitability.

Of special interest in this equation is the degree to which tropical hardwoods, temperate hardwoods, and softwoods can and may substitute for one another. Information and understanding regarding this issue are limited, both because information is lacking and because the factors involved are complex and difficult to evaluate.

To facilitate greater understanding of this subject, FAO commissioned the Center for International Trade in Forest Products (CINTRAFOR) to undertake a study of the trends, influences, and possible effects of hardwood and softwood substitution, with special focus on the Pacific region. The objective was also to identify areas where further work could usefully be carried out.

FAO is pleased to be associated with CINTRAFOR in making available the information and findings of the study in order to increase awareness of this important subject.

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PREFACE

Global trade in forest products has expanded in both volume and scope within the last decade. Traditional producers of roundwood and forest products have found the world changing. New producers have entered the international trade arena. Some markets have matured. Others have opened and grown rapidly while some have declined in importance.

No region has been more affected by these swirling changes than the tropical hardwood subregion of the Asian-Pacific area. Resource conditions in the forest have changed with increased harvesting of the natural tropical hardwoods and with land clearing for agriculture, settlement, and other purposes. Export trade in roundwood has slackened as individual nations strive for greater returns from their forest resource and press for a comparative advantage in processing wood prior to export. Producers of roundwood have enhanced their positions, but frequently at the expense of processors in other parts of the subregion who had depended on imported logs.

Consumers have likewise changed. Importers now shop on a global basis for the wood they want and need. Strategic shopping results in new trade patterns. Economic forces have changed, with transportation and exchange rates impacting the apparent advantages of relatively remote growers and harvesters.

This study was undertaken for the Forestry Department, FAO, Rome, in order to document the trends and developments related to tropical hardwood production and trade, with a focus on the Asian-Pacific region as a case study. The study has been prepared under contract with Dr. Thomas R. Waggener as the senior author, supported by Dr. Gerard F. Schreuder and Ivan L. Eastin. The three authors are affiliated with the Center for International Trade in Forest Products (CINTRAFOR), College of Forest Resources, University of Washington, Seattle. The study draws freely upon the research and analysis conducted by FAO and CINTRAFOR, as well as other published studies related to hardwood production and trade. No added field research or data collection was possible given the timing and scope of this study. Rather, this overview seeks to document major trends, highlight major issues, and suggest further areas of research in the face of growing competition from conifers, temperate hardwoods, and nonwood materials.

The authors would like to thank Dr. I. J. Bourke, Senior Forestry Officer, Trade Analysis, FAO, for suggesting this study and for contributing to its completion. CINTRAFOR has provided assistance and access to the statistical and reference data bases. Special appreciation is acknowledged to Ms. Wendy Ekern and Ms. Dorothea Kewley for assistance in the preparation of the report manuscript.

INTRODUCTION

This case study deals with the tropical hardwood producers of the Asian-Pacific region. But since these countries must also be seen within the broader context of global—especially Pacific Rim—patterns of production, trade, and consumption of wood products, a total of twenty-four countries were considered relevant to this review, and are grouped into five subregions as shown in the table below.

The Asian countries were separated into Asian Exporters (those that have been major exporters of hardwood saw and veneer logs) and Asian Importers (those that typically have imported tropical hardwoods, perhaps in addition to significant domestic production). This distinction was thought desirable to help identify some of the important intraregional trade affecting tropical hardwoods.

In this analysis, emphasis is placed on the role of the two Asian subregions, complemented by the Oceania subregion. While the scope of countries included is not comprehensive for any of the subregions, it was felt that to provide a manageable data base the groupings are adequate in order to incorporate the significant trends in forest products trade.

Increasing concerns over the exploitation of tropical forests have been expressed by both the forestry and environmental communities. At issue is the sustainability of the tropical hardwood forests given past and current levels of harvest, and the outlook for those countries where tropical hardwoods constitute a significant part of the economic base. More recently, the issue of competition in the world market, particularly with temperate zone hardwoods and conifers, has arisen. New markets are being sought in order to sustain production and ensure continued viability of the forest products sector. The thrust for "value added" and to upgrade production beyond the roundwood, or even basic commodity, level is increasingly the choice of traditional roundwood producer countries, as a means of ensuring regional development and jobs.

Protectionism, usually expressed in terms of import barriers, is shifting toward greater use of export restrictions or taxes to discourage roundwood or unprocessed exports in favor of semiprocessed or finished goods.

Countries Grouped by Subregion for the Pacific Rim Tropical Hardwood Trade.

ASIA (EXPORTERS)*	NORTH AMERICA
Burma	Canada
Indonesia	United States
Malaysia	
Philippines	CENTRAL AND SOUTH AMERICA
ASIA (IMPORTERS)*	Chile
	Colombia
China (PRC)	Ecuador
China (Taiwan)	Mexico
Hong Kong	Peru
India	
Japan	OCEANIA
Singapore	
South Korea	Australia
Thailand	Fiji
	New Zealand
	Papua New Guinea
	Solomon Islands

* Classification based on 1986 FAO Yearbook of Forest Products (SITC 247.2 Sawlogs and Veneer Logs (NC)).

ORGANIZATION OF THE STUDY

Chapter 1 of this study gives a summary overview of the production, exports, and imports of forest products, with a major focus on the Pacific Rim within a global context. A separate section deals with trends in the twelve countries of the Asian subregions; and the main Pacific Rim importers and exporters of hardwood products are compared for 1971 and 1987 in a brief section at the end of the chapter.

Chapter 2 offers summary background and evaluation of trends related to hardwood trade and potential substitution by both temperate hardwoods and conifers. This review is mainly directed at identifying major issues, although general information from the recent literature is used whenever possible. The treatment is not exhaustive, but rather attempts to provide a sense of the complexity of the issues and to serve as a means for identifying areas for further research and analysis.

Chapter 3 provides a brief summary of the data availability and needs for a comprehensive analysis of the tropical hardwood situation in the emerging global context.

Chapter 4 brings together some of the available information on trends and forecasts, and summarizes issues and possible consequences.

Chapter 5 concludes the review with suggestions on major areas for future research and analysis to assist in guiding tropical forest policies at national and international levels. These recommendations rest on the premise that a more complete and factual understanding of trends and developments—as well as the economic, social, and political issues behind them—is needed before responsible international policies can be developed and implemented. The long-term outlook for tropical hardwoods appears to be encouraging, from both an environmental and an economic perspective, once the dynamics of the global marketplace are better understood.

CHAPTER 1. TRENDS IN PRODUCTION AND TRADE

TRENDS BY PRODUCT CLASSIFICATION

Current trends for major forest products, in the order listed in Table 1.1, are summarized in this section. All product categories are as defined by FAO (FAO 1989). Information was compiled on production, exports, and imports to the extent that source materials were available (see Table 1.1). Major trends for both softwood and hardwood species are given wherever possible. Data sources that provided more specific product information on a limited or country basis were reviewed and utilized as feasible.

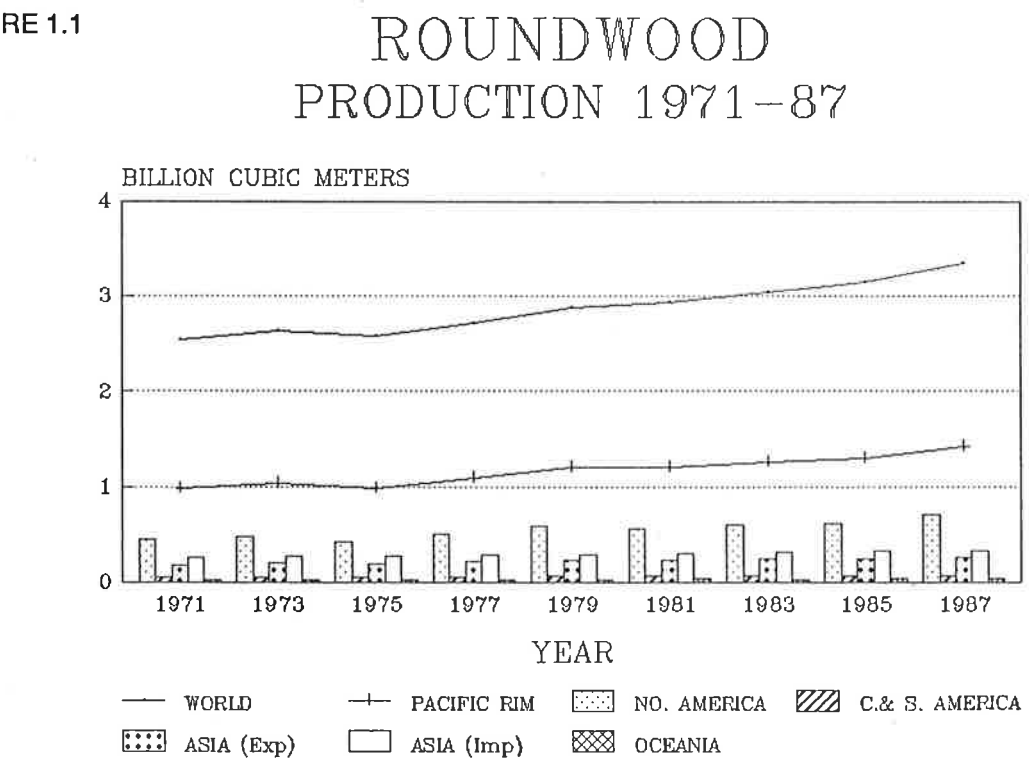
Roundwood (Figures 1.1-1.3)

Production. Global production of all roundwood increased from 2.5 billion cubic meters in 1971 to almost 3.4 billion in 1987. Total Pacific Rim production increased from almost 1 billion to 1.4 billion. In 1971, the Pacific Rim accounted for 38.5% of global roundwood production, increasing to 42.3% in 1987.

The combined Asian subregions produced some 446 million cubic meters of roundwood in 1971, or 45.6% of the Pacific Rim total (17.6% of the global total). By 1987, Asian production of roundwood was 592 million cubic meters (41.8% of the Pacific Rim total and 17.7% of the global). The Asian Exporter subregion accounted for 260 million in 1987 (18.4% of Pacific Rim) and Asian Importers accounted for 331 million (23.4% of Pacific Rim), clearly indicating that these countries are not only net importers of tropical hardwood timber but also major roundwood producers.

In the Pacific Rim, the North American subregion remained the major roundwood producer, with 454 million cubic meters in 1971 (46.5% of Pacific Rim; 17.9% of global), increasing to 716 million in 1987 (50.4% Pacific of Rim; 21.3% of global). Oceania had roundwood production of 26.9 million in 1971 (2.8% of Pacific Rim; 1.1% of global). By 1987, this region had production of 38.4 million cubic meters (2.7% of Pacific Rim; 1.1% of global).

FIGURE 1.1



CINTRAFOR/FAO

Table 1.1. Product classification scheme (FAO 1989).

Product	Production	Export	Import
Total Roundwood	x	x	x
Hardwood	x		
Softwood	x		
Fuelwood and Charcoal total	x	x	x
Fuelwood	x	x	x
Hardwood	x		
Softwood	x		
Charcoal	x	x	x
Industrial Roundwood total	x	x	x
Hardwood	x		
Softwood	x		
Saw/Veneer Logs total	x	x	x
Hardwood	x	x	x
Softwood	x	x	x
Pulpwood and Particles total	x	x	x
Pulpwood	x	x	x
Hardwood	x		
Softwood	x		
Chips and particles		x	x
Wood residues		x	x
Other Industrial Roundwood	x	x	x
Hardwood	x		
Softwood	x		
Sawnwood and Sleepers total	x	x	x
Sawnwood: Hardwood	x	x	x
Softwood	x	x	x
Veneer and Plywood			
Veneer sheets	x	x	x
Plywood	x	x	x
Particleboard	x	x	x
Fiberboard	x	x	x
Wood pulp	x	x	x
Paper and Paperboard	x	x	x

Note: The items marked with an x are discussed in this chapter.

FIGURE 1.2

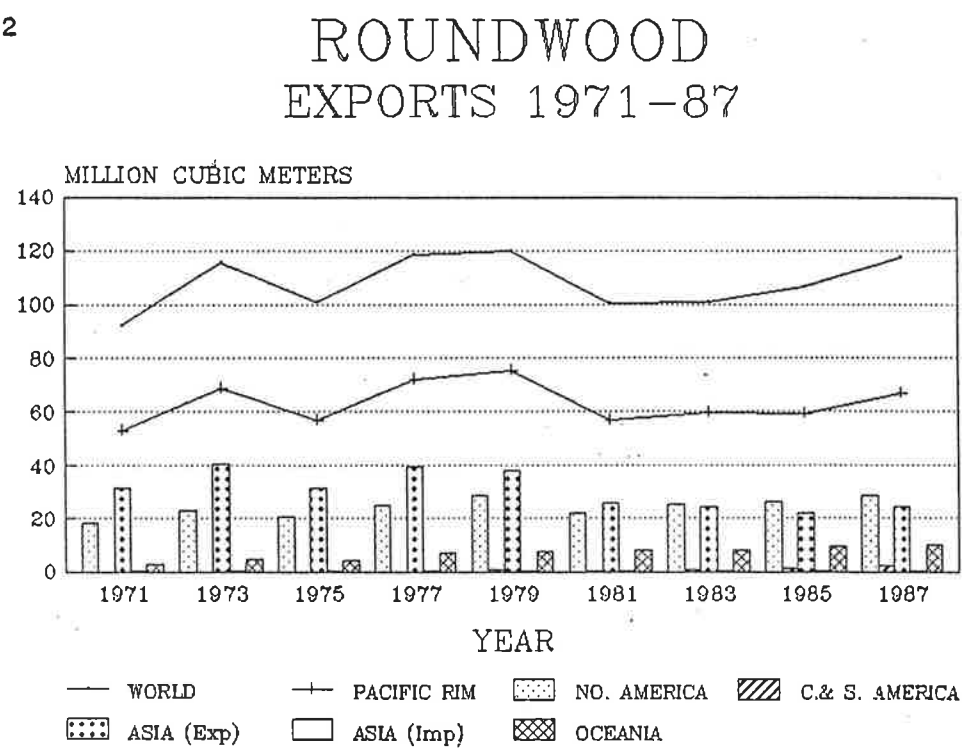


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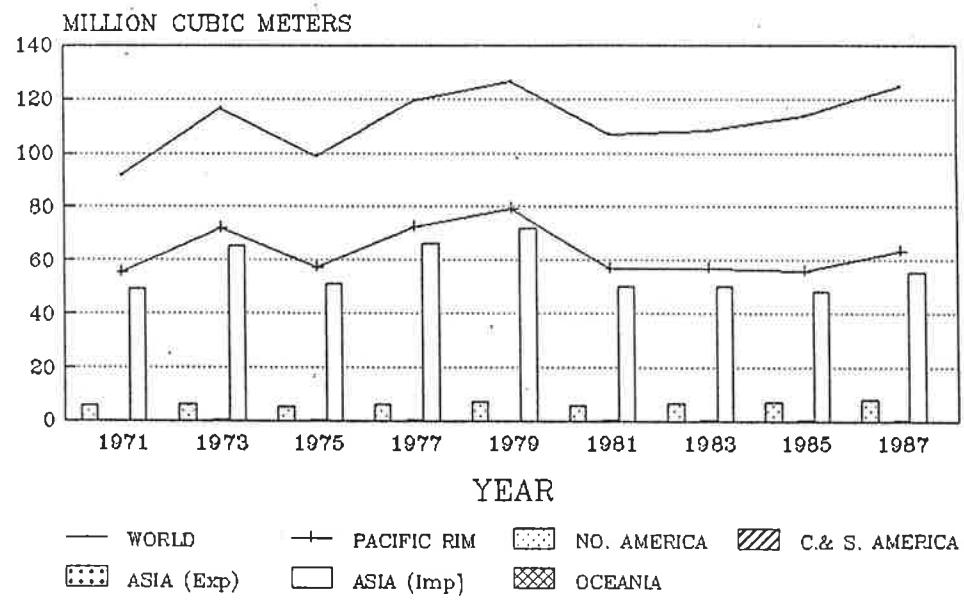
FIGURE 1.3



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Trade. The Pacific Rim accounted for 57% of global roundwood exports (53.1 million cubic meters) and 60.5% (55.5 million) of global imports in 1971. By 1987, the region as a whole exported 66.7 million cubic meters (56.8%) and imported 63.7 million (51.2%), a growth in total roundwood trade but a slight decline in the global share.

The combined Asian subregions exported 32 million cubic meters in 1971, or 34.7% of global roundwood exports (60.1% of Pacific Rim exports). Exports had decreased to 25 million cubic meters by 1987, with the two subregions accounting for 21.3% of global exports and 37.6% of Pacific Rim exports. The Asian Exporters accounted for the largest portion of Asian exports: 36.8% of Pacific Rim and 20.9% of global exports in 1987. While Indonesian exports increased from 1971 to 1977, they declined steadily in 1980-85 because of the 1980 ban on roundwood exports. In contrast, exports from Malaysia increased steadily, more than doubling in 1971-87.

Oceania had roundwood exports of 3 million cubic meters in 1971 and 10.2 million in 1987. While representing only 3.3% of global and 5.8% of Pacific Rim exports in 1971, this subregion accounted for 8.7% of global and 15.4% of Pacific Rim in 1987. The most significant increase was from Australia: an increase to 7.4 million cubic meters in 1987 from under 350 thousand in 1971. Roundwood imports by Pacific Rim countries were dominated by the Asian Importers, which together showed a growth from 49.3 million cubic meters to 55.3 million in 1971-87. This subregion was in turn dominated by imports by Japan, which accounted for over 46.5 million cubic meters in 1987, or fully 84% of Pacific Rim imports and 73% of global imports. The North American subregion accounted for practically all other roundwood imports.

Hardwood and Softwood Roundwood Production

World production of hardwood roundwood increased from 1.4 billion cubic meters to 1.9 billion in 1971-87. Production in the Pacific Rim increased from 534 million to 801 million, increasing its global share from 39.2% in 1971 to 42.8% in 1987.

Hardwood roundwood production in the Pacific Rim was distributed between the Asian Exporters (32.1%), Asian Importers (35.2%), and North America (24%, 1987), accounting for 13.7%, 15.1%, and 10.4%, respectively, of global production in 1987.

Softwood roundwood production totaled just over 1 billion cubic meters in 1971, and increased to almost 1.4 billion by 1987. Pacific Rim production went from 424.8 million in 1971 to over 590 million in 1987. On a global basis, Pacific Rim countries accounted for 38.8% in 1971 and 43.5% in 1987. Pacific Rim softwood production was consistently dominated by North America (85.5%, 1971; 87.8%, 1987). Asian Importers (Japan and India) accounted for 34.7 million cubic meters in 1987 (5.9% of Pacific Rim), and Oceania for 15.9 million (2.7%).

Fuelwood and Charcoal

Production. Total global production of fuelwood and charcoal increased from 1.2 billion cubic meters in 1971 to 1.7 billion in 1987. The production of fuelwood and charcoal in the Pacific Rim increased from 388.3 million to 632.8 million. The Pacific Rim share of global production increased from 31.4% to 36.8%.

Production in the Asian subregions was most significant, with the Asian Importers accounting for 268 million cubic meters in 1987 (42.4% of Pacific Rim; 15.6% of global), and Asian Exporters for an additional 186.9 million (29.5% of Pacific Rim; 10.9% of global). In 1987, 45% of all roundwood harvested in Asia went toward the production of fuelwood and charcoal.

Trade. Reported trends in fuelwood trade are inconsistent. Global exports are reported as 2.3 million cubic meters in 1971, 2.8 million in 1983, and 2.2 million in 1987; global imports as 2.6 million in 1971 and 3.9 million in 1987. The Pacific Rim accounted for 37.6% of exports in 1971 and 42% in 1987. The exports by Pacific Rim nations were almost entirely from the Asian subregions (89.8% in 1971; 91.3% in 1987). However, the share for Exporters declined from 69.1% to 45.1% of the Pacific Rim exports, while Importers increased from 20.7% to 46.2%.

The Pacific Rim represented 30.1% (771 million cubic meters) of 1971 fuelwood and charcoal imports, and 35.7% (1.4 billion) of 1987 imports. Of this, Importers had the greatest share (62.2%, 1987), followed by Exporters (26.1%).

Fuelwood (Hardwood and Softwood)

Production. Fuelwood production increased from 1.2 billion cubic meters in 1971 to 1.6 billion in 1987. Pacific Rim production was 371 million in 1971 and 605 million in 1987. Thus the Pacific Rim share increased from 32% to 38%. The Asian subregions accounted for 72.3% of the Pacific Rim total in 1987, with the North American share increasing from 4.8% to 19.3%.

Hardwood fuelwood production was 989.8 million cubic meters in 1971; softwood was 169 million. In 1987 the figures were 1.4 billion and 222.9 million. The Pacific Rim accounted for 41.3% of hardwood and 17.7% of softwood production in 1987. This hardwood production is concentrated in the Asian subregions (75.6%); North America accounts for 16%. For softwood production, North America has 59.1% of Pacific Rim output and 10% of global.

Trade. Global exports declined rapidly from 1971 through 1981, from 1 million cubic meters to 301 thousand. In 1987, global exports had increased to 412 thousand. The Pacific Rim accounted for 443 thousand of exports in 1971 (42% of global). In 1987, Pacific Rim exports were only 4.5 thousand, a mere 1% of global exports. Within the Pacific Rim, Asian Exports accounted for virtually all exports in 1971 (439 thousand cubic meters, 99.3%) but only 1.7 thousand in 1987. Central and South America accounted for 2.8 thousand in 1987, or 62.2% of the greatly diminished Pacific Rim total.

Reported fuelwood imports do not agree closely with exports at the global level. Reported imports were 998 thousand cubic meters in 1971, increasing to over 1.4 million in 1973-75, declining to 612 thousand in 1981, and then increasing to over 1 billion in 1983-85. Pacific Rim imports were insignificant, reported at 66 thousand in 1971 and 10 thousand in 1987, a decline from 6.6% of world imports to only 1% in 1987. Asian Importers accounted for over 75% of imports throughout the 1971-87 period.

Charcoal

Production. Global production of charcoal has increased steadily from 13.1 million metric tons in 1971 to almost 21 million in 1987. Pacific Rim production has also increased, but more modestly, from 2.9 million to 4.6 million. The Pacific Rim accounted for approximately 22% of global production in 1971-87.

Over half the Pacific Rim production is by Asian Importers, although the regional share has declined from 62.4% to 53.9%. The majority of this subregion's production was by Japan (1.8 million metric tons, 1987) and Thailand (589 thousand).

Trade. Trade in charcoal is relatively modest, with exports increasing from 204 thousand metric tons in 1971 to 344 thousand in 1985 before declining to 304 thousand in 1987. The Pacific Rim has accounted for an increasing share of world charcoal exports, rising from 33.9% in 1971 to 61% in 1975-77. Since 1977, the Pacific Rim percentage of world charcoal exports has declined, but remained at 51.2% of global exports in 1987.

The Asian subregions accounted for 91.5% of exports, with almost equal shares held by Exporters (45.1%) and Importers (46.4%) in 1987. Indonesia and Thailand are the largest exporters, followed by Singapore, Malaysia, and the Philippines.

Reported charcoal imports indicate an increase in global imports from 261 thousand metric tons in 1971 to 511 thousand in 1987. The Pacific Rim accounted for an increasing volume of imports, on up from 117 thousand metric tons in 1971 to over 232 thousand in 1987. The regional market share of imports, however, remained at about 45% over this period, having reached a maximum of 50% in 1977 before declining again. Asian Importers accounted for 144 thousand metric tons in 1987, or 62.1% of the Pacific Rim total. Japan was the leading importer, followed by Hong Kong and Singapore.

Industrial Roundwood

Production. Industrial roundwood production globally has increased steadily from 1971 to 1987, reflecting only the general economic slowdowns of the mid-1970s and early 1980s. Production of 1.3 billion cubic meters in 1971 grew to 1.6 billion in 1987. The Pacific Rim increased production from 587.8 million cubic meters to 785.6 million, accounting for about 45% of total global industrial roundwood.

North America had the largest share of Pacific Rim production, with 436 million cubic meters in 1971 and almost 595.5 million in 1987 (75.8% of Pacific Rim; 36.5% of global). The Asian subregions together accounted for almost 20% of Pacific Rim production, with almost 115 million cubic meters in 1971 and 136 million in 1987. The regional share for Importers, however, went from 11.1% to 8.0%, while the Exporters went from 8.5% to 9.4%. Oceania increased from 20.8 million to 29.7 million, and its regional share increased from 3.5% to 3.8%.

Hardwood production increased from 371.5 million cubic meters in 1971 to 499 million in 1987; Pacific Rim, from 181 million to 234.5 million. The Pacific Rim share of world production was 48.7% in 1971 and 47% in 1987. North America, Asian Exporters, and Asian Importers account for the leading share. Exporters increased from 49.7 million cubic meters (27.4%) to 72.9 million (31.1%); Asian Importers, from 35.7 million to 37 million. This represented about 19% of Pacific Rim production. North America increased from 77 million to almost 101.3 million (43.2% of Pacific Rim and 20.3% of world production in 1987). Oceania accounted for about 6% of Pacific Rim production in 1971-87, with output increasing from 10.5 million cubic meters to 14.5 million.

Softwood production has been more than twice that of hardwood, growing from 924.5 million cubic meters in 1971 to over 1.1 billion in 1987. The Pacific Rim has accounted for 45% of global production, rising from 407 million cubic meters in 1971 to 551 million in 1987. North America is the dominant producer, with about 89% of Pacific Rim production. Asian Importers account for about 5%, although this share has been declining slightly. Central-South America and Oceania account for about 3% each.

Trade. Trade in industrial roundwood is significant, with exports growing from 89.9 million cubic meters in 1971 to 115.2 million in 1987. The Pacific Rim increased from 52.3 million (58.2%) to 65.7 million (57.1%) in 1987. North America (43.6%) and Asian Exporters (36.7%) accounted for the majority of Pacific Rim exports. Oceania increased exports from 3 million cubic meters to over 10.2 million, increasing Pacific Rim share from 5.9% to 15.6%.

Imports have also increased, from 89.1 million cubic meters in 1971 to 120.5 million in 1987. The Pacific Rim imports increased from 54.7 million to 62.3 million. This more modest increase resulted in the Pacific Rim share of global imports declining somewhat, from 61.4% to 51.7%.

Asian Importers had imports of 48.9 million cubic meters in 1971 (89.3% of the Pacific Rim total). Imports increased to 54.4 million by 1987 (87.3% of the total). For this subregion, Japan accounted for 46.1 million cubic meters in 1987, or 84.7% of the total for the subregion and 74% of the Pacific Rim total.

Saw/Veneer Logs

Production. The largest proportion of industrial roundwood production is saw/veneer logs. Global production increased from 783.2 million cubic meters in 1971 to just over 1 billion in 1987. For the Pacific Rim, production increased from 393.8 million cubic meters to 542.9 million. The Pacific Rim consistently accounted for about half of global production, with a share of 54.2% in 1987.

Within the Pacific Rim, North America had the most significant proportion. Production increased from 284.6 million cubic meters (72.3%, 1971) to over 409 million (75.4%, 1987). Asian Exporters went from 44.4 million cubic meters in 1971 to 65.7 million in 1987. Asian Importers accounted for 40.5 million cubic meters in 1971 and 40.6 million in 1987. Oceania produced about 16.1 million in both 1971 and 1987.

Trade. Trade in saw/veneer logs has been significant, although the general trend for both imports and exports has been stable to slightly downward during 1971-87.

Total exports reflect the dynamics of the global economy, particularly the depressed wood markets of the mid-1970s and the early 1980s. Global exports were 62.1 million cubic meters in 1971, peaking at 80.7 million in 1973. This level was not reached again, with exports again peaking at 77.7 million in 1979. Exports have increased slightly from the low of 1981 (55.5 million) to 68.4 million in 1987.

Pacific Rim exports mirror worldwide figures. The Pacific Rim accounted for about 71-73% of global exports from 1971 to 1987. Asian Exporters accounted for the largest share (68.8%) in 1971, a level sustained through 1979. Exports peaked for this subregion in 1977 at 37.2 million, then dropped sharply, primarily because of Indonesian export restrictions. For 1981-87, exports from the subregion averaged about 23 million cubic meters.

North American exports have increased, from 11.2 million cubic meters in 1971 to over 22 million in 1987. The North American share of Pacific Rim exports thus increased from 25% to 45.4%, while Asian Exporters dropped from 68.8% to 47.6%.

Reported global imports closely follow reported exports, increasing from 60.5 million cubic meters in 1971 to 66.7 million in 1987, with the anticipated market swings. The Pacific Rim accounted for 43 million cubic meters of imports in 1971 (75.1% of global imports) and 43 million in 1987 (64.5%).

Asian Importers accounted for the majority of imports of saw/veneer logs, by far, importing 43.1 million cubic meters in 1971, or fully 94.7% of the Pacific Rim total and 71.2% of the global total. In 1987, imports were 39.5 million cubic meters (92% of Pacific Rim and 59.3% of global). North America accounts for the balance of remaining imports. Japan is the major importer, with 31.3 million cubic meters in 1987, over 79% of the Asian Importer total and almost 47% of the global.

Hardwood Saw/Veneer Logs

Production. The production of hardwood saw/veneer logs has increased from 212.8 million cubic meters in 1971 to 273 million in 1987. The growth has been modest and steady over 1971-87 except for a slight downturn due to recession in 1975. Pacific Rim production reflects this general global pattern, with an increase from 114.2 million cubic meters to 144 million. The Pacific Rim has accounted for over 50% of global production in 1971-87, representing 52.7% in 1987.

Within the Pacific Rim, Asian Exporters are the most significant producers: 44.3 million cubic meters in 1971 and almost 64 million by 1983. In 1987, this subregion produced almost 65.3 million cubic meters (45.3% of Pacific Rim production, up from 38.8% in 1971). North America increased production from 38.4 million cubic meters (1971) to 43.6 million in 1987 (30.3% of Pacific Rim production). Asian Importers produced 16.9 million cubic meters in 1971 (14.8% of Pacific Rim) and 20.9 million by 1987. Oceania and Central-South America each produced about 5% of Pacific Rim production.

Trade. Trends in the trade in hardwood saw/veneer logs illustrate the decline in hardwood log availability. From 1971 to 1979, the trend generally reflected economic conditions, rising from 40.5 million cubic meters to 51.9 million. Following a drop in 1975, in response to economic conditions, exports increased to over 45 million in 1977 and 1979. Production dropped sharply thereafter, reaching a low of just under 30 million in 1985. Production in 1987 was 32.8 million.

The Pacific Rim is the greatest source of hardwood saw/veneer log exports: 78.3% of total global exports in 1971, increasing gradually to over 80% in 1977 and 1979 before falling slightly to 78.8% in 1987.

Exports by Asian Exporters dominate both Pacific Rim and global trade, in 1971 totaling 30.5 million cubic meters (96.2% of Pacific Rim and 75.4% of global exports). However, exports peaked at 39.3 million cubic meters in 1973, declined in 1975, and increased moderately in 1977 and 1979, being about 36 million cubic meters (96% of Pacific Rim; 78% of global).

Following 1979, and the imposition of the export ban on roundwood from Indonesia, exports from Asian Exporters dropped rapidly, to just over 20.6 million cubic meters in 1985. Regional share also declined, to 89.9% by 1987. The greatest change was the sharp decline in exports from Indonesia as the log ban was implemented. Indonesian exports reached 18.6 million cubic meters in 1977 and 17.8 million in 1979 prior to the ban. By 1981, exports had dropped to 6.2 million, reflecting both the economic recession and the export ban. By 1987, exports were only 2.5 thousand cubic meters.

Increased exports from Malaysia have partly made up for the decline from Indonesia. In 1971, Malaysian exports were 11.1 million cubic meters, increasing to 18.8 million in 1983 and 22.8 million in 1987.

Oceania's exports increased from less than 700 thousand cubic meters in 1971 to over 1.6 million in 1987. However, this represented only 6.7% of Pacific Rim exports.

Hardwood saw/veneer imports also indicate the changes within the Pacific Rim. Total imports closely match recorded exports at the global level. The Pacific Rim has accounted for between 60 to 70% of global imports, with the Asian Importers dominating with imports of 26.7 million cubic meters in 1971 (97.8% of Pacific Rim; 68.4% of global). North America, the second leading subregion in imports, accounted for 414 thousand cubic meters in 1971, increasing only to 737 thousand by 1987 (a Pacific Rim share of only 3.7%).

Japan is the dominant importer of hardwood saw/veneer logs, both within the Pacific Rim (69%) and globally (43.8%). Japanese imports have declined, however, from a high of 26.3 million cubic meters in 1973 to 13.9 million in 1987. The Republic of Korea has been second, with about 3.5 million cubic meters in both 1971 and 1987. Korean imports peaked in 1979 at almost 7 million, then declined sharply with the Indonesian ban. Hong Kong imports have grown modestly, reaching 595 thousand cubic meters in 1987. India's imports jumped sharply between 1981 and 1985, from 19.8 thousand cubic meters to 860 thousand. North America (U.S.) accounted for over 674 thousand cubic meters in 1987, up significantly from the recession low of 354 thousand in 1981 and 225.5 thousand in the previous low year of 1977.

Softwood Saw/Veneer Logs

Production. The production of softwood saw/veneer logs has increased steadily, interrupted only by the economic downturns in global markets. Production was 570.4 million cubic meters in 1971, increasing to over 729.6 million in 1987. The Pacific Rim contributed substantially: 279.6 million (49%) in 1971; 399 million by 1987 (54.7% of global production).

Pacific Rim production is dominated by North America (88-90% of regional production). North American production of 246 million cubic meters increased to 365.6 million in 1987. Asian Importers declined from 23.7 to 19.7 million, while Oceania increased from 7.7 million to 8.4 million. Production in other subregions was less significant, although Central-South American production increased from 1.9 million to over 4.8 million.

Trade. Softwood trade is dominated by the Pacific Rim. Total exports of 21.6 million cubic meters in 1971 grew to 35.7 million in 1987; Pacific Rim exports grew from 12.7 million to 22.9 million (64.2% of world exports). North America accounted for over 91% of regional and almost 60% of global exports. Most North American exports originated in the United States, because of log export restrictions in Canada.

Oceania's exports exceeded 1.8 million cubic meters in 1971-73, fell sharply to 534 thousand in 1975, recovered to about 1.1 million in 1977-79, declined sharply through 1985, and were up slightly to 433 thousand in 1987.

Imports also reflect the position of the Pacific Rim and Asian Importers in particular. The Pacific Rim imported 84.4% of all global imports in 1971 (18.2 million cubic meters), with this share falling to 59% (19.6 million) in 1985. Imports increased to 22.9 million in 1987, representing 65.4% of world total.

Asian Importers accounted for 80-85% of Pacific Rim imports, reaching 20.2 million cubic meters in 1987 (88.1%). This was about 58% of global imports. North American imports account for almost all the remaining Pacific Rim imports, increasing from 1.8 million cubic meters in 1971 to 2.8 million in 1985, then declining slightly to 2.7 million in 1987 (11.8% of Pacific Rim and 7.7% of global imports). The North American flow was predominantly from the United States to Canada.

Pulpwood and Particles

Production. Global production of pulpwood and particles has increased from 309 million cubic meters in 1971 to almost 405.4 million in 1987. The Pacific Rim accounts for over half, with 207 million in 1987 (51.1%). North American production increased from 137.7 million (1971) to 173.4 million (1987), representing 83.8% of Pacific Rim and 42.8% of global production. Asian Importers produced 13.3 million in 1987 (6.4% of Pacific Rim), while Oceania produced 11.8 million (5.7%).

Trade. Export trade grew from 24 million cubic meters in 1971 to 44.4 million in 1987. The Pacific Rim accounts for about one-third of global exports, with 1987 exports of 16.6 million cubic meters (37.5%). Pacific Rim exports are distributed between North America (6.2 million, 37.5%) and Oceania (8.2 million, 49%). Since 1971, the North American share of Pacific Rim exports has declined while Oceania has increased its share significantly.

Pulpwood and particle imports are also significant for the Pacific Rim, accounting for 34.7% of world imports in 1987. Imports are dominated by the Asian Importers: 5.8 million cubic meters in 1971 and 14.8 million in 1987. North American imports have averaged about 2 million. Imports are almost exclusively to Japan, with 14.8 million in 1987 (87.2% of Pacific Rim; 30% of global).

Pulpwood

Production. Pulpwood is the primary component of total pulpwood and particle production. Pulpwood production increased from 309 million cubic meters in 1971 to 405.4 million in 1987. The Pacific Rim accounted for about 51% of total production. North America is the dominant producer, with 173.4 million cubic meters in 1987.

While production by Asian Importers has declined slightly (13.3 million cubic meters in 1987), the trends have been variable, increasing from 1971 to 1979 and then decreasing. From the 1979 peak of 1.9 million, production declined to about 1 million in 1985-87. Production in Oceania has increased from 3.7 million in 1971 to almost 11.8 million in 1987. Central-South American production increased from 2.8 million to 7.4 million.

World hardwood production went from 80.7 million cubic meters in 1971 to 132 million in 1987. While Pacific Rim production increased, the trend has been less dramatic: from 48 million in 1971 to 70 million in 1987. The Pacific Rim global share declined from 59.8% to 51.2%. North America dominated (33 million in 1971 and 53.2 million in 1987) with 75.9% of regional production in 1987. Asian Importers accounted for the second largest share of Pacific Rim production, going from 12.9 million in 1971 to 9.6 million in 1987. Oceania increased from 1.4 million to 5.7 million.

Softwood pulpwood production is almost three times greater than hardwood, with 228 million cubic meters in 1971 and 273.3 million in 1987.

Trade. Trade in pulpwood has increased, although the overall volumes are relatively small. Exports were 16.3 million cubic meters in 1971, with Pacific Rim exports totaling 2.2 million (13.2%). World exports increased to 23.5 million by 1987, with Pacific Rim exports of 1.7 million accounting for only 7.4%. Pacific Rim exports are primarily from North America (52.3%, 1987), although this share has dropped significantly from 97.5% in 1971, and represents a 50% reduction in North American pulpwood exports. Second in the Pacific Rim is the Central-South American region, accounting for 676.6 thousand cubic meters in 1987, or 39% of the Pacific Rim total, after reporting no exports previously. Asian Exporters increased from 25.9 thousand cubic meters in 1971 to 146.2 thousand in 1987.

The Pacific Rim imported only 2.1 million cubic meters in 1971 (9.1%) and 1.8 million in 1987, while world share decreased to only 3.7%. Major importers were the Asian Importers (56.2%) and North America (43.5%).

Trade in chips and particles has increased rapidly. Exports increased from 5.2 million cubic meters in 1971 to 16.9 million in 1987. The Pacific Rim accounted for 4.7 million in 1971 (91.2%) and 14.3 million in 1987 (84.6%). Major exports in 1987 were from North America (4.7 million, 32.9%) and Oceania (8.2 million, 57.2%). Although North America had growing exports, the share of Pacific Rim exports declined because of the strong growth in exports from Oceania. Exports from Asian Exporters have also grown more moderately, from 536 thousand cubic meters to 743 thousand. Central-South American exports of chips from Chile jumped significantly in 1987, to 670 thousand cubic meters.

The import of chips and particles is heavily dominated by the Asian Importers and the Pacific Rim. The Pacific Rim accounted for 90.3% of world chip imports in 1971, and 79.1% in 1987.

By far the most chips and particles are imported by the Asian Importers: 4.2 million cubic meters in 1971 (90.3% of Pacific Rim total) and 13.8 million in 1987 (94.9%). North America is the only other Pacific Rim importing region.

Wood residue exports increased from 2.6 million cubic meters in 1971 to 4.1 million in 1987. The Pacific Rim accounts for a declining share of world trade, slipping from 647 thousand cubic meters in 1971 (25.2%) to 528 thousand in 1986 (14.7%). North America accounted for essentially all the Pacific Rim exports.

The Pacific Rim role in world residue imports averaged about 725 thousand cubic meters (declining from 28.1% in 1971 to 14.3% in 1987). North America went from 294 thousand cubic meters in 1971 to 628.6 thousand in 1987. Asian Importers reduced imports from 459.7 thousand in 1971 to only 7.1 thousand in 1987, a Pacific Rim share declining from 61% to 30.5%.

Other Industrial Roundwood

Production. Total production was 168.8 million cubic meters in 1971, increasing to 225 million by 1987. The Pacific Rim accounted for only 29.3 million in 1971 (17.3%), increasing to 31.8 million in 1987 (14.1%), with the largest share from North America (12.9 million, 40.7%), and the combined Asian subregions (15.7 million, 50%).

Hardwoods accounted for 67.2 million cubic meters of production, while softwoods totaled 101.5 million in 1971. Hardwoods increased to 94 million in 1987, with the Pacific Rim accounting for 21.8% (20.5 million). The Asian subregions accounted for 14 million (68.3% of Pacific Rim) while North America produced another 4.5 million (22.1%).

Softwoods increased to 131 million cubic meters in 1987, with the Pacific Rim totaling 11.3 million (8.6%). The largest share (8.4 million, 74.5%) was produced in North America, with 15% (1.7 million) produced by the Asian Importers.

Trade. Trade is variable. Exports are sporadic, increasing sharply from 2.2 million cubic meters in 1971 to 6.7 million in 1975, then dropping sharply to 2.4 million in 1987. The Pacific Rim exports follow a corresponding trend, going from 331 thousand cubic meters in 1971 to 2.9 million in 1975, then falling to 393 thousand in 1987. The surge in both Pacific Rim and world exports is largely an increase for Asian Exporters in 1975-79. This increase traces to Indonesia, and may well represent a surge in anticipation of the log export restrictions imposed in 1980 as well as strong markets in the late 1970s. With the exception of this surge, the North American region has accounted for most exports of other industrial roundwood. A surge also occurred in the late 1970s for North American exports.

Import trends do not correspond well with reported exports at the world level. Imports as reported increased from 3.5 million cubic meters to 5 million from 1971 to 1987. Pacific Rim imports increased from 1.5 million to 2.4 million, accounting for 42.8% of world imports in 1971 and 46.8% in 1987. Virtually all Pacific Rim imports were by North America, totaling 2.3 million cubic meters in 1987, or 97.4% of the Pacific Rim total.

Sawnwood and Sleepers

Production. Production of industrial roundwood obviously gives rise to manufacture of a variety of products. The most significant in terms of the use of saw/veneer logs are sawnwood and sleepers. Production can be based on either domestic or imported sawlogs.

Total production of sawnwood and sleepers has increased gradually, reflecting economic cycles. Production in 1971 was 429 million cubic meters, increasing to 502.2 million by 1987. The Pacific Rim increased from 185 million to 251.6 million. The share of world production increased slightly, from 43% to 50%. Production in North America was most significant, increasing from 117.9 million to over 168 million. This represented about 63-66% of Pacific Rim and 27-33% of world production.

Asian Exporters went from 6.3 million cubic meters to 17.1 million. In large part, this was a shift away from log exports to further processing. This subregion increased its share of Pacific Rim production from 3.4% to 6.8%. Production by Asian Importers increased from 50.5 million to 53.3 million, reflecting the increasing difficulty in obtaining logs. This subregion's share of Pacific Rim production declined from 27.3% to 21.2%.

Oceania's production increased from 5.4 million cubic meters to 5.5 million. Regional production share dropped slightly, from about 2.9% to 2.2%. South-Central American production went from 5 million to just over 7.6 million, with a corresponding increase in Pacific Rim share from about 2.7% to 3%.

Trade. Trade has increased globally, from 59.8 million cubic meters in 1971 to 94.9 million in 1987, declining in 1975 and 1981. The Pacific Rim recorded increased exports, from 26.3 million to 60 million (a global production share increase from 44.1% to 63.2%).

North American exports increased from 22.9 million cubic meters in 1971 to 49.4 million in 1987 (82.4% of Pacific Rim and 52.1% of global exports).

The Asian subregions also increased exports. Asian Exporters went from 1.8 million cubic meters in 1971 to 7.5 million in 1987, a growth in Pacific Rim share from 6.7% to 12.5%. Asian Importers saw a reduction in Pacific Rim share from 3.6% to 2.4%, even though production increased from 949 thousand cubic meters to 1.5 million. This intraregional shift again reflects the changing pattern of availability of logs.

Imports show a similar global trend, increasing during 1971-87 and reflecting the economic cycles. Pacific Rim imports were 22.3 million cubic meters in 1971, or 38.2% of world imports. By 1987, imports had increased to 47.6 million, or 51.8% of world imports. North America increased from 18.5 million to 36.6 million. Most of this represented intra-North American trade from Canada to the United States. North America accounted for about 80% of Pacific Rim exports.

Asian Importer imports increased from 2.6 million cubic meters to 9.5 million, rising from 11.7% of Pacific Rim imports to 20%.

Hardwood Sawnwood

Production. Production has increased gradually, from 96.1 million cubic meters in 1971 to 121.8 million in 1987. Pacific Rim production also increased, from 45.7 million to 61.8 million. Regional production share increased from 47.5% to 50.8% of global production.

Pacific Rim production is shared by North America (30.1%), Asian Exporters (27.5%), and Asian Importers (34.4%). North American production has not increased significantly, allowing Pacific Rim share to decline from 38% to 30%. Asian Exporter nations have increased share, from 13.4% to 27.5% through an increase in production from 6.1 million cubic meters to 17 million. Asian Importers have also increased production, from 16.6 million to 21.3 million. Regional production share has remained at 34-36%.

Trade. Exports have increased together with production, and also reflect the general economic cycle. Global production increased from 7.2 million cubic meters in 1971 to 15.5 million in 1987. Pacific Rim countries have a significant part of total exports, increasing from 3.6 million to 10.8 million. The Pacific Rim share of global exports increased from 49.5% to 69.6%.

Asian Exporters are the dominant subregion, with exports increasing from 1.7 million cubic meters (48.3% of Pacific Rim) in 1971 to 7.4 million in 1987 (68.2%). Major increases have been evident in exports from both Malaysia and Indonesia. North American exports have also increased, from 786.5 thousand to 2.2 million (20.2% of Pacific Rim exports in 1987). Asian Importers showed a much more variable trend, averaging about 1.1 million, with a high of 1.6 million in 1979 and a low of 783 thousand in 1985. The majority of these exports were from Singapore.

The Pacific Rim plays a somewhat lesser role in hardwood sawnwood imports, accounting for 32.5% of the global total in 1971 and 38% in 1987. Imports for the Pacific Rim region increased from 2.2 million cubic meters in 1971 to 5.9 million in 1987. Imports are primarily by the Asian Importers (58.5%, 1987) and North America (35.3%).

Softwood Sawnwood

Production. Softwood production also increased over 1971-87, from 325.4 million cubic meters to 377.3 million. The Pacific Rim accounted for about 45% of the world total, with a slight increase over this period. In 1987, the Pacific Rim accounted for 49.9% with production of 188.4 million.

North American production increased from 100.1 million cubic meters in 1971 to 149.3 million in 1987. For 1987, this was 75.9% of the Pacific Rim and 33.4% of world production. The Asian Importers averaged about 32 million, with 1987 production at 31.4 million, 16.7% of the Pacific Rim total. The majority of this was in Japan, with 26.1 million in 1987, in large part accomplished by processing imported softwood sawlogs. India and Korea both had production of about 2.5 million in 1987.

Production in Central-South America increased moderately, from 2.1 million cubic meters in 1971 to 4.2 million in 1987, while production in Oceania increased from 2.4 million to 3.6 million in 1985 before slipping to 3.3 million in 1987.

Trade. Trade clearly illustrates both the cyclic nature of major wood product markets and the overall growth in trade in processed wood products in response to growing demand and the tendency to seek greater value added through processing prior to export.

Total world exports increased from 51.7 million cubic meters in 1971 to 78.8 million in 1987. Pacific Rim exports, dominated by North America, increased from 22.6 million (43.8%) to 49 million (62.2%). North American exports increased from 22 million to over 47 million, accounting for 96.7% of Pacific Rim and 54.3% of world exports in 1987. Central-South American exports increased also, from 204 thousand to 1.2 million and accounted for 2.4% of Pacific Rim exports in 1987. Oceania exports increased from 315 thousand to 499.8 thousand in 1985 but accounted for under 2% of Pacific Rim exports.

Imports by Pacific Rim countries closely mirror exports in the aggregate. Total imports were 20 million cubic meters in 1971, or 39.4% of world imports. Pacific Rim imports grew to 41.6 million in 1987, representing 54.8% of the world total. Pacific Rim imports are heavily weighted by North America, representing Canadian shipments to the United States. North American imports increased from 17.4 million to 34.4 million, and accounted for 82.7% of Pacific Rim and 45.3% of world imports in 1987.

Imports by the Asian Importers increased from 1.8 million cubic meters in 1971 to 6 million in 1987, increasing the share of Pacific Rim imports from 9% to 14.5%. This increase in both absolute and relative imports reflects in part the shift from roundwood trade to greater processing.

Veneer and Plywood

Production. The production of veneers and plywood represents a second major use of industrial roundwood. Saw/veneer logs may be processed into veneer sheets as an intermediate product, or the veneer sheets may be directly integrated into panel products. In this review, the production and trade of both veneer sheets and plywood panels are discussed together. Unfortunately, currently available data do not lend themselves to a meaningful separation between hardwoods and softwoods, although some inferences can be drawn from the geographic location where production occurs.

The production of veneer sheets increased steadily during 1971-87, from 3.2 million cubic meters to 5.1 million. Pacific Rim production increased from 1.1 million (34% of total) in 1971 to 2 million in 1983 (40.8%). Thereafter, production has stabilized at about 1.9 million in 1983-87. Pacific Rim production is dominated by three subregions. North America has seen an increase from 174 thousand cubic meters to 750 thousand, with an increase in Pacific Rim share from 16.1% to 39.6% in 1971-87. The Asian subregions together experienced an increase from 854 thousand to 1.1 million, with a total Pacific Rim share of 55.7% in 1987. This was a considerable drop from a share of 79% in 1971.

The production of plywood panels, utilizing veneers either imported or integrated with peeling or slicing operations, increased from 36.6 million cubic meters in 1971 to 49 million in 1987, with a sharp decline in 1975 due to recessionary influences. Plywood production also reflected the economic decline in the early 1980s, but to a smaller extent. The Pacific Rim dominates world plywood production, with 1971 production of 28.2 million cubic meters accounting for 77.2% of global production. Pacific Rim production grew to 40 million in 1987, with an increase in global share to 81.6%.

Production in North America increased from 18.3 million cubic meters in 1971 to 21.7 million in 1987. This slower growth resulted in a reduction in share from 64.6% to 54.2% for the Pacific Rim and from 49.9% to 44.2% for world production.

Plywood production by Asian Importers went from 8.7 million cubic meters in 1971 to 11.9 million in 1979, with a Pacific Rim share of 28% at that time. Following the log export ban by Indonesia, plywood production declined to 9.5 million in 1987.

Production by Asian Exporters was 890 thousand cubic meters in 1971, growing to 1.6 million by 1979. Thereafter, production increased rapidly, to 8.2 million in 1987, representing a 20.5% share of Pacific Rim production, and almost equaling production in the traditional Asian Importer subregion.

Trade. Trade in veneer sheets and plywood has been affected by both general economic cycles and trade policies, primarily the log export ban by Indonesia.

World exports of veneer sheets grew from about 1 million cubic meters in 1971 to 2 million in 1987. The Pacific Rim accounted for 57.3% of this in 1971, and 62.8% in 1987. North American exports increased from 263 thousand to 550 thousand, representing a 35.3% share for the Pacific Rim. The Asian Exporters saw exports change from 246 thousand to a high of 751 thousand in 1983, with the largest share exported by Malaysia (554 thousand). Asian Exporter exports then declined to 556 thousand in 1987, representing 45.1% of Pacific Rim exports. The majority of the remaining veneer sheet exports originated in the Asian Importer subregion, where volume exported declined after 1971, remained substantially below 1971 levels until 1983, and then reached 107 million in 1987, accounting for 8.7% of Pacific Rim exports.

Global plywood exports increased significantly, from 5.3 million cubic meters in 1971 to 11.2 million in 1987. Pacific Rim exports increased from 2.8 million (52.9%) to 8.3 million (73.9%). Asian Exporters experienced the greatest change, increasing from 469 thousand in 1971 to just under 1 million in 1979. Production then increased rapidly, reaching 4.4 million in 1985 and 6.4 million in 1987. The Asian Exporter share of Pacific Rim exports increased from 16.9% to 77.5%.

Asian Importers saw a reversal in this trend, with exports going from 1.8 million cubic meters in 1971 to 2.4 million in 1977, with a Pacific Rim share of 64.5%. Thereafter plywood exports declined, to 845 thousand in 1985 and 980 thousand in 1987. Pacific Rim share in 1987 was only 11.8%. North American exports increased from 449 thousand to 833 thousand. Pacific Rim share dropped from 16.1% to 10%.

While precise information by species is not available, exports from North America are essentially softwoods, while exports from the Asian subregions are almost all hardwoods. It can be inferred that softwood plywood exports increased from about 450 thousand cubic meters to about 830 million, while hardwood exports increased from 1.3 million to something like 7.4 million between 1971 and 1987. This rapid increase represents in part a growing market demand but also a dramatic shift toward plywood manufacture and export by Asian Exporters, particularly Indonesia, in place of previous trade in logs and veneer sheets.

The import of veneer sheets for the Pacific Rim has grown somewhat, from 687 thousand cubic meters in 1971 to 964 thousand in 1987. The Pacific Rim has accounted for about 45-50%. North America and the Asian Importers account for almost all veneer sheet imports, although this mix has changed. North American imports were 551 thousand in 1971 and reached 720 thousand in 1977 before declining and remaining close to 500 thousand thereafter. In contrast, imports by Asian Importers increased from 110 thousand to 406.7 thousand, representing a 42.2% share of Pacific Rim imports. This growth was most rapid after 1979 as Asian Importers sought substitutes for the declining log supply from Indonesia, the traditional supplier.

Imports of plywood panels increased from 5.1 million cubic meters in 1971 to 11.1 million in 1987, with most of the increase achieved in 1971-73 and 1985-87. Pacific Rim imports increased from 2.7 million to 4.3 million in 1973, then declined to 2.2 million in 1981. Thereafter, imports increased in the Pacific Rim, gradually through 1985, and then sharply to 5.4 million in 1987.

The majority of Pacific Rim imports were by North America, 2.6 million cubic meters (48.1%), and Asian Importers, 2.7 million (49.6%), in 1987. The North American import share dropped from 89.2% in 1971, even though volume remained fairly constant between 1971-75 and 1987. This drop reflected the great increase in imports by the Asian Importers, which went from 232 thousand in 1971 (8.5%) to 2.7 million in 1987 (49.6%). This was largely a substitution of imported plywood for previously (but unavailable) hardwood logs that were domestically processed.

Particleboard

Production. Wood-based panel products, generally produced from waste and residue fiber, constitute an important and growing share of total forest products production. Total global production of particleboard increased from 22.8 million cubic meters in 1971 to almost 50 million in 1987. Pacific Rim production increased from 5.6 million to over 15 million. By far the largest share was in North America, growing from 4.8 million to 12.4 million, accounting for 81.8% of Pacific Rim production in 1987 (30.2% of global).

Within the Pacific Rim, particleboard production outside of North America was concentrated in the Asian Importer subregion, followed by Central-South America and Oceania. Asian Importers had an increase from 421.3 thousand cubic meters in 1971 to 1.35 million in 1987, accounting for 7.5% of Pacific Rim produc-

tion in 1987. Japan dominated the subregional production, with output more than doubling, from 373 thousand to over 1 million. Mexico, Australia, New Zealand, and Chile also had significant production in 1987.

Trade. Trade in particleboard has also increased significantly over the study period, with a global increase in exports from 2.5 million cubic meters in 1971 to over 7 million in 1987. Pacific Rim exports, however, are considerably smaller, growing from only 54 thousand to 1.4 million, or only 20.2% of the global total.

North America has dominated exports, increasing from 42 thousand cubic meters (1971) to 1.3 million (1987), accounting for a growing share of both Pacific Rim and global exports. In 1987, North America accounted for 93.2% of Pacific Rim and 18.8% of global exports.

Oceania was second, with total exports of only 110 thousand cubic meters in 1987, primarily from New Zealand. Asian Exporters did not export particleboard after 1977. Exports from Asian Importers were minor, growing from 12 thousand cubic meters to 71 thousand. Exports were primarily from Japan and Thailand.

Imports of particleboard globally grew in parallel with exports. FAO statistics show global imports as 2.2 million cubic meters in 1971, growing to 7.9 million in 1987. The Pacific Rim was again a minor player in particleboard import trade, with 1.5 million cubic meters in 1987. This was, however, up sharply from 133 thousand in 1971. Accordingly, the Pacific Rim share of global imports increased from 6% to 18.9%.

Pacific Rim imports were primarily by North America, accounting for 1.3 million cubic meters (89.1%) in 1987. Other imports were by the Asian Importers (131 thousand), almost all accounted for by Japan. Although comparatively small in total volume, Japan's imports increased significantly, from only 5.3 thousand to over 100 thousand.

Fiberboard

Production. In contrast to particleboard, fiberboard production has not increased significantly, averaging about 16.5 million cubic meters over the study period. The trend reflects market cycles with reduced production in 1975 and again in 1981. In 1987, total production was 17.9 million cubic meters.

Pacific Rim production reflects the global trend, with corresponding market declines in 1971 and 1981. Total Pacific Rim production has been about 8.5-9.0 million cubic meters, with a decline since 1981 to 7.5 million in 1987, up from 6.7 million following the 1981 recession. The Pacific Rim accounted for a diminished share of global production, falling from 58.1% to 41.9%.

Pacific Rim production is highly concentrated in the North American subregion, which accounted for 6 million cubic meters in 1987, or 80% of Pacific Rim production. North American production dropped sharply in 1981 and has only recovered modestly. Production by Asian Importers is small by comparison, but grew from 738 thousand to 912 thousand. As with particleboard, the major production was in Japan. Oceania grew modestly, with a decline in Australia but an increase in New Zealand.

Trade. Global trade in fiberboard averaged about 2.3 million cubic meters over 1971-72. Export trade dipped to 1.9 million in 1975, increasing to over 2.7 million in 1987. The Pacific Rim share doubled, from 14.4% to over 28%. Exports in the Pacific Rim rose from 310 thousand to over 782 thousand.

Pacific Rim export trade was dominated by North America, with from 75 to 80% of the Pacific Rim total. Oceania exports have been quite variable, dropping from 69 thousand cubic meters in 1971 to under 17 thousand in 1977, reflecting the drop in Australian exports. Subsequently, exports increased to 110 thousand in 1987, with almost all the growth coming from New Zealand.

Exports by Asian Importers have generally accounted for less than 10% of the Pacific Rim total, coming primarily from Japan and Thailand. Chile, accounting for almost all the Central-South American exports, was the only other significant exporter.

The Pacific Rim imports increased from 474 thousand cubic meters in 1971 to almost 803 thousand in 1987, making the Pacific Rim a net importer for most of the study period. North America accounted for the majority of imports, reaching 596 thousand in 1987. Asian Importers imports were over 200 thousand in

1987, a fourfold increase from earlier years. Japan was the major source for the increase, with imports of 166 thousand in 1987, up from under 21 thousand in 1985.

Wood Pulp

Production. Global production of wood pulp increased from about 100 million metric tons in 1971 to over 145 million in 1987, a steady growth except for the economic decline of 1975. The Pacific Rim share remained steady at about 62-63%.

Pacific Rim production was concentrated in North America, where production increased from 54 million metric tons to almost 77 million, accounting for about 83% of Pacific Rim production. Asian Importers were second, with output increasing from 9.3 million to just over 11 million in 1987. Japan accounted for most of this, with output of 9.7 million tons in 1987. Pulp production in India increased to 1 million in 1987, up from only 139 thousand in 1971. Production in South Korea also increased, from 51 thousand metric tons in 1971 to 162 thousand in 1987.

Oceania's production increased from 1 million to 2 million metric tons, with a doubling in both Australia and New Zealand. Production in Central-South America also doubled, from 704 thousand in 1971 to almost 1.6 million in 1987. The largest gains were in Chile, Mexico, and Colombia.

Production by Asian Exporters was considerably less, increasing from 52 thousand metric tons in 1971 to 270 thousand in 1987. Production was mainly in Indonesia and the Philippines.

Trade. Trade also increased steadily over the study period, with the exception of the 1975 recession. Exports of 14.9 million metric tons in 1971 grew to over 24.5 million in 1987. The Pacific Rim exports grew from 7.4 million to 13.7 million, with a corresponding increase in global share from 49.4% to 55.8%.

North America consistently accounted for almost all wood pulp exports from the Pacific Rim, increasing from 7.1 million metric tons in 1971 to 12.6 million in 1987, or over 90% of Pacific Rim and 50% of global exports. Central-South America and Oceania each accounted for about 5% of wood pulp exports in 1987, originating primarily in Chile and New Zealand.

Imports of wood pulp by the Pacific Rim increased from 4.7 million metric tons in 1971 to over 9.3 million in 1987, making the region as a whole a net exporter on the strength of North American exports. All other subregions, except Oceania, were net importers in 1987.

North America was the largest wood pulp importer, growing from 3.2 million metric tons in 1971 to 4.6 million in 1987. The majority of the imports were by the United States, with 4.4 million metric tons in 1987.

The Asian Exporters were the next largest importers, growing from 949 thousand metric tons in 1971 to 3.7 million in 1987. Japan had the largest share, growing from 661 thousand metric tons to 2.7 million. South Korean imports grew from 204 thousand to almost 787 thousand. Thailand and India were also important importers.

Imports by the Asian Importers grew almost tenfold, from 35 thousand metric tons to 327 thousand. The largest increase was by Indonesia, accounting for 256 thousand metric tons in 1987. Imports by Malaysia and the Philippines also increased significantly, yet with substantially lower total volumes.

Oceania imports were mixed, but averaged about 290 thousand metric tons over the study period. The majority of imports were by Australia.

Paper and Paperboard

Production. The global production of paper and paperboard products has also shown a strong and steady increase from 1971 to 1987, broken only by the recession in 1975. Total production increased from 128.6 million metric tons in 1971 to over 212.8 million in 1987. Pacific Rim production increased from 75.7 million to almost 119 million, or a global share of about 56% over the period, with a slight decline overall.

Pacific Rim production of paper and paperboard products is heavily concentrated in North America, yet not to the extent exhibited for pulp. North American production increased from 58.1 million metric tons in 1971 to 83.6 million in 1987, with a decline in Pacific Rim share from 76.8% to 70.3%.

Asian Importer production of paper and paperboard increased significantly, from 14.2 million metric tons to 28.2 million. Production in Japan increased from 12.9 million to over 22.5 million. Production in South Korea also increased significantly, from 433 thousand to 3.2 million, while Thailand production increased from 111 thousand to 557 thousand.

Central-South American production grew from 1.6 million metric tons to 3.7 million, with the greatest increase from Mexico. Oceania production grew from 1.5 million to almost 2.3 million, with most of the increase in Australia.

Production by Asian Exporters was relatively modest, yet with a proportionately large increase, from 212 thousand metric tons in 1971 up to 1.1 million in 1987. The largest increase was in Indonesia, followed by the Philippines.

Trade. Global trade had increased considerably over the 1971-87 period, slowed only by the 1975 recession. Global trade increased from about 23.5 million metric tons in 1971 to over 47 million in 1987.

Exports by the Pacific Rim nations increased from 11.4 million metric tons to 17.5 million, with a decline in global share from about 49% to 37.3% in 1987.

North America dominated Pacific Rim exports, accounting for a declining share in spite of growing volumes. Exports by North America increased from 10.6 million metric tons to 15.5 million, but its Pacific Rim share declined from 92% to 88%.

Asian Importers came second, increasing from 586 thousand metric tons in 1971 to over 1.4 million in 1987. Major exports were from Japan and South Korea, with important volumes from Singapore, Hong Kong, and Thailand.

Exports from Oceania increased from 189 thousand metric tons to 330 thousand, with about two-thirds originating in New Zealand in 1987. Within the Central-South American region, exports from Chile almost doubled, from 79 thousand to 140 thousand. Indonesia, within the Asian Exporter subregion, was the major exporter, increasing exports from zero in 1977 to almost 148 thousand metric tons in 1987.

Imports of paper and paper products were slightly below exports for the Pacific Rim as a whole, with net exports of about 2 million metric tons over the study period. Total imports grew from 9.2 million in 1971 to 16.9 million in 1987.

The North American subregion accounted for over one-third of Pacific Rim imports, increasing from 6.9 million metric tons to over 12 million in 1987, representing some 71.5% of Pacific Rim imports in 1987. The United States was the largest importer in the Pacific Rim, accounting for 11.4 million metric tons in 1987.

Asian Importers increased imports from 930 thousand metric tons to 2.8 million in 1987. The increase was the greatest for Japan, rising from 82 thousand in 1971 to over 1 million in 1987. Other major importers in 1987 were Hong Kong (818 thousand), Singapore (306 thousand), Thailand (268 thousand), and India (238 thousand).

Imports by Asian Exporters increased from 424 thousand metric tons to 643 thousand, with Malaysia the major importer with 361 thousand in 1987. Oceania imports increased from 537 thousand to 835 thousand, with Australia (686 thousand) accounting for the majority. Central-South America imports increased moderately from 1971 to 1977, reaching 868 thousand, and then subsequently declined to 548 thousand in 1987. Colombia, Ecuador, and Mexico each imported about 145 thousand metric tons in 1987.

TRENDS IN TROPICAL HARDWOOD PRODUCER COUNTRIES

The information reviewed in this report provides a broad global and Pacific Rim framework for the current situation in the Asian-Pacific region. The twelve countries of the Asian subregions (Exporters and Importers) had almost 500 million ha of forests in 1980, representing 11.3% of global forests and 31% of Pacific Rim forests. These countries had 415 million ha of hardwood forests (14.5% of global and 43.2% of Pacific Rim hardwood forests). For the four Asian Exporter countries, over 97% of the forest was hardwood; for the eight Asian Importers, hardwoods account for over 77%.

The Asian Exporter subregion has, however, seen a loss of forest, through timber harvesting and other land clearing unrelated to commercial forest use. This loss was greatest in Indonesia and Malaysia. In contrast, the Asian Importer countries showed a net gain in forests, mainly in China. FAO estimates for Asian tropical forests show a loss of forests of over 1.8 million ha per year for the 1976-85 period, with a slight increase in 1981-85.

In contrast, the Asian hardwood producers have been much slower to establish plantations. Tropical Asia is reported as having about 5.1 million ha of plantations in 1980, with an estimated gain of about 2.2 million ha for 1981-85. Insular Southeast Asia was projected to have about 2 million ha by 1985, mostly in slow-growing hardwood. Obviously, the relatively recent emphasis on plantations has resulted in a rate of establishment well below the recorded rates of deforestation.

Trends in hardwood production for the Asian subregions are summarized and reviewed briefly below by major product.

Hardwood Roundwood Production

The production of Asian hardwoods is shown in Figure 1.4. Both Exporter and Importer subregion production increased steadily, from about 400 million cubic meters per year in 1971 to over 540 million in 1987. Major producers were India and Indonesia, both with about 50% increases in production from 1971 to 1987. Other leading producers were the Philippines, Thailand, and Malaysia.

Hardwood Fuelwood Production

A comparison of Figures 1.4 and 1.5 shows that the largest share of hardwood harvested goes for fuelwood. For Asian Exporters, production increased from about 130 million cubic meters to over 185 million, while for the Asian Importers it increased from about 180 million to 245 million. Production was greatest in India and Indonesia, and accounted for the largest share of increased total hardwood production in these countries. Thailand, Philippines, and Burma were the next leading producers.

Hardwood Pulpwood Production

Production of hardwood pulpwood is summarized in Figure 1.6. Production has been the greatest in the Asian Importer subregion, dominated by Japan. For the subregion, production dropped from about 13 million cubic meters in 1971 to less than 10 million in 1987. Japanese production dropped from about 12.5 million to just over 8 million. India and South Korea have been minor producers.

In contrast, production by the Asian Exporters has been minimal, only 1-1.5 million cubic meters. Malaysia and the Philippines have been the largest producers.

Hardwood Industrial Roundwood Production

Total industrial hardwood production by Asian Importers has remained at about 38 million cubic meters in 1971-87, increasing slightly in 1985-87 (Figure 1.7). Production by Asian Exporters was about 50 million cubic meters in 1971 and 1975, and about 65-70 million throughout the rest of the study period.

Trends by individual country have been variable. Over the study period, major producers of hardwood industrial roundwood have been Japan, Malaysia, Indonesia, Philippines, and India. Production in Japan has dropped, from about 20 million cubic meters in 1971 to 10 million in 1987. Production in Malaysia has gone from about 20 million cubic meters to over 38 million in 1987, with the greatest growth from 1971 through 1983. Production by Indonesia increased from 16 million to almost 28 million in 1987, with major growth in 1975-79.

Production by the Philippines dropped sharply, from over 12 million cubic meters in 1971 to under 6 million in 1987. India went from almost 12 million in 1971 to over 21 million in 1987, thus replacing Japan as one of the top three producers.

FIGURE 1.4

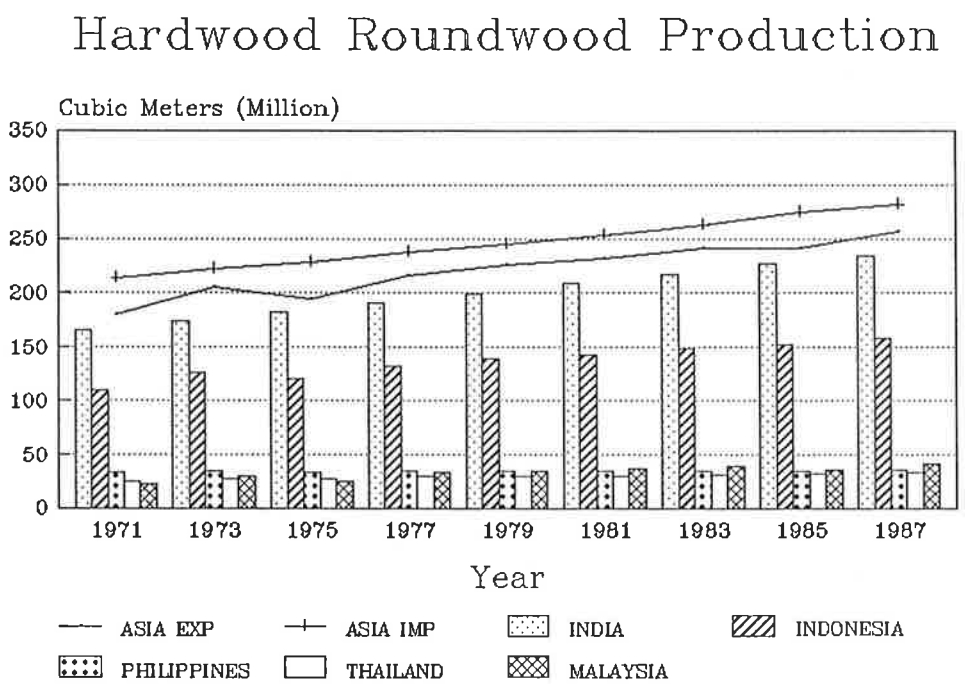

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FIGURE 1.5

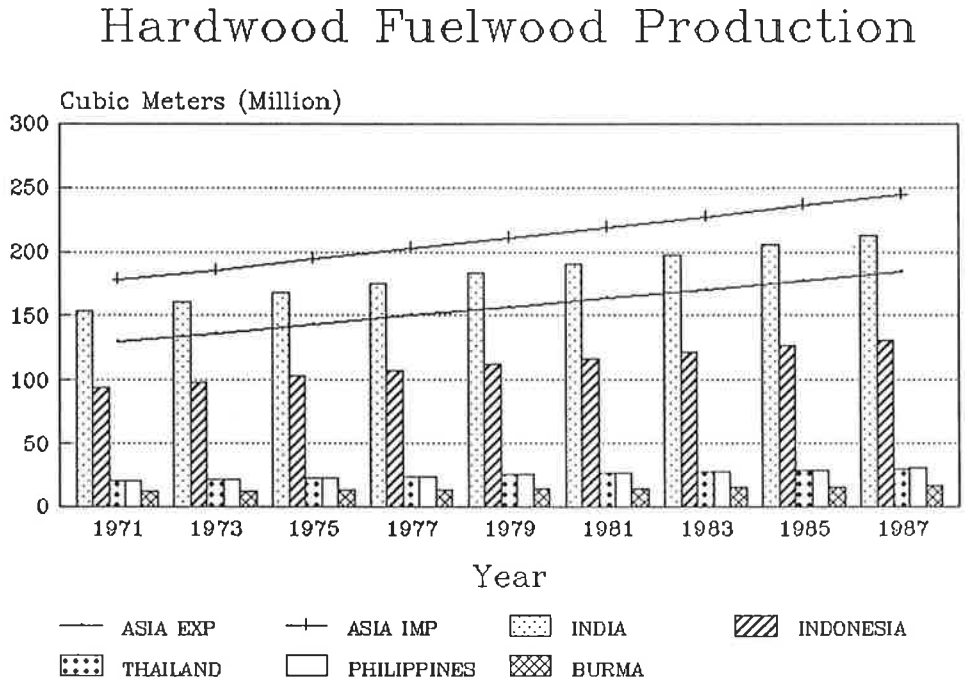

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FIGURE 1.6

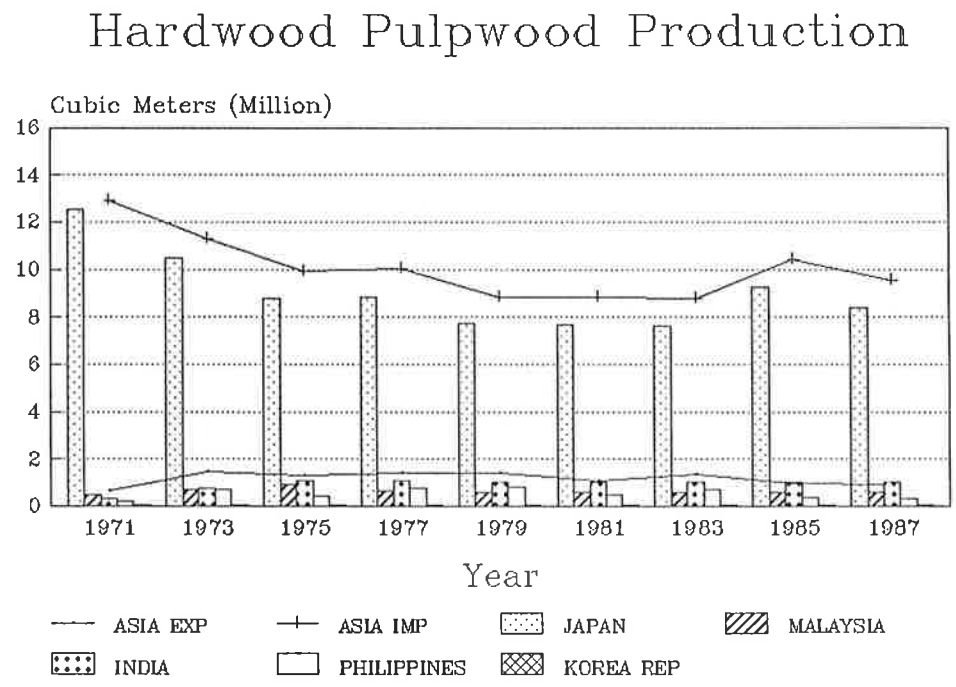

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FIGURE 1.7

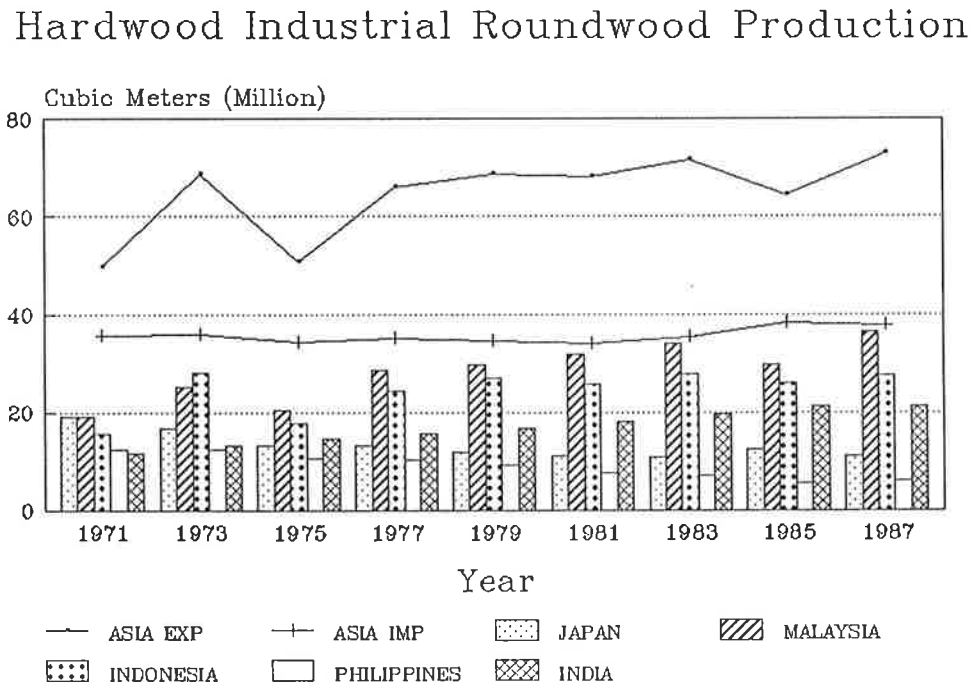

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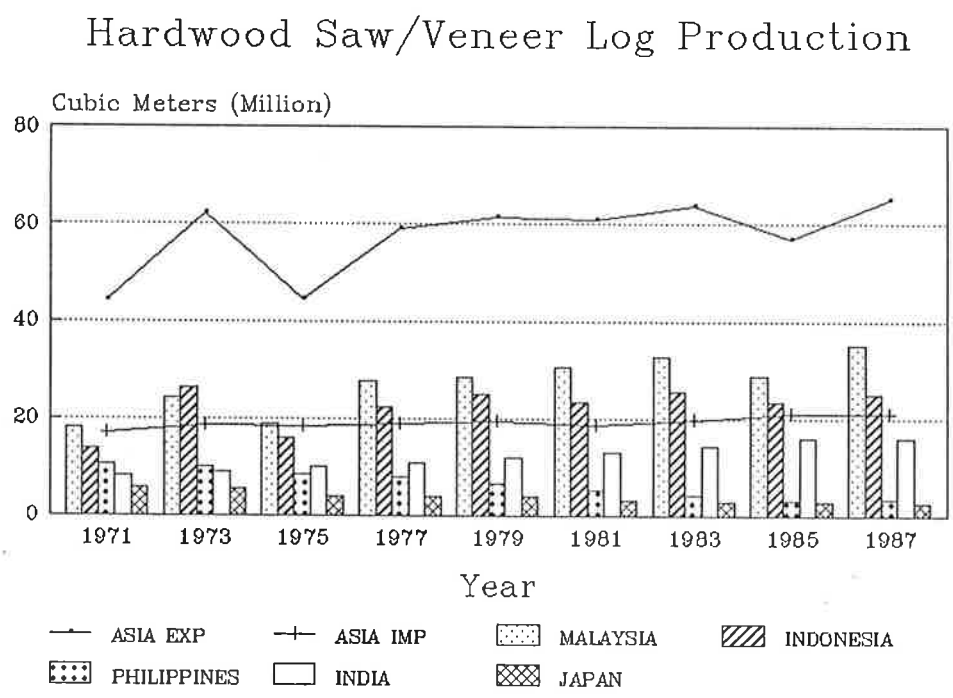
FIGURE 1.8



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Hardwood Saw/Veneer Log Production and Trade

As the largest proportion of hardwood industrial roundwood, the production of hardwood saw/veneer logs has shown a similar trend. Production by the Asian Importers has been steady, with a slight increase from about 17 million cubic meters in 1971 to almost 21 million in 1987. The Asian Exporters produced 44 million in 1971 and 62 million in 1973, thereafter remaining at about 60 million except for a market drop in 1975 and 1985. Production was 65 million in 1987 (Figure 1.8).

Leading producers in 1971 were Malaysia, Indonesia, Philippines, India, and Japan. Production trends were variable, with increases in Malaysia, Indonesia, and India, and declines in the Philippines and Japan, although these five countries remained the top producers.

Trade patterns for hardwood saw/veneer logs are summarized in Figures 1.9 and 1.10.

Exports of tropical hardwood logs declined (Figure 1.9) from a high of 39 million cubic meters in 1973 to about 20 million in 1985 before a slight increase to 23 million in 1987. Malaysia and Indonesia were the largest exporters in 1971 at about 10 million cubic meters each, followed by the Philippines at 8.4 million. With the exception of the recession year of 1975, exports increased for both Malaysia and Indonesia to 1979, while Philippine exports dropped steadily.

With the export ban imposed by Indonesia in 1980 (phased in over five years), Indonesian exports of hardwood logs dropped sharply while Malaysian exports grew, reaching 22.8 million cubic meters (89% of Asian Exporter total) in 1987. Log exports by Asian Importers dropped, from 120 thousand cubic meters in 1971 to only 80 thousand in 1987, with the majority originating in India. While Thailand was the largest subregion exporter in 1971 (64 thousand cubic meters), exports declined through 1981 and were reported as zero thereafter.

The import of hardwood logs reflects the general trend in Asian exports (Figure 1.10). The majority of imports have been by the Asian Importer subregion, led by Japan and South Korea. While imports were

FIGURE 1.9

Hardwood Saw/Veneer Log Exports

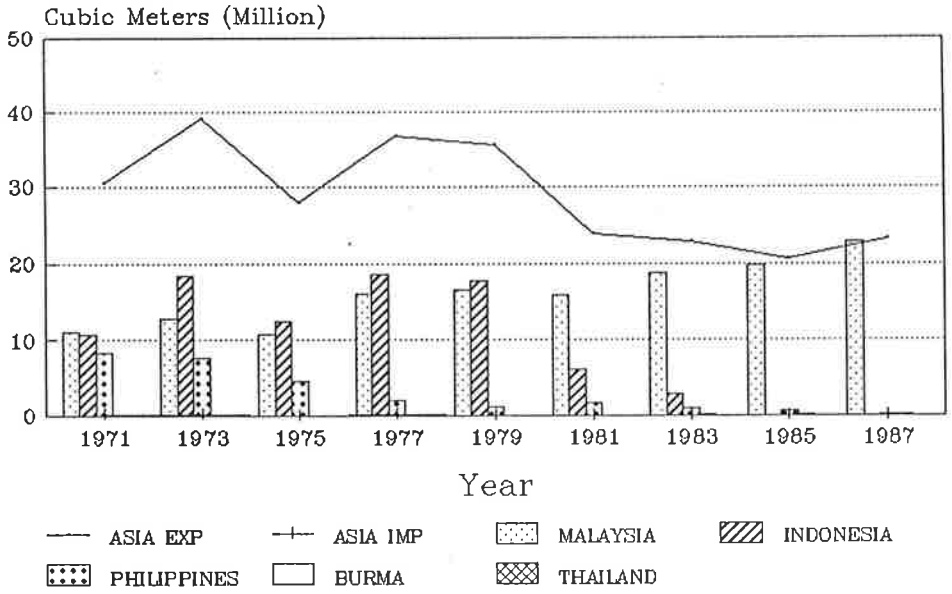

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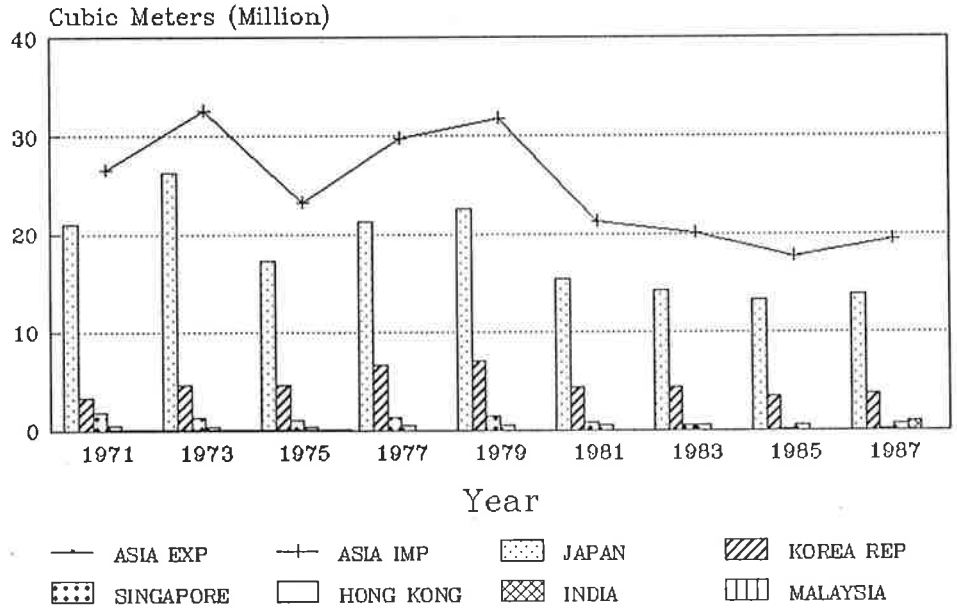
FIGURE 1.10

Import of Hardwood Saw/Veneer Logs



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significant through 1979 (about 30 million cubic meters per year) with the exception of the market drop in 1975, the Indonesian export ban had immediate and sharp consequences for the Asian Importers. Total subregion imports dropped to 21 million cubic meters in 1981, down 10 million from 1979. Imports have averaged about 20 million per year in 1981-87.

Japan has remained the major importer, with imports averaging about 20 million cubic meters in 1971-79 and about 14 million in 1981-87. While South Korean imports increased steadily from 1971 to 1979, reaching 7 million cubic meters, the Indonesian ban reduced imports to about 4 million in 1981-87. India has imported a growing volume of hardwood logs, up sharply in 1987 to 860 thousand cubic meters from only 19 thousand in 1983-85.

Hardwood Sawnwood Production and Trade

Trends for the Asian production of hardwood sawnwood are shown in Figure 1.11. For the Asian Importer subregion, production increased from 16.6 million cubic meters in 1971 to 21.3 million in 1987. This subregion experienced modest declines in 1977 and 1981 reflecting economic recessions. Production by Asian Exporter countries increased steadily from 6 million cubic meters in 1971 to almost 17 million in 1987, with only a slight drop in 1985 with the economic recession.

The makeup of production with the Asian subregions has shifted considerably. In 1971, Japan was the largest producer, accounting for almost 11 million cubic meters. India was second at 4 million, followed by Malaysia (3 million), Indonesia, and Thailand. Japan's production has fluctuated, but has declined to less than 4 million cubic meters, placing it fourth in 1987. Indian production has increased significantly, to almost 15 million in 1987, making it the largest producer. Production in Malaysia also increased, doubling to 6 million in 1987. Indonesian production increased sharply, to over 9 million, ranking second behind India's. Thailand's production increased to 1.9 million cubic meters in 1973 before slowly declining to about 1 million for 1981-87.

The export of hardwood sawnwood by the Asian subregions has been diverse: exports by the Asian Importers has been modest at or just below 1 million cubic meters per year. This compares to production of

FIGURE 1.11

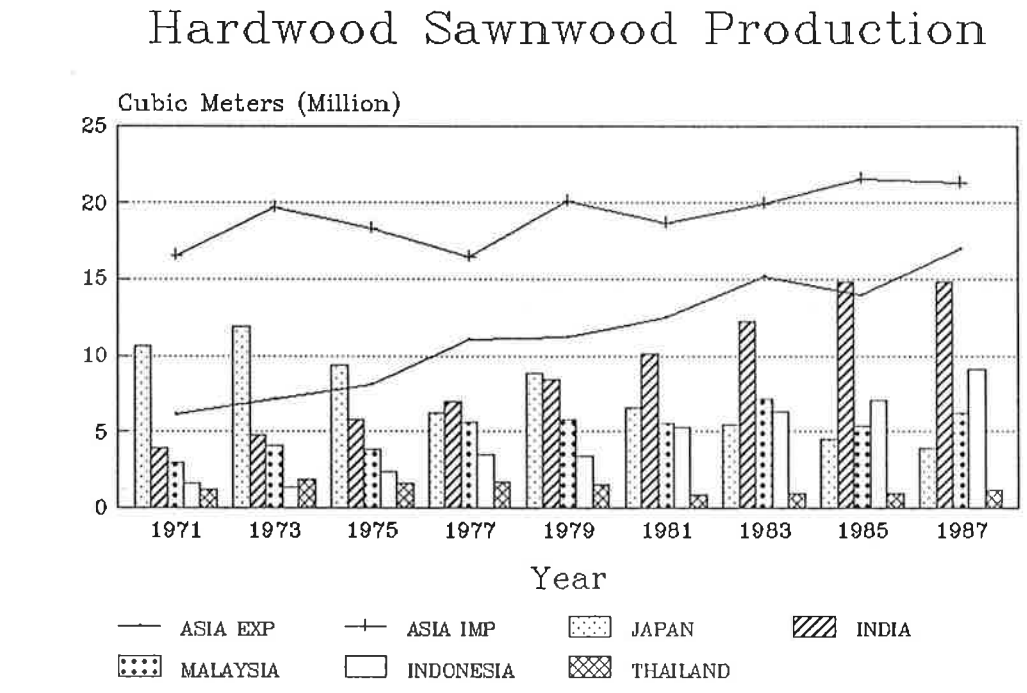

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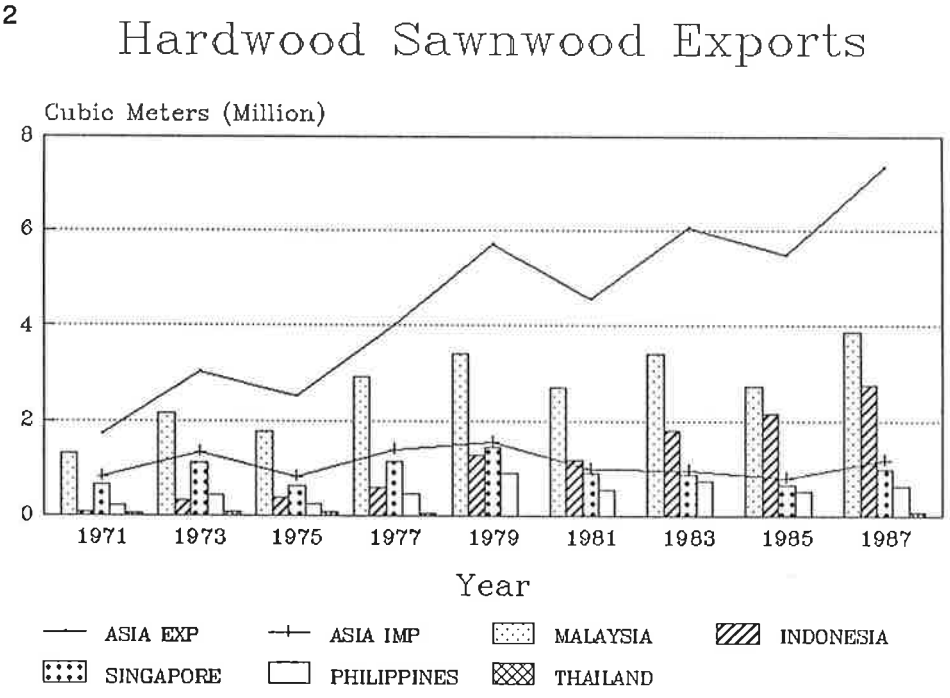
FIGURE 1.12



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about 20 million. In contrast, exports by the Asian Exporter subregion have increased significantly, from less than 2 million cubic meters in 1971 to 7.3 million in 1987. Declines in the general upward trend were evident in 1975, 1981, and 1985 (Figure 1.12).

Malaysia and Singapore were the major exporters in 1971, together accounting for almost 2 million cubic meters, or 76.8% of the total exports for the two Asian subregions. Malaysian exports have varied together with the overall trend, but have increased significantly, from 1.3 million cubic meters in 1971 to 3.9 million in 1987. Malaysia was the leading exporter of hardwood sawnwood during the study period. Singapore exports have been more variable, increasing from 650 thousand cubic meters to 1.4 million in 1979 and then declining to about 1 million through 1987.

The most significant change in exports has been from Indonesia, where shipments increased from 80 thousand cubic meters to almost 2.8 million in 1987. Exports by the Philippines grew more modestly, from 231 thousand to a high of 915 thousand in 1979 before declining to about 600 thousand in 1987. By 1987, Malaysia and Indonesia clearly dominated hardwood sawnwood exports, with a combined export volume of over 6.6 million cubic meters, or 78% of the total Asian subregion's exports.

Asian subregion imports of hardwood sawnwood (Figure 1.13) account for roughly half the volume of exports. Total imports by the Asian Importers increased from 764 thousand cubic meters to over 3.4 million. Growth in imports was most rapid during 1975-79 and 1985-87 following recession periods. Imports by Asian Exporters were relatively insignificant, growing from only 30 thousand in 1971 to 81 thousand in 1987, almost entirely accounted for by Malaysia.

Major importing countries over the study period were Japan, Singapore, Thailand, South Korea, and Hong Kong. Japanese imports increased from 323 thousand cubic meters to 1.4 million. Singapore also increased imports sharply, from 278 thousand to 1.2 million (1977). Since 1977, Singapore's imports have fallen slightly, averaging about 1 million cubic meters. Trends by other importers were less substantial. Thailand imports increased from 95 thousand cubic meters to 806 thousand (1979) before declining to half that level,

FIGURE 1.13

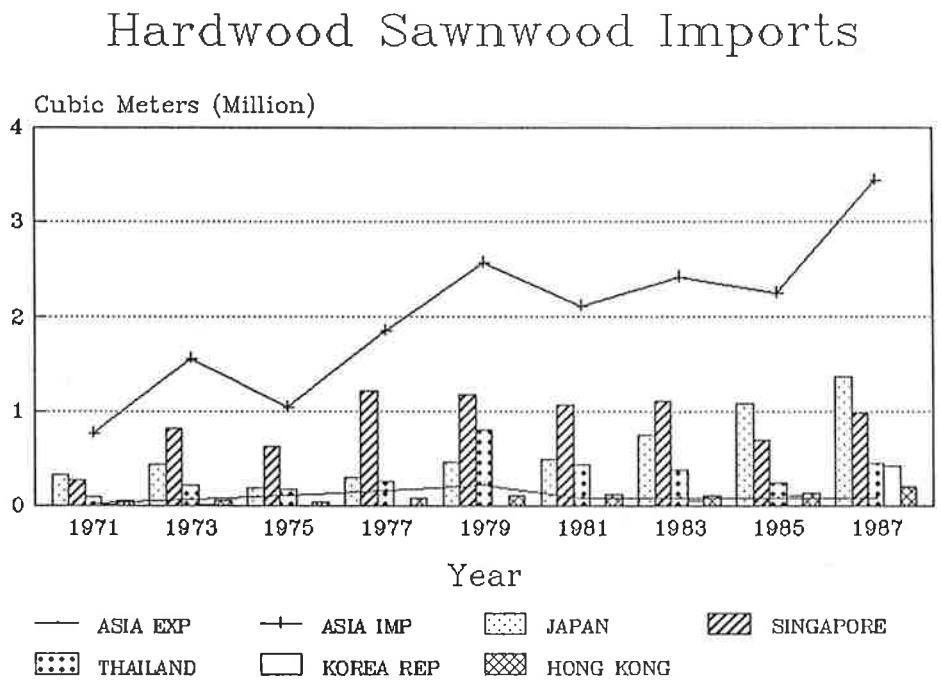

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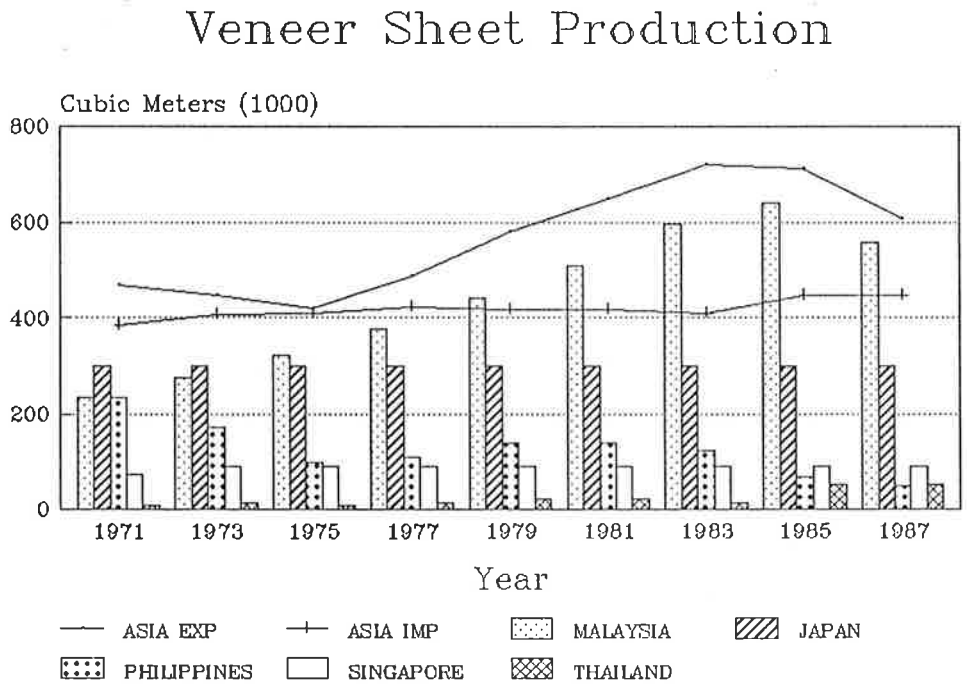
FIGURE 1.14



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remaining below 500 thousand through 1987. South Korean imports increased also, primarily during 1983-87, reaching 420 thousand in 1987. Finally, Hong Kong has emerged as an important Asian importer, increasing imports from 59 thousand cubic meters in 1971 to 212 thousand in 1987.

Veneer Sheet Production and Trade

The production of veneer sheets is shown in Figure 1.14. The Asian Importer subregion has remained relatively steady, with a slight increase from 385 thousand cubic meters to 447 thousand. Production by Asian Exporters, however, increased considerably to 1983-85, peaking at 721 thousand cubic meters before declining to 608 thousand in 1987.

Malaysia has been the dominant producer, with a high of 642 thousand cubic meters in 1985. Japan has been a major producer, with a steady output estimated at 300 thousand cubic meters per year. Production in the Philippines has declined sharply, from 234 thousand cubic meters to 50 thousand. Singapore has remained relatively steady, with output ranging from 73 thousand cubic meters to an estimated 90 thousand thereafter. Thailand has seen a major increase from 8 thousand cubic meters to over 53 thousand.

Trade patterns for the Asian subregions are shown in Figures 1.15 and 1.16. Exports have been a significant share of production for the Asian Exporter subregion, having drifted downward from a peak of 400 thousand cubic meters in 1973 to under 200 thousand in 1979-81 before sharply increasing in 1983 to over 750 thousand. Exports from this subregion were 556 thousand in 1987.

Exports by Asian Importers were steady, with a modest increase from a 1975 low of 39 thousand cubic meters to almost 107 thousand in 1987.

Major exporter countries included the Philippines, Malaysia, Singapore, and Japan, with growing exports from Indonesia. Malaysian exports increased from less than 200 thousand cubic meters through 1981 to over 554 thousand in 1983 before declining to approximately 400 thousand in 1985-87. Exports from the Philippines fell, from 136 thousand cubic meters to only 63 thousand. Exports of veneer sheets from Japan fell through 1977, then increased from only 6 thousand cubic meters to 67 thousand in 1987.

Imports of veneer sheets by the Asian subregions have been almost exclusively by Asian Importer countries, with Asian Exporter imports consistently less than 10 thousand cubic meters. For the Asian Importer subregion, imports were 125 thousand cubic meters or less through 1977, then increased steadily to over 406 thousand in 1987. As shown in Figure 1.16, almost all of the increase in imports was by Japan, with Singapore's imports dropping sharply after 1981.

Plywood Production and Trade

Perhaps the most significant change in addition to the changing pattern of export of hardwood logs by Asian hardwood producer countries has been the production and trade in plywood. Data for softwood and hardwood production are not available, but can be inferred from the location of production.

Production by Asian Importers (Figure 1.17) has averaged about 10 million cubic meters, reaching a peak of 11.9 million in 1979. The most dramatic change has been for the Asian Exporter subregion, where production has increased from less than 1 million cubic meters in 1971-77 to almost 8.2 million in 1987.

This trend is the result of the embargo on export of logs from Indonesia and the corresponding rapid development of the hardwood plywood capacity in that country. Indonesian plywood production has increased from 7 thousand cubic meters in 1971 to 6.8 million in 1987, making it the largest Asian subregion producer behind Japan, traditionally the largest producer. Japan has averaged about 7 million cubic meters over the 1971-87 period, with production exceeding 8 million in 1972 and 1979.

South Korea increased production from 1 million cubic meters in 1971 to 2.3 million in 1977-79. Largely because of the difficulty in obtaining logs, production subsequently declined, to about 1.2 million cubic meters in 1985-87.

Malaysian production has been modest in comparison to its role in veneer sheet production and trade. Plywood production has been variable, increasing to a peak of 938 thousand cubic meters in 1983, with a decline to 857 thousand in 1987. Philippines production has also been variable, generally declining after a peak of 705 thousand cubic meters in 1975. Production was 517 thousand cubic meters in 1987.

FIGURE 1.15

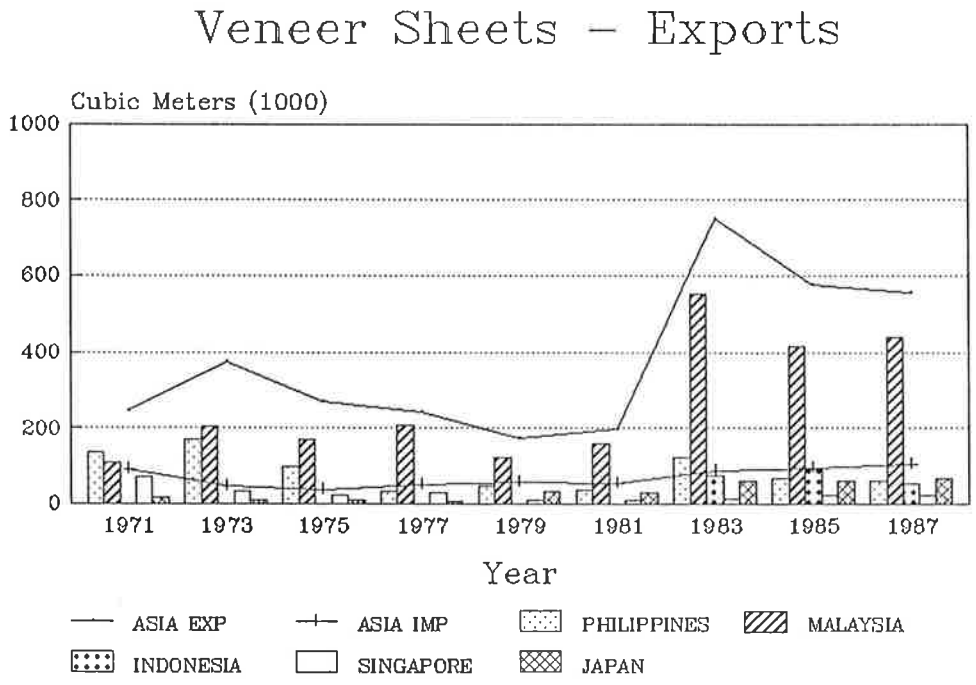

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FIGURE 1.16

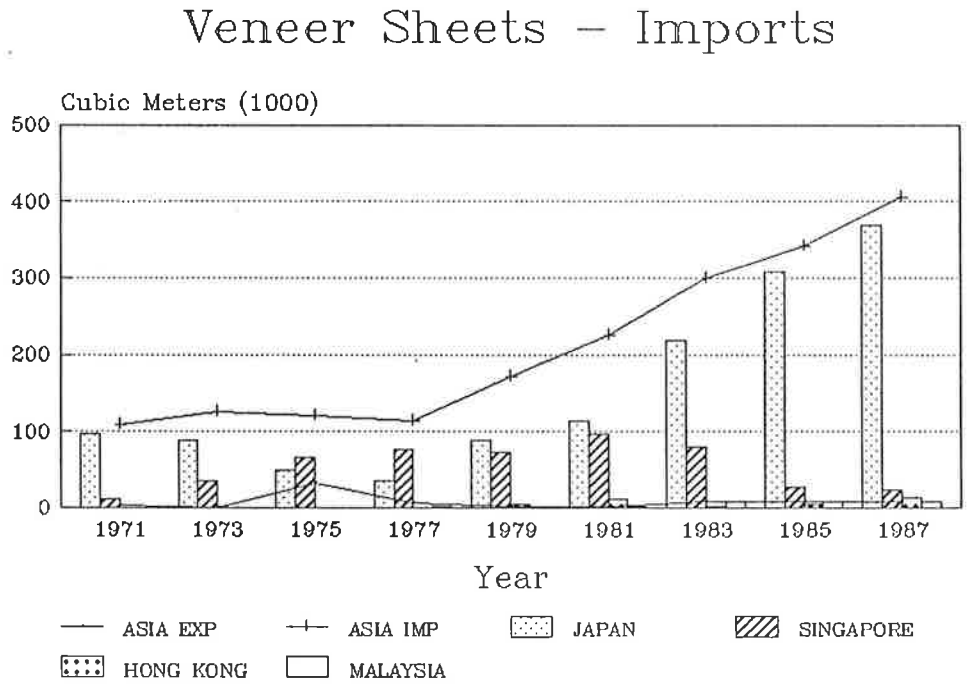

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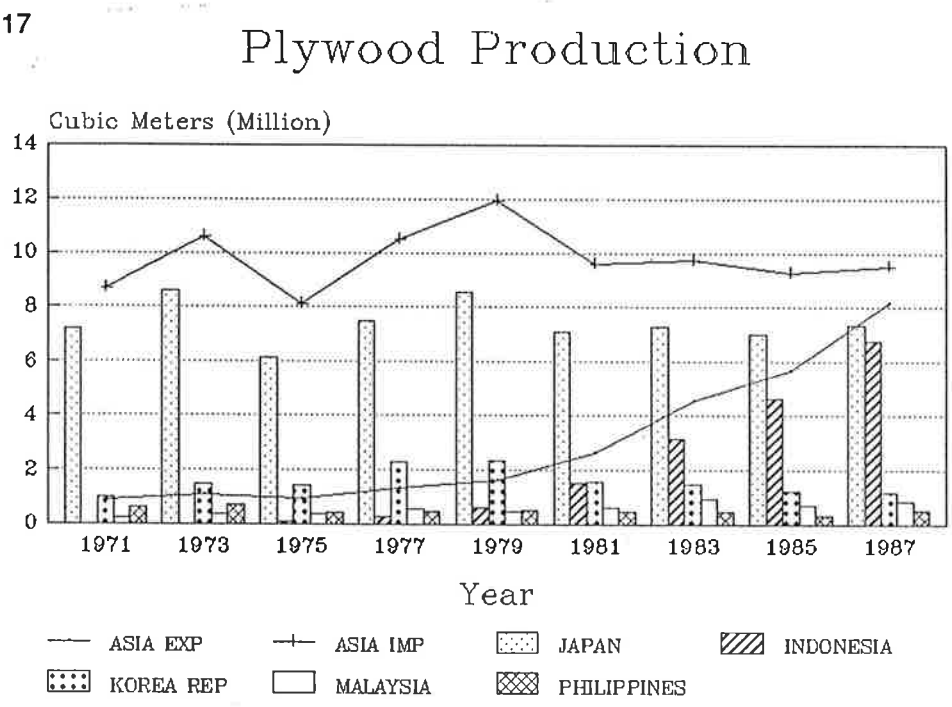
FIGURE 1.17



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The rapidly changing pattern of production of plywood in Asia is also reflected in changing trade (Figures 1.18 and 1.19). Exports by the Asian Importers averaged about 2 million cubic meters through 1979, thereafter declining to under 1 million. At the same time, exports from Asian Exporter countries increased rapidly after 1975, from only 390 thousand cubic meters to over 6.4 million in 1987.

While South Korea was the leading exporter in 1971-81, Indonesia rapidly dominated exports beginning in 1983, when exports reached 2 million cubic meters. In 1987, exports were 5.5 million, or 74% of all Asian subregion exports. By 1987, Malaysian exports had grown to 680 thousand cubic meters, almost equal to those from Singapore. South Korean exports had dropped to 691 thousand cubic meters in 1987, significantly below the 1.7 million exported in 1977.

Plywood imports by the Asian subregion have also changed significantly (Figure 1.19). Imports by Asian Importers account for practically all imports, with Japan the largest importer in the peak years of 1975 and 1987, when imports were 1.5 million and 1.8 million cubic meters respectively. In other years, Japanese imports were considerably less, averaging about 150 thousand cubic meters but with considerable year-to-year variation. Major increases in imports were by Singapore and Hong Kong, with these two countries being the second and third leading importers in 1987 with import volumes of over 400 thousand cubic meters each.

FIGURE 1.18

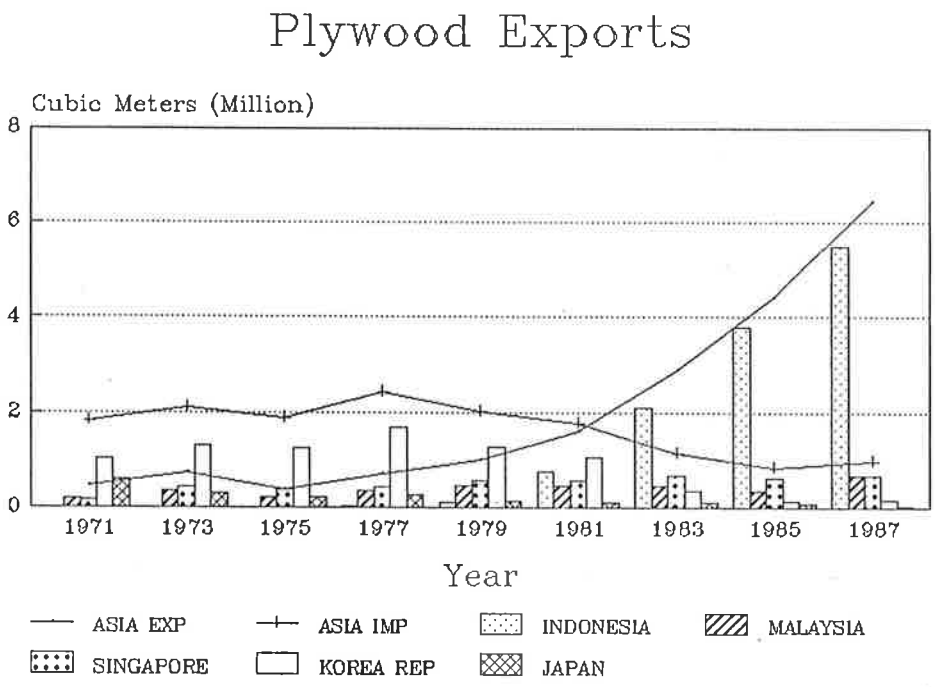

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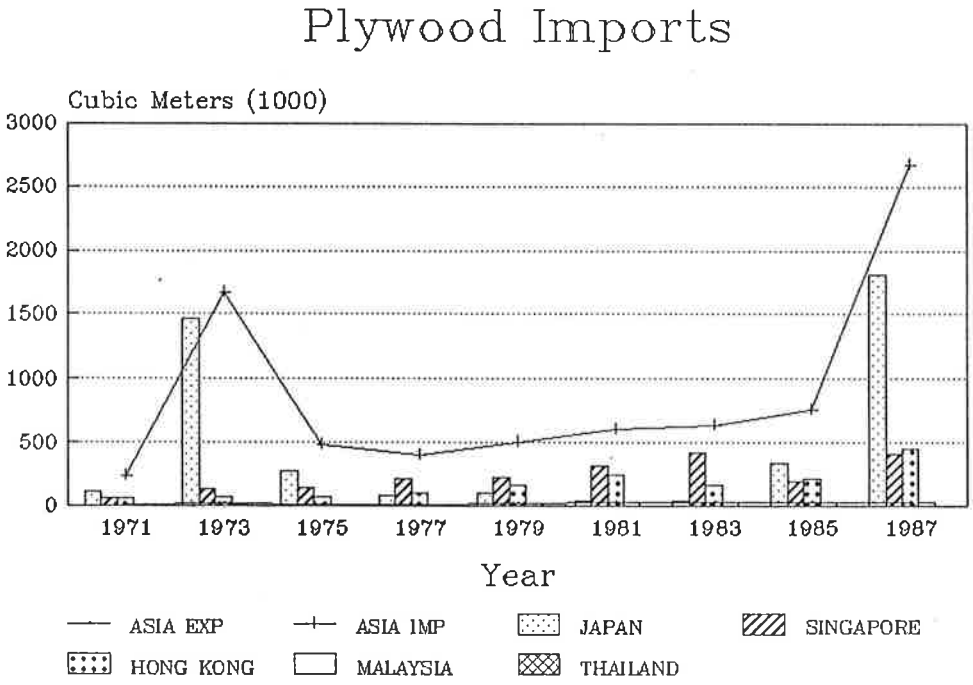
FIGURE 1.19



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BILATERAL HARDWOOD FLOWS

In this study it was not possible to develop detailed bilateral flows from country to country for major Pacific Rim hardwood products. A brief summary is provided in table form below of the major Pacific Rim importers and exporters in 1971 compared with 1987. This trade represents both tropical and temperate hardwoods.

Table 1.2. Main Pacific Rim importers of major hardwood products, 1971 versus 1987.

	Main Importers	Hardwood Saw/Veneer Logs	Pulpwood	Hardwood Sawnwood	Veneer Sheets	Plywood
1971	Australia			x	x	x
	Canada	x	x	x	x	x
	Hong Kong	x				x
	Japan	x	x	x	x	
	Singapore	x		x	x	x
	South Korea	x				
	Thailand			x		
	United States	x	x	x	x	x
1987	Australia			x	x	
	Canada	x	x	x	x	x
	China	x	x	x	x	x
	Hong Kong	x		x		x
	Japan	x	x	x	x	x
	Singapore			x	x	x
	South Korea	x		x		
	Thailand			x		
	United States			x	x	x

Table 1.3. Main Pacific Rim exporters of major hardwood products, 1971 versus 1987.

	Main Exporters	Hardwood Saw/Veneer Logs	Pulpwood	Hardwood Sawnwood	Veneer Sheets	Plywood
1971	Canada		x	x	x	x
	China					x
	Indonesia	x				
	Japan					x
	Malaysia					
	Sabah	x			x	
	Sarawak	x		x		
	West			x		x
	Papua New Guinea	x				
	Philippines	x		x	x	x
	Singapore			x	x	x
	South Korea					x
	United States	x	x	x	x	x
1987	Canada		x	x	x	x
	China					x
	Indonesia			x	x	x
	Japan				x	
	Malaysia	x		x	x	x
	Papua New Guinea	x				
	Philippines	x		x	x	x
	Singapore			x		x
	South Korea					x
	United States	x		x	x	x

CHAPTER 2. HARDWOOD TRADE AND SUBSTITUTION

The prospect is for an increasingly more expensive, less available, and less competitive supply of tropical hardwoods compared with temperate hardwoods and, more important, conifers. Certainly one would expect the major consumer countries (Japan, Europe, United States) to substitute the use of conifers and temperate hardwoods for tropical hardwoods in all but the very high value end of the use of tropical hardwoods, for which there are no substitutes and where demand is very price inelastic (i.e., teak, ebony, rosewood, etc.). Equally important, there will be an increased use of nonwood product substitutes such as brick, cement, aluminum studs, and so forth.

In the short run, only a dramatic increase in the use of the noncommercial tropical hardwood species, coupled with a dramatic reduction in waste and residues in the exploitation and use of commercial species, would mitigate this substitution. Ample opportunity exists for achieving both these goals. Present harvest levels use as little as 2-5% of the standing volume in tropical forests (in most of Latin America and Africa) to as much as 30% (in the meranti rich forests of Asia). The remaining volumes are very lightly used, if at all; and if not, they are burned by subsequent swidden agriculture. And even those trees that are harvested are typically subject to heavy residue and waste generation when converted to products. New hardwood products such as medium density fiberboard, oriented strandboard, hardboard, waferboard, and blockboards are ideally suited to use both the currently unutilized hardwood species and the manufacturing residues and waste. These products are not only attractive in the local and domestic markets but can be equally competitive in the international markets.

TIMBER SUPPLY AND AVAILABILITY

Forest Land Base

Most recent information on the forest land base of the Pacific Rim is from the 1980 FAO forest resources review (FAO 1985a). Table 2.1 provides summary statistics by subregion.

The Pacific Rim region had a total of 1.6 billion hectares of forests in 1980. This was 36.5% of global forest land. Only 39.1% of this is conifer species, or 614.7 million ha. Hardwoods occupy some 962 million ha, fully 60.9%. The majority of the Pacific Rim hardwood forest is closed (775 million ha), with 187 million ha of "open" or other hardwood cover.

The largest share is in the North American subregion, with almost 737 million ha. North American forests are predominantly conifer (508 million ha), accounting for 69.3%. Hardwoods constitute just over 226 million ha, or 30.7%.

The other subregions of the Pacific Rim, in contrast to North America, are dominated by hardwoods. The Asian Importer subregion has the lowest proportion of hardwoods, at 77.2%. The Asian Exporter subregion is 97.2% hardwood, followed by Oceania at 93.1%.

The Pacific Rim accounts for one-third (33.7%) of global hardwood forests and 42.4% of closed hardwood forests. The actual hardwood forest distribution is surprisingly even, with about 23% each in the North American and Asian Importer regions. The dis-tinction, of course, is that the North American hardwood forest is of temperate species while the Asian Importer hardwood forest is tropical. Central-South America and the Asian Exporter subregions each account for about 18% of Pacific Rim hardwood forest, being almost entirely tropical. Oceania, with 147 million ha of hardwoods (15% of Pacific Rim), has both tropical and temperate species.

Pacific Rim conifer forests are primarily in North America. The Asian Importer subregion, with only 67 million ha of conifer forest, is the second leading subregion. The majority of its conifer forest is in China (PRC and Taiwan combined), with 45 million ha. Other conifer forests in this subregion are primarily in Japan, with 12.7 million ha.

The remaining conifer forests of the Pacific Rim are mainly in Central-South America (22.8 million ha); where Mexico, with 20.5 million ha, dominates. Oceania's 10.9 million ha are mainly in Australia (8 million ha) and New Zealand (2 million ha).

Table 2.2 contains summary information from FAO sources on forest loss and renewal (FAO 1985a). As reported for 1980, global forest renewal was almost twice forest loss (14.5 million versus 7.3 million ha).

Table 2.1. Forest land base of the Pacific Rim, 1980 (1,000 ha).

Country/Region	Forest Area							% Land Area	% Hardwood Forest
	Total	Coniferous			Hardwood				
		Total	Closed	Other	Total	Closed	Other		
North America	736,478	508,057	287,792	220,245	226,439	171,564	54,875		30.7%
Central-South America	195,490	22,804	22,804	0	172,686	163,836	8,850		88.3%
Asia (Exporters)	192,102	5,355	5,355	0	186,747	183,747	3,000		97.2%
Asia (Importers)	296,524	67,677	61,797	5,880	228,847	176,264	52,583		77.2%
Oceania	158,291	10,850	6,915	3,935	147,441	79,680	67,761		93.1%
Total Pacific Rim	1,578,885	614,743	384,663	230,060	962,160	775,091	187,069		60.9%
Total World	4,320,503	1,463,562	1,120,805	342,757	2,856,941	1,827,486	1,029,455	32.3%	66.1%
	Percent of World								
North America	17.0	34.7	25.7	64.3	7.9	9.4	5.3	0.0	
Central-South America	4.5	1.6	2.0	0.0	6.0	9.0	0.9	0.0	
Asia (Exporters)	4.4	0.4	0.5	0.0	6.5	10.1	0.3	0.0	
Asia (Importers)	6.9	4.6	5.5	1.7	8.0	9.6	5.1	0.0	
Oceania	3.7	0.7	0.6	1.1	5.2	4.4	6.6	0.0	
Pacific Rim region	36.5	42.0	34.3	67.1	33.7	42.4	18.2	0.0	
	Percent of Pacific Rim								
North America	46.6	82.6	74.8	95.7	23.5	22.1	29.3		
Central-South America	12.4	3.7	5.9	0.0	17.9	21.1	4.7		
Asia (Exporters)	12.2	0.9	1.4	0.0	19.4	23.7	1.6		
Asia (Importers)	18.8	11.0	16.1	2.6	23.8	22.7	28.1		
Oceania	10.0	1.8	1.8	1.7	15.3	10.3	36.2		

Source: FAO (1985a).

For the Pacific Rim region as a whole, forest renewal was just over 7.7 million ha, or 53.4% of the global total. Forest loss was 1.9 million ha, or just 26.2% of the global total.

Forest renewal or loss is reported by FAO on a net basis for each country. In Table 2.2, the subregion totals reflect the aggregate net renewal or loss for the combined countries as a whole. Losses for any one country are offset against renewals for that country, and would not be aggregated into the subregion total. Thus it is evident that the subregions of the Pacific Rim have exhibited varying trends in forest loss and renewal. Central-South America and Asian Exporters have shown a net loss of forest, while North America, Asian Importers, and Oceania have shown a net increase or renewal.

Table 2.2. Pacific Rim forest loss and renewal, 1980 (1,000 ha).

Country/Region	Forest Renewal	Forest Loss
North America	2,495	
Central and South America	62	783
Asia (Exporters)		977
Asia (Importers)	5,075	147
Oceania	113	
Total Pacific Rim	7,745	1,907
Total World	14,511	7,266
	Percent of World	
North America	17.2	0.0
Central and South America	0.4	10.8
Asia (Exporters)	0.0	13.4
Asia (Importers)	35.0	2.0
Pacific Rim region	53.4	26.2
	Percent of Pacific Rim	
North America	32.2	0.0
Central and South America	0.8	41.1
Asia (Exporters)	0.0	51.2
Asia (Importers)	65.5	7.7
Oceania	1.5	0.0

Source: FAO (1985a).

The largest gain in renewal has been in the Asian Importer subregion, accounting for over 65% of the Pacific Rim net gain. By far the largest proportion of this gain was for China. Japan, South Korea, and Thailand recorded small net gains in renewal, while India showed a net loss of 147 thousand ha.

For Central-South America, the trend was variable, with Chile, Colombia, and Ecuador showing net renewals, and both Mexico and Peru showing significant losses.

The Asian Exporter subregion showed universal loss of forest among countries, with Indonesia experiencing the largest loss (550 thousand ha) followed by Malaysia (230 thousand ha). Overall, this subregion experienced a net forest loss of almost 1 million ha. The Asian Exporter subregion accounted for 51.2% of net Pacific Rim forest losses, or 13.4% of global forest loss.

Table 2.3 is from the 1981 FAO report on tropical forests, indicating average annual deforestation for the tropical Asian region (sixteen countries) for the comparative periods 1976-80 and 1981-85. The overall regional average loss increased slighty, from 1,815 thousand ha to 1,826 thousand. By subregion, the average annual losses are shown in Table 2.4.

Accelerated rates of annual loss were noted for South Asia, insular Southeast Asia, and Papua New Guinea. Reduced rates of deforestation were noted for continental Southeast Asia and the centrally planned Asian countries. Countries with significant increases in the estimated annual deforestation were Sri Lanka, Burma, Indonesia, Malaysia (Sabah, Sarawak), and Kampuchea. Major reductions in deforestation were noted for Thailand, the Philippines, and Laos. Other countries were expected to continue with approximately the 1976-80 rates of deforestation.

Table 2.3. Average annual deforestation of closed broadleaved, coniferous, and bamboo forests (N.f) in tropical Asian countries (1,000 ha).

Country	Productive									
	Undisturbed (N.f1uv)		Logged (N.f1uo)		Total (N.f1)		Unproductive (N.f2)		All (N.f)	
	1976-80	1981-85	1976-80	1981-85	1976-80	1981-85	1976-80	1981-85	1976-80	1981-85
Bangladesh	2	2	3 [1]	3 [1]	5	5	3	3	8	8
Bhutan			2	1.5	2	1.5			2	1.5
India	12	12	121 [2]	121 [2]	133	133	14	14	147	147
Nepal	47	47	21	21	68	68	16	16	84	84
Pakistan	2	2	3 [3]	3 [3]	5	5	2	2	7	7
Sri Lanka			21	45	21	45	4	13	25	58
South Asia	63	63	171	195	234	258	39	48	273	306
Burma	59	65.5	36 [4]	39.5 [5]	95	105		39	95.5	105
Thailand	213	113	110	100	323	213	10		333	252
Continental Southeast Asia	272	179	146	139	418	318	10	39	428	357
Brunei	7	5	—	—	7	5	—	—	7	5
Indonesia			550	600	550	600	—	—	550	600
Malaysia	32.2	34.8	177.8	200.2	210	235	20	20	230	255
(Pen. Malaysia)	(7.2)	(6.8)	(82.8)	(83.2)	(90)	(90)	—	—	(90)	(90)
(Sabah)			(44)	(60)	(44)	(60)	(16)	(16)	(60)	(76)
(Sarawak)	(25)	(28)	(51)	(57)	(76)	(85)	(4)	(4)	(80)	(89)
Philippines			101	91	101	91	—	—	101	91
Insular Southeast Asia	39	40	829	891	868	931	20	20	888	951
Kampuchea	13	20	2	3	15	23	—	2	15	25
Laos	85	60	20	25	105	85	20	15	125	100
Vietnam	21	21	23	23	44	44	21	21	65	65
Centrally Planned Tropical Asia	119	101	45	51	164	152	41	38	205	190
Papua New Guinea	10	12	3	2	13	14	8	8	21	22
Tropical Asia	503	395	1,194	1,278	1,697	1,673	118	153	1,815	1,826

[1] Of which 3(000) ha of managed forests (n.f1m).
[2] Of which 99(000) ha of managed forests (N.f1m).
[3] Of which 2(000) ha of managed forests (N.f1m).
[4] Of which 14(000) ha of managed forests (N.f1m).
[5] Of which 15.5(000) ha of managed forests (N.f1m).

Source: FAO (1981).

Table 2.4. Estimated average annual rates of deforestation in tropical Asian subregions, 1976-80 compared with 1981-85 (1,000 ha).

Subregion	1976-80	1981-85
South Asia	273	306
Continental Southeast Asia	428	357
Insular Southeast Asia	888	951
Centrally planned countries	205	190
Papua New Guinea	21	22
Total	1,815	1,826

The Tropical Resource

Inventory Statistics. There is little agreement among students of tropical forestry on the extent of tropical forests, and even less agreement on the rate of change, in either total area or status. Much controversy exists over the status and condition of tropical forests and how they are changing under the influence of human activities. FAO has conducted regional and global assessments of forest resources since its inception.

Although these reports are often cited as the data base for various conclusions concerning the status of tropical forests, many limitations and uncertainties render most statements rather tentative. Only a small fraction of tropical forests had ever been covered by a forest inventory as of 1971. For Europe, 74% of the forests have been inventoried; for North America, 60%. In the USSR, 40% or more have been inventoried. For the tropical regions the percentages are low: 10% in Latin America, 15% in Africa, 35% in Asia, and 20% in the Pacific. Globally, 35% of the forests have been subjected to inventory.

The President's Council on Environmental Quality made an assessment of tropical forests as a part of its Global 2000 study (U.S. Council on Environmental Quality 1980). It based forest area estimates on reports from U.S. embassies. Table 2.5 shows the tropical forest areas used in the study. This table includes some nontropical countries from each region.

The interagency task force (U.S. Department of State 1980) estimated tropical forest area as a part of its study, *The World's Tropical Forests.* Table 2.6 indicates these estimates by region and forest type.

Table 2.7 shows data collected and assembled by FAO from qualitative and quantitative information on tropical forests termed abundant, scattered, and diverse. This is perhaps the most comprehensive listing to date.

Table 2.8 summarizes the information from these FAO studies in a format similar to Tables 2.5 and 2.6.

Rate of Change in Forest Status. In Latin America over 91% of the productive forest is natural forest, about 9% is logged over, and about 0.01% is under intensive management. The sit- uation in Asia is quite different: 54% of the productive forest is natural, 3% is under intensive management, and 43% has been logged over. These figures are supported by production statistics (FAO 1981c), which show that the Asian countries have more in- tensively exploited their natural forests. The Asian countries have apparently also placed a larger percentage of land under legal protection and under intensive management. Table 2.9 presents estimates by FAO of the average *annual* rate of industrial harvesting by country and region for 1981-85, based on recent trends reflecting the rate of harvesting in undisturbed productive closed forest. These rates are also shown as percentages of the current areas of this forest type.

Table 2.10 presents 1980 FAO data on the 1976-80 average annual rate of conversion for different closed forest categories.

The FAO results suggest deforestation in the tropics of about 7.3 million ha/yr. In contrast, the Global 2000 study (U.S. Council on Environmental Quality 1980) estimated annual deforestation at 18 to 20 million ha. There may have been some unfortunate double counting in that study. The Global 2000 figures suggest that tropical forest could disappear by 2020. Based on the FAO data, it would take 165 years, assuming a linear extrapolation is valid. The National Academy of Sciences study, *Conversion of Tropical Moist Forest*

Table 2.5. Tropical forest area by region, 1973.

Region	Area (million ha)		
	Closed forest	Open forest	Total*
Latin America	590	152	795
Asia/Pacific	480	165	720
Africa	190	570	800
Total	1,260	887	2,315

*Closed plus open does not equal total, which also includes scrubland and brush-covered lands.
Source: U.S. Council on Environmental Quality (1980).

Table 2.6. Tropical forest area by region, mid-1970s.

Region	Area (million ha)		
	Closed forest	Open forest	Total*
Latin America	590	230	820
Asia/Australia	300	60	360
Africa	210	524	734
Total	1,100	814	1,914

Source: U.S. Department of State (1980).

(Myers 1980), suggests that tropical forests may disappear before the end of this century. The NAS study, however, presents few data that can be used to calculate rates to support this conclusion; rather it is a more qualitative assessment. Implicit in its prediction is a deforestation rate double that of Global 2000 and therefore five to six times higher than that indicated by the FAO data.

In tropical America new plantations are being created at a rate of about 380,000 ha/yr. Recent planting rates in tropical Asia and Africa are 419,000 and 93,000 ha/yr, respectively.

It is apparent that plantation development is accelerating in some of the tropical countries to serve a variety of industrial and nonindustrial purposes. Thus, while conversion of natural tropical forest has been proceeding at about 7.3 million ha annually, plantations are being created at the rate of 892,000 ha/yr. This indicates an increasingly serious supply problem for tropical hardwoods unless the plantation areas increase dramatically and the forest conversion rates decrease.

Plantations

On a global scale, much of the current timber harvest derives from the liquidation of natural forest stands that have matured as a result of biological processes, with little human input. The opportunity cost for these forests has been minimal, representing primarily the lost income from earlier harvest. Little investment has been made in the growth realized from natural processes, protection, or reforestation following earlier harvest.

Most forest costs have been from gaining access to natural forests, and from harvest and transport of the timber to points of processing or utilization. The timber economy has been largely extractive, with little strategic investment in productive growth of wood. Economic rents paid for natural timber may be returned to the further production of forests, but in many cases these rents are diverted to other needs.

As the global timber economy changes, the development of man-made (or stimulated) forests has increased. Natural reforestation is risky and largely unpredictable in much of the world. High-grading of primary species often has left inferior species as the seed source for subsequent natural reforestation, leading to a declining productivity of valuable species. Delay in successful regeneration also has meant delay in the receipt of incomes from new forest stands. Poor stocking levels also reduce future harvests. Part of the site

Table 2.7. Area of natural forest estimated at end of 1980 (1,000 ha).

	Closed Forest												
	Productive				Unproductive					Fallow of			
Country	Undisturbed	Logged	Managed	Total	Physical reasons	Legal reasons	Total	Closed Forest Total	Open Forest	Closed formations	Open formations	Scrub	Total
Indonesia	38,915	34,780	40	73,735	34,730	5,430	40,160	113,895	3,000	13,460	3,900	23,900	158,155
Malaysia	7,529	5,524	2,499	15,552	4,484	959	5,443	20,995	—	4,825	—	—	25,820
Philippines	3,000	3,890	—	6,890	1,930	690	2,620	9,510	—	3,520	—	—	13,030
Thailand	4,620	—	—	4,620	2,395	2,220	4,615	9,235	6,440	800	—	500	16,975
Subtotal	54,064	44,194	2,539	100,797	43,539	9,299	52,838	153,635	9,440	22,605	3,900	24,400	213,980
Total Tropical Asia	101,352	59,847	39,790	200,989	86,935	17,586	104,521	305,510	30,948	69,225	3,990	35,503	445,176

Source: FAO (1981).

Table 2.8. Tropical forest area by region, 1980.

Region	Area (million ha)		
	Closed forest	Open forest	Total
Latin America	679	533	1,212
Asia	305	140	445
Africa	217	1,095	1,312
Total	1,201	1,768	2,969

Source: FAO (1981).

Table 2.9. Estimated areas of undisturbed productive closed forest to be logged annually (sawlogs and veneer logs), 1981-85.*

Country	Total (1,000 ha)	% of Current Area of This Forest Type
Indonesia	880	2.3
Malaysia	375	5.0
Philippines	80	2.7
Thailand	100	2.2
Subtotal	1,435	2.6
Total Tropical Asia	1,741	1.7
Total Tropical Africa	639	0.5
Total Tropical America	2,003	0.4

*In addition to areas of undisturbed productive closed forests cleared (mainly for agriculture).
Source: FAO (1981).

Table 2.10. Average annual conversion of closed forests, 1976-80 (1,000 ha).

Country	Productive						Unproductive		Total	
	Undisturbed		Logged		Total					
	ha	%	ha	%	ha	%	ha	%	ha	%
Indonesia	—	—	550	1.4	550	0.7	—	—	550	0.5
Malaysia	32	0.4	178	3.2	210	1.4	20	0.4	230	1.1
Philippines	—	—	101	2.6	101	1.5	—	—	101	1.1
Thailand	213	4.6	110	—	323	7.0	10	0.2	333	3.6
Subtotal	245	0.5	939	2.1	1,184	1.2	30	<0.05	1,214	0.8
Total Tropical Asia	503	0.5	1,194	2.0	1,697	0.8	118	0.1	1,815	0.6

Source: FAO (1981).

productivity has been lost. Lack of silvicultural practices may also reduce yields through failure to capture mortality or to stimulate growth.

The concept of "plantation" is elusive, conveying a wide range of human influence on forest growth. The term may imply the conscious establishment of forests on lands not previously occupied by trees. It may also convey the idea of species selection for increased productivity—frequently a species not native to the particular site. A plantation may undergo intensive silviculture, including site preparation, seed or stocking selection, spacing, weeding, thinning, fertilization, and various harvest practices designed to aid reforestation, avoid stand damage, or protect forest productivity. Such practices may also have the goal of shortening the time to the realization of harvest, enhancing income flows, and reducing capital costs.

In general, plantation forestry implies intensive tree farming, with the related investment of capital in producing a timber crop. Time, effort, and money are invested in order to realize an income. Plantation forestry is also viewed as a means of stabilizing the sustainable harvest of timber in particular regions or countries where the exploitation of natural forests is approaching an end. Natural forests are largely a stock resource, available for one-time liquidation. Plantations represent the potential for a renewable resource harvested on a continuing cycle.

The distinction between "natural" forests and "plantations" is not totally clear. For example, much of the natural forest of the United States was harvested and the land then "abandoned," resulting in natural reforestation incidental to conscious forest objectives. However, these forests have become part of the ongoing timber harvest base.

Forest protection has also been extended to "natural" forests, requiring at least a minimal investment. Protection from fire, disease, and insects represents a conscious decision to "assist" nature in preserving the growth of the forest over time. The decision to leave "seed trees" to enhance natural reforestation likewise represents a minimal investment decision. Aerial seeding increases the chance for successful reforestation. Hence much of the current industrial and a significant portion of the public forests of North America could be considered plantations.

Globally, forest plantations are still a small part of the total forest area. As reported by Sedjo (1983), plantations constituted approximately 90 million ha in 1975, with about half (47 million ha) in the centrally planned economic regions of Europe, the USSR, and Asia.

More recent information on plantations of tropical Asia, as reported by FAO (1981), is summarized here.

A total of about 5.1 million ha of plantations were reported for the tropical Asian region up to 1980, with almost 2.1 million ha established during 1976-80. At the time of the FAO review, plantation efforts were expected to continue at about the same level for the period 1981-85, with total plantings at about 2.2 million ha.

The annual rate of planting for 1981-85 was expected to increase slightly from 419 thousand ha to 439 thousand for the sixteen tropical Asian countries. By subregion, gains in the rate of plantation establishment were anticipated for South Asia (primarily Bangladesh, India, and Sri Lanka), continental Southeast Asia (mainly Thailand), the centrally planned countries, and Papua New Guinea. In contrast, a decline in the rate of establishment was projected for the insular Southeast Asian countries (Kampuchea, Laos, Vietnam), a drop in annual rate from 233 thousand ha (1976-80) to 202 thousand for 1981-85.

The majority of Asian plantations, as would be expected, are hardwood species. In 1980 all hardwood species accounted for 2,896 thousand of the total of 3,502 thousand ha. Softwood species accounted for only 606 thousand ha of plantations, over half of which had been established during 1976-80. About one-third of the hardwood plantations were considered fast-growning plantations (1,083 thousand ha) while other hardwoods accounted for almost two-thirds (1,813 thousand ha).

Fast-growing hardwood plantations were primarily in South Asia, with 941 thousand ha (86.9%) in India. Sri Lanka, Malaysia (Sabah), and the Philippines accounted for the majority of the remainder.

Softwood plantations were almost entirely in Indonesia (430 thousand ha; 71%). Other countries with softwood plantations include India, Nepal, Malaysia (Sabah, Sarawak), Philippines, Vietnam, and Papua New Guinea.

Tropical Asian plantations were estimated at 4,670 thousand ha by 1985, an increase of 1,168 thousand. This compares to an estimated *annual* loss (deforestation) of 1,826 thousand ha (see Table 2.3). The increase in tropical plantations was 801 thousand ha for all hardwoods, and 367 thousand for softwoods. Fast-growing hardwood plantations were estimated as increasing by 477 thousand ha, or almost 60% of new hardwood plantations.

It was estimated that India would have 1,940 ha of hardwood plantations, two-thirds of them fast growing. Indonesia would have over 1 million ha, most in other than fast-growing species. Bangladesh, Thailand, and Sri Lanka were estimated at over 100 thousand ha of hardwood plantations by 1985, again mostly not in fast-growing species. Malayasia, with an estimated 85 thousand ha of hardwood plantations, almost all fast growing, was the only other country reported with significant hardwood plantations.

As with estimates for 1980, Indonesia dominated softwood plantations, with an estimated 685 thousand ha, or 70%. Increases were estimated for India, Nepal, Sri Lanka, Malaysia (Peninsular Malaysia, Sabah), Philippines, Vietnam, the centrally planned Asian region, and Papua New Guinea. On a country basis some of the increases were significant, but in total the added area of softwood plantations outside of Indonesia, India, Malaysia, and Vietnam was quite small.

It is evident that the rate of new plantation establishment is falling far short of the tropical deforestation. Although many of the plantations are tropical hardwoods, a significant proportion have been established only since 1980, and almost one-third are fast-growing species likely to be utilized heavily for fuelwood in addition to industrial wood. Over 2 million ha are other hardwoods, with slower growth rates to reach industrial size. Almost 1 million ha of softwood species have been established, while a significant area remains quite small by international dimensions.

Currently established plantations cannot be expected to make a significant contribution to harvest in the near future. Present levels of harvest, if maintained, will in all likelihood continue to reduce the net area of forest, and by implication the total tropical hardwood timber inventory. It is not possible to infer here whether the current rate of cutting is excessive in total, with reference to the long-term sustainability of harvest. What is clear is that the longer-term outlook is not encouraging with respect to the ability of plantations to absorb any significant part of reduced harvest due to declining harvest from natural tropical hardwood forests.

Environmental Policies and Constraints

The forests in the tropical regions are being subjected to increased human use as a result of population growth in the less developed countries (LDCs). These countries have some of the highest rates of population growth in the world, and with such growth comes greater pressure on forest land. Some land occupied by forest is cleared for permanent or temporary farms. Some is converted to urban homesites, roads, railroads, airports, reservoirs, and a score of other nonforest uses. But the forest also provides wood needed by the growing population—wood for solid fuel or charcoal, structural materials for building homes, barns, and business buildings, and sometimes raw material for paper.

Many geneticists feel that the greatest potential loss as a consequence of conversion of tropical forests would be the extinction of the germ plasm of economically important agricultural, ornamental, medicinal, and timber species. Accelerated tropical forest conversion is reducing the genetic base of many of these agricultural species, while normal forest harvesting has much less of an effect in reducing species diversity, sometimes none at all. But the agroforest and the managed forest may have an impact on species diversity, depending on the system used.

Among the more serious concerns about adverse effects are those related to long-term reduction in site productivity. The extreme view is that tropical forest soils are infertile, fragile, and almost totally destroyed by forest harvesting. Those holding this view fear great losses in productivity that could seriously affect future wood supply. Although these concerns have been expressed, actual changes are difficult to document.

The great diversity of tropical tree species in the forests of the humid tropics has often led to a selective system of harvest. If only a few timber species are cut (less than 30% of basal area) and the forest is then left to regenerate naturally, the forest soil may suffer no ill effects from the logging operation. In many cases, however, the establishment of temporary or permanent roads is part of, perhaps inadvertently so, the general development of a previously inaccessible region. Because of these roads, pioneering farmers enter these

areas and advance the deforestation initiated by the logging operation. Thus logging operations play a significant role in the development of many lowland tropical forest regions by creating access to the area.

It is inescapable that population and development pressures will continue to lead to the conversion of large sections of moist tropical natural forest to other forms of land use. The principal option currently selected is conversion to agriculture, including grasslands. The most fertile soils are often converted to agricultural use while less productive sites are retained as forest. This is accepted as the natural consequence of a priority system that puts food ahead of fiber, in order to feed the domestic population. But often this is not what happens. The agricultural crop may be coffee, cacao, rubber, cassava, oil palm, domestic livestock, or another agricultural commodity produced for export.

On a global basis, concerns have been expressed that range from a gradual warming trend (greenhouse effect) to the exact opposite, a gradual trend toward the next ice age. The tropical wet forest constitutes approximately 11% of the continental land area, but produces 32% of the continental biomass. When the net primary productions of seasonal and wet tropical forests are combined, their total organic matter production and also carbon dioxide utilization are greater than for the open ocean, which covers 60% of the earth's surface. It has been speculated that deforestation in the tropics contributes significantly to an increase in atmospheric carbon dioxide. This, it is suggested, is the result of a reduction in the photosynthetic base and the burning of forest components. In fact, it has been speculated that deforestation activities may be adding as much carbon dioxide to the atmosphere as is the combustion of fossil fuels. Fossil fuel combustion and forest harvesting combined are said to have caused an estimated 15% increase in the atmospheric carbon dioxide concentration over the past century.

The risks of ignoring the possible consequences of an increased level of carbon dioxide in the atmosphere justify urgent scientific investigation of the climatic processes involved. However, it appears that the deforestation that is relevant to change in atmospheric carbon dioxide is primarily conversion to nonforest use. There is no persuasive evidence that harvesting of forest in a sustained-yield forest management system is likely to contribute to an adverse carbon dioxide atmospheric effect.

The impact of these environmental issues is difficult to predict. Certainly, elected officials and forest management agencies in some of the major tropical hardwood producing countries (such as Indonesia and Brazil) have become very sensitive to the concerns expressed. In some of the smaller countries (such as Costa Rica), the development rights to tropical hardwood forests are being acquired with funds from donations, with the objective of conserving or preserving the forests; a debt swap for these development rights has even been proposed. Import bans and consumer boycotts have been proposed in some European countries for tropical hardwoods and the products containing tropical hardwoods (such as furniture, presumably even when it contains rubberwood which would have been burned otherwise); some of these boycotts have been institutionalized or legalized at a subpolitical level (city or town). One cannot help but wonder whether some of these measures are not at least partly aimed at stimulating or protecting the use of domestic (temperate) hardwoods and hardwood products.

These environmental concerns coincide with a rapidly dwindling supply of tropical hardwoods from such major producers as Indonesia, Colombia, Brazil, and Malaysia. As an example, Indonesia's supply is increasingly coming from more remote areas in Kalimantan and from Irian Jaya (in addition, in Irian Jaya, the species composition in terms of marketability is much less favorable than that of Kalimantan and Sumatra). In an attempt to conserve the remaining supply, to capture more of the value added, and to stimulate investment in the local industry, these countries increasingly have gone beyond the mere imposition of log export bans. Indonesia has dramatically increased the export tax on hardwood lumber and plywood. Thailand has instituted a flat prohibition on the export of teak in anything but a final product form. Finally, the lack or failure of attempts to start large-scale plantations of tropical hardwoods (possibly with the exception of eucalyptus, but this is meant primarily for the pulp and paper industry) has been documented amply in the literature; according to FAO less than 0.1% of the total tropical forest land cover is in plantations (and even these are not all made up of hardwood species).

ECONOMICS OF DEMAND

Elasticity Analysis

Using the CINTRAFOR-GTM (CGTM), a short-run analysis of timber supply is given. Table 2.11 is the estimate of sawtimber production (harvest and removals) used in the model. The west coast is represented here by the Pacific Northwest (westside).

Sawtimber supply elasticities with respect to stumpage price and/or delivered sawlog price are given in Table 2.12. Elasticity may be defined as the proportionate rate of change in quantity divided by the proportionate rate of change of the respective price. This gives a measure of how responsive a good is to price changes. An elasticity much greater than one is very responsive to price changes. An elasticity between one and zero is not as responsive to price changes. Since elasticity is a unitless measure, the type of currency and its exchange rate do not matter. The elasticities in Table 2.12 are computed at the 1986 values.

Product supply elasticities for coniferous and nonconiferous sawnwood/plywood are given in Table 2.13. Korea, for example, is shown to have an elastic (2.4) product supply response with respect to changes in the price of nonconiferous sawnwood. As the price of nonconiferous sawnwood increases, the product supply response increases by a greater proportion. By contrast, Indonesian nonconiferous product supply is shown to be inelastic (0.7) with respect to changes in price.

Input-output coefficients from the conversion of logs into product are given in Table 2.14. This offers additional insight into the demand for sawtimber. For example, when the coefficient is high, such as with the U.S. North, then as the demand for coniferous sawnwood increases, it will take a greater volume of sawtimber to produce that output. Korea, by contrast, has a lower coefficient, revealing that less sawtimber is needed to produce coniferous sawnwood.

Table 2.15 shows the elasticity of demand for coniferous and nonconiferous sawnwood/plywood. Note that most countries have inelastic demand for most products. That is to say, these products are essentially necessities. Any given increase in price is associated with a relatively low decrease in the quantity demanded. Also note that since demand is downward sloping, the negative sign is implied in front of the elasticities given in Table 2.15.

Table 2.11. Sawtimber production, 1987 (m^3 sawlogs/m^3 product).

Region/Country	Coniferous	Nonconiferous
PNW West (private)	43.38	1.87
PNW West (public)	23.33	0.00
U.S. South	81.46	22.97
U.S. North	10.93	20.98
B.C. Coast	23.60	0.24
Canada Interior	56.60	0.85
Canada East	35.91	4.80
Japan	16.65	2.52
Korea	0.68	0.08
China	33.07	21.02
Taiwan	0.26	0.16
Malaysia East	0.00	24.78
Malaysia West	0.00	10.32
Indonesia	0.35	30.54
Philippines	0.04	3.41
Papua New Guinea	0.05	2.42
Australia	3.47	5.23
New Zealand	5.07	0.04
Rest of Oceania	0.19	0.71

Source: Cardellichio et al. (1989).

Table 2.12. Sawtimber elasticity of supply.

Region/Country	Coniferous		Nonconiferous	
	Stumpage	Delivered Price	Stumpage	Delivered Price
PNW West (private)	0.7	1.5		
PNW West (public)	1.3	2.8		
U.S. South	0.7	1.0	0.5	1.2
U.S. North	0.5	1.4	0.7	1.1
B.C. Coast		3.2		
Canada Interior		1.1		
Canada East		1.5		
Japan		0.9		
Malaysia East			2.2	2.7
Malaysia West			0.9	1.1
Indonesia			0.9	1.0
Philippines			1.2	1.2
Papua New Guinea			1.6	1.7
New Zealand	1.0	2.2		

Source: Cardellichio et al. (1989).

Table 2.13. Product supply elasticities, sawnwood and plywood.

Region/Country	Product Response to Price Change			
	CSAW	NSAW	CPLY	NPLY
PNW West (private)	1.7		2.1	
PNW West (public)	3.0		2.8	
U.S. South	1.0	0.8		
U.S. North	1.7	0.8		
B.C. Coast	1.3			
Canada Interior	1.0			
Canada East	1.5			
Japan	1.0	1.9		0.7
Korea	2.1	2.4		1.2
Taiwan	0.5	0.9		1.9
Malaysia East		1.2		0.6
Malaysia West		1.7		2.0
Indonesia		0.7		0.7
Philippines		1.1		3.3
New Zealand	0.9			

Source: Cardellichio et al. (1989).

Table 2.14. Technological coefficients for log consumption for sawnwood and plywood (m^3 sawlog/m^3 product).

	Product			
Region/Country	CSAW	NSAW	CPLY	NPLY
PNW West (private)	2.12	2.50	1.62	
PNW West (public)	2.66		1.61	
U.S. South	2.82	2.07	2.03	1.00
U.S. North	3.02	1.95	2.03	1.00
B.C. Coast	2.44			
Canada Interior	2.70			
Canada East	2.86			
Japan	1.42	1.42	1.60	1.54
Korea	1.37	1.37		1.47
China	2.00	2.28	2.50	2.50
Taiwan	2.90	2.13		1.89
Malaysia East		1.72		2.00
Malaysia West		1.72		1.82
Indonesia		2.00		1.82
Philippines		1.72		1.82
Papua New Guinea		5.00		2.41
Australia	2.67	2.78	2.27	
New Zealand	2.17	2.00	2.63	
Rest of Oceania	2.10	2.55		2.55

Source: Cardellichio et al. (1989, for 1987).

Table 2.15. Price elasticity of demand.

	Sawnwood		Plywood	
Region/Country	Coniferous	Nonconiferous	Coniferous	Nonconiferous
U.S. West	0.30	0.00	0.50	0.00
U.S. South	0.30	0.50	0.50	0.50
U.S. East	0.30	0.50	0.50	0.50
Canada	0.30	0.50	0.50	0.00
Japan	0.67	2.42	0.00	0.55
Korea	1.51	1.06	0.00	0.85
Taiwan	0.00	0.89	0.00	0.91
Malaysia East	0.00	0.99	0.00	0.00
Malaysia West	0.00	0.55	0.00	0.00
Indonesia	0.00	0.92	0.00	1.50
Philippines	0.00	1.56	0.00	0.00
New Zealand	0.45	0.00	0.00	0.00

Source: Cardellichio et al. (1989).

Table 2.16. Tariff barriers of tropical hardwood importing countries.

Harmonized Code and Description	Australia	New Zealand	Canada	Japan	Korea	Taiwan
4403: Wood in the Rough or Roughly Square						
4403.2 Coniferous	free	no data	free	free	3%	free
4403.31 Other tropical	free	no data	free	free	1.50%	free
4403.91 Nonconiferous	free	no data	free	free	3%	free
4407: Wood Sawn or Chipped Lengthwise (Lumber)						
4407.1 Coniferous	15%	no data	free	free	15%	free
4407.21 Tropical woods	15%	no data	free	free	10%	free
4407.91 Nonconiferous	15%	no data	free	free	20%	free
4408: Veneer Sheets (Plywood)						
4408.1 Coniferous	5%	no data	free	5%	15%	free
4408.2 Tropical woods	5%	no data	free	5%	10%	free
4408.91 Nonconiferous	5%	no data	free	5%	15%	free
4412: Plywood						
4412.1 Nonconiferous	25%	no data	free	15%	20%	7.50%
4412.194 Coniferous	25%	no data	free	15%	20%	15%

Source: NFPA/ITC tariff data base, 1988.

Trade Barriers and Government Trade Policy

A trade barrier is any government law, policy, or practice that restricts trade in a discriminatory manner. Such barriers may include tariffs, quantitative restrictions on imports or exports, licensing requirements, minimum pricing regulations, embargoes, prior deposits, special standards, government procurement, export subsidization, and customs and administrative entry procedures. "Natural" trade barriers such as distance from markets and language differences are not considered restrictive in this sense.

Tariff Barriers. In general, tariff barriers are easy to identify. Tariff schedules and the product classifications they apply to are typically published and readily available. The effect that the tariff has on restricting trade is easy to determine because the level is usually expressed as an ad valorem amount. Table 2.16 lists tariff rates imposed by the tropical hardwood importing countries. There tends to be a higher duty levied on goods that are more processed. For example, Korean tariffs increase from 1.5% for tropical

Table 2.17. Tariff barriers of tropical hardwood exporting countries.

Harmonized Code and Description	Indonesia	Malaysia	New Guinea	Philippines
4403: Wood in the Rough or Roughly Square				
4403.2 Coniferous	15%	20%	no data	10%
4403.31 Other tropical	15%	20%	no data	10%
4403.91 Nonconiferous	15%	20%	no data	10%
4407: Wood Sawn or Chipped Lengthwise (Lumber)				
4407.1 Coniferous	15%	20%	no data	20%
4407.21 Tropical woods	15%	20%	no data	20%
4407.91 Nonconiferous	15%	20%	no data	20%
4408: Veneer Sheets				
4408.1 Coniferous	30%	25%	no data	30%
4408.2 Tropical woods	30%	25%	no data	30%
4408.91 Nonconiferous	30%	25%	no data	30%
4412: Plywood				
4412.1 Nonconiferous	30%	45%	no data	40%
4412.194 Coniferous	30%	45%	no data	40%

Source: NFPA/ITC tariff data base, 1988.

hardwood in the rough to 20% for hardwood plywood. This reveals the discriminatory nature of trade barriers. Table 2.17 shows the tariff barriers of the tropical hardwood exporting countries. These rates apply, of course, to importing the respective product. They do not directly affect the exportation of tropical hardwoods.

Nontariff Barriers. Nontariff barriers are difficult to identify and quantify. In some situations a nontariff barrier may have no effect on one country but severely limit another. The importance of such barriers is that they tend to limit free trade or in some way discriminate against certain foreign agents. A low nominal tariff rate may mask a much higher effective rate. It may also be the case that the effective protection is negative, such as when the trade barrier has the effect of raising the cost of inputs into the production process of any domestic industry.

Import permits are required in Canada; the Australian government requires submission of an intent to import notice; and Taiwan requires import licensing, as does the PRC. Suppliers to the PRC must negotiate a price with the Chinese importer before an application is submitted, allowing for a search for lower prices

and possible cancellation of the license if the Ministry of Foreign Economic Relations and Trade decides the transaction is not in the best interest of the Chinese.

Shipping restrictions also serve as nontariff barriers. In South Korea, shipments must enter through specified ports, and foreign flag carriers have not been allowed to form associations to express their interest in shipping to Korea. In Japan, U.S. companies are not allowed to operate their own trucking services; the Westbound Ocean Shipping Cartel essentially sets the price for ocean freight; ports are closed on Sundays, unlike most shipping ports; and logs may be imported only through certain ports. In Indonesia, at least 45% of all cargo must be carried on vessels under the Indonesian flag. In the PRC, transportation of goods is not allowed by foreign firms. Australia requires that at least 40% of certain government cargo be carried by domestic ships; foreign vessels must be licensed for coastal trade, and such licenses are rarely granted. In Taiwan, foreign lines cannot lease out their own terminals at the port of Kaohsuing; only companies with two-thirds Taiwanese ownership may do so.

In addition to tariffs, Indonesia employs an import charge of 10 to 30%, to protect domestic producers; various other customs barriers promote local development. The PRC has an import regulatory tax, which the Chinese claim is necessary to keep from raising the tariff; there is an unpublished products tax of 3-5% on all wood imported. In Korea, the duty on wood products tends to favor Southeast Asian countries, rebates of tariff charges are given on imported goods when used to manufacture export products, and other quotas or bans are imposed on certain imports. In the Philippines, governmental decisions not to issue an import license may be equivalent to a ban.

Foreign investment in Malaysia has been reduced by restricting foreign equity in local projects. Canadian law limits foreign investment, and exporters may be subsidized by commercial credit guarantees through the Export Development Corporation. The Philippine government also uses export subsidy programs, such as tax and duty exemption for manufacturing equipment and tax credits for domestic equipment. In Taiwan, there is a general lack of legal property protection, such as trademarks, copyrights, and patents.

In Australia, government procurement efforts tend to discriminate against foreign suppliers. Also, the government employs differential pricing to lower posted price levels in order to promote new businesses. Trade agreements between Australia and New Zealand may serve to reduce the competitiveness of other countries in exporting products. In Japan, government procurement often requires that delivery occur at unreasonable times so that foreign suppliers are discouraged. Indonesia subsidizes exporters through rebates and preferential short-term export financing.

The Japanese Agricultural Standards (JAS) do not authorize foreign inspection; codes restrict wood frame construction and many types of wood products, multifamily dwellings cannot be made of wood, and fire-retardant treated wood is not recognized as an acceptable construction material. In the PRC, wood is generally discouraged or prohibited as a building material. In Korea, the Ministry of Construction controls building codes and considers comments on draft standards only from domestic producers; in various ways the government discourages the use of wood in construction. U.S. plywood is not included in Canadian product standards, thus limiting opportunities to export U.S. plywood to Canada.

Unprocessed logs cannot be exported from federal lands in the United States, and individual states are also investigating such restrictions. In Canada, provincial laws prohibit the export of any logs that could be processed by domestic agents; this is commonly handled by first advertising the sale within Canada for a specified period. Peninsular Malaysia has maintained log export controls since the early 1970s, and in 1985 these exports were effectively zero. It is likely that the Malaysian government will soon implement a ban on log exports from East Malaysia. Indonesia has a ban on the export of logs, plywood, and some types of lumber; it also has a strong cartel and controls worldwide markets for hardwood plywood, by employing such practices as dumping, rebates, price controls, and quotas.

Forestry subsidies in Japan tend to artificially depress domestic log prices; also, the government keeps some firms in business even when they are marginal or uncompetitive. Many special laws give the Korean government leeway in establishing domestic market stabilization; it can establish customs surcharges when it feels a particular industry is threatened. Japan, along with other Organization for Economic Cooperation and Development (OECD) countries, offers beneficial treatment to developing countries by giving aid and export credits, thus serving to promote OECD exports to developing countries.

NEW TECHNOLOGICAL DEVELOPMENTS

This section analyzes technological developments influencing the substitution of tropical hardwoods by other species (temperate hardwoods or conifers). The discussion focuses on (1) new developments in forest management, (2) new developments in harvesting and transportation, (3) new developments in product manufacturing, and (4) new products.

New Developments in Forest Management

When large areas of natural or secondary forests are readily accessible for exploitation through some form of economic selection (high grading), the technology of intensive forest cultivation is not necessary. The forest may be gradually degraded over time, but the impact is often not noticeable.

Where there is a large demand for wood for a particular use, such as fuel or pulpwood, selective harvesting of natural forests is rarely an appropriate management technology. Even-aged, single-species plantations have proved to be much more productive forests. Sometimes native species are used in these plantations (such as teak in the forest villages of Thailand), but often exotic species are selected (*Gmelina* in Brazil and *Leucaena* in the Philippines are examples).

Forest management involves such a long growing cycle that human activities must be harmonized with it as much as possible. Forest management requires control over land use, stable land tenure systems, control over grazing, control over threats such as fire, disease, and insects, and control over the use of the forest products by local people. Such long-term commitments on the part of people living near the forest call for successful community-level institution building, as well as substantial capital investments.

The countries that can attract capital and forest industry are those that have the potential for substantial production of industrial wood. Among these are the countries of the humid tropics. They are countries that typically do not practice intensive forest management on a sustained-yield basis. Their laws generally prescribe archaic and relatively unproductive forest management systems under the guise of forest conservation. Too frequently these prescriptions restrict the opportunities to utilize high-yield forest management technology and lead instead to economic high grading. Custodial governments and potential domestic partners in a joint venture commonly engage in very short-term planning. The tendency is for tropical countries to utilize exploitation concessions rather than management concessions. It is much easier for forest product firms, especially foreign concessionaires, to confine their activities to manufacturing and marketing and to leave forest management to the local governments.

Intensive silviculture and forest management essential to the practice of high yield forestry requires a long-term commitment from the local government and the forest product firms. This effort to develop tree improvement, regeneration, site enhancement, and stand improvement methods for the tropical hardwood forests is essential if tropical hardwoods are to compete, not only with hardwoods and conifers of the temperate zones but also with nonwood-based products such as cement, brick, steel, and glass. Unless this effort is made, the economic margin of utilizing the tropical hardwood resource will move to render this resource noncompetitive or nonproductive for extended periods (as happened in the Philippines). Fortunately, some success stories are beginning to occur, such as eucalyptus production in Brazil. (Though eucalyptus is not a product of the humid tropics, it is a tropical hardwood).

New Developments in Harvesting and Transportation

The felling and bucking operation in tropical forests can be performed using hand tools typical of temperate forestry operations. Yarding can be accomplished with animals such as elephants and water buffalo or with tractors or high-lead cable systems. Most of the sophisticated logging systems of the temperate regions have been used some place in tropical forestry. Many are highly capital intensive and energy consumptive. In countries where labor is plentiful and inexpensive relative to capital or energy, the less elaborate animal systems may be better choices. Where unfavorable topography or special environmental problems are critical, systems that are capital and energy intensive may be justified.

One area of concern in yarding is potential damage to the residual stand in selective harvesting. Another is that the type of tropical timber harvested, and thus the volume harvested per unit of land, are generally a function of the market demand for light tropical timbers. Light timbers have physical properties that contribute to relative ease in manufacture (machineability or conversion to specific product form), compared

with heavier, dense tropical timbers, and are also relatively cheaper to transport. Consequently, their cost per unit volume is much less. Of course, species that command a significantly higher price in the marketplace will be utilized whatever the physical properties of the wood. Rosewood and ebony are two prime examples. Timber selection for use is species oriented, sometimes on the basis of traditional use but more often because of availability, size, cost, and performance.

Much has been written about the diversity of the tropical hardwood forests. From a harvesting point of view, if only X% of the standing volume is harvested, that X% has to bear all the costs of harvesting, road construction, and transportation. This is true of both temperate and tropical hardwood forests. The higher X%, the lower the per unit production costs and the more competitive the material produced will be. Unfortunately, only a small percentage of the tropical hardwood forests are harvested (generally no higher than 30% of standing volume). This places tropical hardwoods in a less competitive situation compared with the less diverse temperate forests, especially when these temperate forests are managed to produce more uniform and marketable products.

Many tropical hardwood species for which demand is great are susceptible to insect attack and decay. This problem can become severe if a lag exists between the time of harvest, transport, and milling. Decay and insect attack can significantly lower the value of the harvested log and can seriously reduce the yield and value of finished products. This can also be a factor in pulpwood production if the cellulose component of the wood is degraded by fungal attack. It was reported that incomplete utilization during harvest, decay, and insect damage may cause up to a 30% loss, while the cutting and transport operations may cause another 35% loss.

Harvesting and transportation advances have been great in the temperate forests over the last four or five decades. Similar developments, specifically geared and adapted to the tropical hardwood forest situation, are urgently needed to keep tropical hardwoods competitive in world product markets. Much more of the standing volume should be harvested and less of the remaining stands should be damaged by harvesting or burned by swidden agriculture.

New Developments in Product Manufacturing

It is an apparent anomaly of the tropical timber trade that extracting and exporting logs almost invariably proves more profitable—in return per unit of investment—than preparing and exporting processed timber. Given the high bulk-to-value ratio and the substantial weight loss on conversion, one would expect, other things being equal, the converse to be the case. But other things are not equal. The product conversion facilities in tropical countries rarely represent an integrated utilization system. Facilities for profitably converting defective logs, low grade lumber, veneer and plywood, residues, and associated minor species are rarely available. Manufacturing facilities in temperate countries are often more efficient, producing higher yields than comparable facilities in the tropical countries. These deficiencies can, of course, be corrected and the inherent advantage of converting a bulky material at source can be captured.

Conversion of the timber resource into a product is generally accomplished by one (or more) of three production groups: sawmills, wood-based panel mills, and pulp and paper operations. The output of sawmills includes squares, cants, railway ties, and lumber. Wood-based panel mills produce such products as veneer, plywood, particleboard, and fiberboard. Pulp and paper operations produce wood pulp using mechanical or chemical processes and, more important, paper as the end product.

The principal products manufactured from tropical hardwoods are lumber, veneer, plywood, and, occasionally, particleboard. The greatest volume of timber exported from tropical countries is used in building construction or furniture manufacture.

Where lumber and timber are to be used under conditions of high stress, the preferred woods are conifers, predominantly produced in temperate regions. This is true even when the use is in the tropics. Tropical hardwood lumber tends to be used in low stress applications, such as for furniture, paneling, ceilings, and flooring. These are uses for which appearance and decorative properties are prized. When lumber and timber of this sort are produced in a tropical setting, the yield is likely to be very low unless there is an associated manufacturing process relatively indiscriminate with respect to species and wood quality. This implies such uses as fuel to provide co-generation of the energy required to operate the sawmill, and the manufacture of particleboard, fiberboard, or pulp. All of these installations tend to be capital demanding and

capital intensive. A challenge to wood utilization in the tropics is to learn how to engage in these similar conversion operations with reduced capital requirements.

In the manufacture of veneer and plywood the problem of increasing the utilization efficiency of a tropical forest system is even more difficult than for lumber. In terms of species and log quality, the fraction of the standing forest biomass that is convertible to veneer is much smaller. There are advantages to combining veneer and lumber manufacture to improve total yield from the forest, but there is still the need to provide for the component that is indiscriminate with respect to species and log quality.

It is difficult to analyze mill and production capacity statistics in individual countries or groups because of continual changes in the mix and modernization of mills not apparent in the data. There are allegations that recovery of end products from logs is inefficient in the tropics. But even in the United States and Canada, recovery of primary lumber product from sawlogs is 33 to 40% of the cubic volume of the logs, the rest being sawdust, bark, and chippable edgings and slabs obtained in converting round logs into rectangular boards. In sawmilling, recovery is dependent on the sawing technology (e.g., thick or thin saw blades), management practices for quality control, the skill of the sawyers, log taper and sweep, the amount of rot and other defects in logs, and markets for various sizes and qualities of lumber. Thus some loss of the gross log volume is unavoidable, especially in the highly defective logs sometimes common in natural forest timber.

Other residues, such as bark, sawdust, and chippables (slabs, edgings, and trimmings), are often termed waste, implying that the industry somehow is doing a poor job of conversion. In fact, in the United States most of this material is used. Chippable residue and sawdust are used as furnish in pulp and paper plants, particleboard plants, and for many other uses. And most bark and other residues are used as fuel to power the facility. In some cases, they produce sufficient excess power to provide energy to local communities. In the tropics, many of the board product plants and pulp mills were developed to take advantage of the readily available residues from sawmills and veneer plants. In other areas, such residue mills usually have not yet been built and the residues may be sold as export chips or go unused. The development of fully integrated systems that can use all parts of a log takes time and capital.

Tropical hardwood conversion operations are rarely integrated utilization systems that permit full use of the roundwood. A fully integrated system will have, in addition to conversion units designed to produce high valued structural products, at least one component relatively indiscriminate with respect to species, size, and grade. Such a unit will make use of otherwise nonutilizable residues. It can be an installation that uses wood for fuel to produce heat or electricity or it can be an installation for the production of chip or fiber products. The availability of such an integrated complex in a developed country may justify shipping roundwood to that country rather than partly processing the raw material in the less developed tropical country.

The opportunity to engage in co-generation of energy is one that is likely to be increasingly attractive to tropical countries with substantial forest resources but limited or no resources of fossil fuels. The manufacture of lumber, veneer and plywood, and particleboard develops residues that, when used as fuel, are more than capable of providing for the energy requirements of the product manufacturing plant. These product conversion operations can produce a surplus of energy that may then be sold either as heat or electricity to provide an additional product of the industrial complex. To accomplish this objective imposes restrictions on the character, size, and location of the manufacturing plant. For example, a power plant designed to co-generate would have to be part of a mill that was at least medium size for lumber, veneer, or particleboard manufacture if it was to have access to enough fuel to operate efficiently.

If structural products are to be produced for export, they must comply with grades and specifications recognized and accepted in international markets. Lumber from tropical tree species is bought and sold in world markets in accordance with standard lumber grading rules. These rules provide for either "shop" grades or "yard" grades, to use U.S. terminology. Comparable FAO terms are "cutting" system and "defect" system. Yard grades (defect system) define boards according to specified minimum defects when the assumption is that the lumber is to be used in board or timber form. Shop or factory grades (cutting system) define boards in terms of the number and sizes of clear and/or sound cuttings they yield. The National Hardwood Lumber Association (NHLA) promulgates U.S. hardwood lumber grades, and these are used to grade much of the tropical hardwood lumber sold in international markets. The NHLA grades are widely used in marketing tropical hardwood lumber from South and Central America. These are shop or factory grades and are particularly applicable where lumber is remanufactured into dimension stock. In Southeast Asia, the Malayan

Grading Rules (MGR) are commonly used as a basis for marketing hardwood lumber in world markets. These rules are also shop or factory grades and are very similar to the NHLA rules.

Fiber product plants have the potential of serving as mills that are relatively indiscriminate with respect to species and wood quality. They are, however, high in capital requirements and low in manpower requirements, and this often makes them unattractive to less developed countries of the tropics. While fiber product mills are low in total requirements for labor per unit of roundwood processed, they are very high in their requirements for technically qualified manpower. Furthermore, some pulping processes are not adaptable to hardwoods. An example is groundwood pulping. Thus the tropical hardwood resource, because of its location and characteristics, appears to have an inherent comparative disadvantage for fiber product manufacturing.

In short, there are many technological improvements that can easily be made in the processes that convert tropical hardwoods to consumer products. Many of these have already been made in the processing of temperate hardwoods. Some of these improvements have to do with quality control, higher utilization standards, and product mix decisions; others with waste utilization and co-generation. As tropical hardwoods become relatively scarce and as raw material quality changes (to smaller dimensions and second or third forest harvests in anticipation of raw material production from managed forests), the prices will go up and make them less competitive to both temperate hardwoods and softwoods as well. Only for those tropical hardwoods for which there are no good substitutes (teak, ebony, rosewood, etc.), those that are at the high value end of the price spectrum, will the price elasticity be low and substitution minimal.

New Products

Several new products have been developed that can utilize smaller wood dimensions formerly discarded, waste, and formerly noncommercial species. As a group, those suitable for tropical hardwoods are in the composite panel category. Specifically, oriented strandboard and waferboard are ideally suited to the diverse and heterogeneous tropical hardwood resource situation. On the negative side, manufacturing plants tend to be more capital intensive than even plywood plants, and demand higher labor skills. On the positive side, demand forecasts are optimistic and consumption is rapidly increasing (albeit sometimes at the expense of other panel products such as plywood).

Chapter 3. INFORMATION AVAILABILITY AND NEEDS

This review has, of necessity, relied heavily on published sources and computerized data files. Much of this information was developed by FAO and is derived from the sources cited in the bibliography. In addition, the CINTRAFOR data base system, INTRADATA, assisted in the processing of the FAO Forest Products data base to derive the individual country and regional summations. Data and information were also utilized from a wide variety of other sources.

Key projections of production, trade, and consumption were derived from the CINTRAFOR Pacific Rim Assessment Study (Cardellichio et al. 1989). This major project updated the IIASA data base used for the Global Trade Model. That model has been extensively amended and modified by CINTRAFOR, and the resulting CINTRAFOR-GTM (CGTM) was used to produce initial base projections for solid wood products. The data base was updated from original source data from each country, verified whenever possible, and cross-referenced to other sources. The base year for this updated data base was 1985. Hence data derived from the CGTM are potentially different from any derived from FAO sources.

Projections used and reported derive from both FAO and CGTM. The CGTM projections are based on a comprehensive econometric model for the Pacific Rim, but reflect the basic economic parameters chosen for the base-case analysis. The details of these parameters are reported in Cardellichio et al. (1989) and are not discussed in detail here.

Several issues have arisen in the course of this study and are summarized here.

FOREST RESOURCE BASE INFORMATION

This review utilizes the FAO 1980 forest land information (FAO 1985a). This source is cited by almost all reports and analyses of forest production, trade, and consumption. The related inventory information is likewise cited as the authorative source. This study suffers from the lack of adequate information about *trends* in both forest land areas and cover type, but a more fundamental weakness is the lack of comprehensive information on inventory balance, growth in comparison with current levels of yield, and the related issues of sustainability of yields. To a limited extent, these issues were researched in the development of the CGTM, but the underlying forest productivity statistics, and related harvest scheduling alternatives, are poor. Hence projections of production, trade, and consumption rest on a questionable basis regarding the sustainability of forests in the future.

Related information on plantations, and the relation to loss of forest lands and renewal, is also weak. One-time estimates as included in FAO reports (FAO 1985a) were supplemented by other available data. Changes in the scope of plantations, species planted, growth rates, and related issues all affect both the level and composition of future timber production.

A particular weakness with respect to forest data is the composition of ownership and tenure rights, and the relation to *economic* forces dictating use. The diversion of forest lands to other competing uses, deforestation for settlement purposes, and other nontimber considerations have had a major impact on forest productivity and sustainability (Bethel et al. 1982).

STATISTICAL DATA

This review relied heavily on the FAO forest products data tapes for production, import, and export data. While this data base is extensive and the most consistent available, there were some difficulties encountered:

1. Up-to-date information on afforestation, deforestation, and plantations by country should be sought and incorporated in the overall reporting by FAO as part of the Forest Products Yearbook or via a related publication with parallel structure to permit cross-reference.

2. The forest products data tapes could be made more useful if organized into regional aggregations like those in the published Forest Products Yearbook.

3. More complete direction-of-trade tables incorporating all major trade flows, for both importing and exporting countries, would greatly facilitate analysis such as that conducted in this study. While it was under-

stood that more complete data were available through the U.N. trade data tapes (external trade statistics), the limitations of time and cost prevented their use in the present analysis.

4. The aggregation of plywood production statistics into a single category limits the usefulness of the FAO forest products data for the analysis of hardwood and softwood trends and issues related to substitution. Inferences based on geographic location of production are increasingly questionable given the movement of wood from point of origin. Separate categories of production and trade are essential for a more complete and accurate understanding of panel products as a whole.

5. Statistics on import and export volumes frequently diverge, sometimes by significant amounts. It would be expected that global totals would roughly agree. This is not the case, with more frequent occurrence of differences for the "minor" categories (fuelwood, chips and particles, pulpwood, etc.). Perhaps the results are not significant in terms of total trade, but such distortions can bias the understanding of trends and developments for these products.

6. Although not directly addressed in this study, problems of product measurement and conversion are critical. The data are expressed in cubic meters, but undoubtedly many of the sources provided data in other units, some of them often misunderstood. A related issues is the use of product classifications. The movement to the international harmonized coding system will hopefully reduce problems of classification. Some differences between import and export statistics, for example, are undoubtedly traceable to such classification differences between countries.

REGIONAL/COUNTRY AGGREGATION

In general, the availability of data by country allows for the aggregation into meaningful regions or subregions. In this analysis, country data were grouped as reported in Chapter 1. As noted, organization of the FAO forest products data tapes to correspond to country and region groupings would be helpful.

Major issues of geographic aggregation arose in both the definition of the scope of the study and the ability to incorporate existing data. The exclusion of the USSR was based on the judgment that the European aspects of Soviet forestry and forest products would unduly complicate the view of the Pacific Rim. The ability to create subregions *within* countries would be extremely valuable, for the USSR as well as for the United States and Canada. This study is perhaps biased in terms of the role of North America, since the total national statistics are used. These countries were retained as part of the Pacific Rim definition, however, on the basis that a significant proportion of trade is with Pacific Rim countries. The bias of intra-North American trade between Canada and the United States, however, remains.

A related issue of FAO's treatment of the PRC and Taiwan as one entity for statistical purposes is critical, and seriously limits the analysis. Production and trade patterns are substantially different, as are the processing industries and consumption. Although China was originally included in the definition of Pacific Rim countries for this study, the lack of time and data prevented development of a sufficient data base to separate the two components. The development of "subregion" data for China to incorporate Taiwan and the PRC individually could be done along the lines of an east-west division of U.S. and Canadian data, or European-Far East USSR data.

SPECIES/PRODUCT AGGREGATION

The inability to separate hardwood and softwood plywood and panel products was the most troublesome aspect of product/species identification. Yet product and species detail will undoubtedly become more significant as special market niches are sought by individual countries or subregions. This issue was addressed by Schreuder et al. (1989) with reference to market niches for Pacific Island nations seeking to penetrate markets of North America, the Indian subcontinent, and the Middle East. Differences in wood properties between natural forests and plantations, species differences (particularly for hardwoods), and related issues will affect compatability of new species to substitute for "traditional" woods, or to create possible comparative advantages.

ECONOMIC/DEMOGRAPHIC DATA

In the course of this study, it was not feasible to do any original modeling of production or trade. Macroeconomic data on consumption and demand were therefore not examined in detail. The available cost data are weak, preventing detailed examination of base production possibilities in many countries. Data on transportation costs are likewise weak or unavailable.

Price information is sketchy at best. Reported statistics are often lacking in documentation, or are highly aggregated by product, location, or species. Averages are frequently reported without indication of the basis for weighting (if any). Further, information on point of measurement is often missing, and it is not possible to determine if reported prices are producer realized price, mill price, FOB, CIF, or other points. Comparisons are also complicated by variable units of measurement and reporting. Items such as trade discounts, handling, and surcharges are seldom reported.

Reliable information on "delivered" costs, including all purchase, transportation, handling, and tax/surcharges, would be invaluable in studies of competitive advantage and market alternatives. No known reliable measure exists on a comprehensive international basis to assess such "final" wood cost to the actual producer.

Information on elasticities is limited and often of questionable value. Own-price elasticity is the most frequent measure explicitly reported. Cross-elasticities with respect to competing materials, including the hardwood-softwood and tropical-temporate hardwood substitution potential, are missing.

Finally, information on exchange rates, currency convertability, and terms of trade (letters of credit, interest charges, payment terms, inspection charges, etc.) is extremely difficult to document and evaluate relative to actual trade transactions. Annual or monthly exchange rates are generally available, although such averages are deceptive as to actual rates influencing current trade. Currency choice for settlement of accounts can greatly influence recorded price. Other aspects of trade transactions and financial arrangements are largely undocumented in standard data sources.

TRADE BARRIER INFORMATION

The most comprehensive information on trade barriers is that compiled and reported by Bourke (1988a,b, 1989). The treatment of nontariff barriers is relatively weak and difficult to document if not define.

Issues related to emerging environmental concerns and policies are widely recognized but poorly understood in terms of data indicating implications for timber production. Land use restrictions, export or import taxes, and tariffs related to tropical forest utilization are growing in importance, with a particular emphasis on tropical ("rain forest") timber and products. It was not possible to fully document or evaluate such emerging barriers in this analysis.

CHAPTER 4. OUTLOOK AND PROJECTIONS

Since no original effort was undertaken to forecast future trends for hardwood products in the Asian-Pacific region, this section summarizes information from two independent sets of projections available in the published forest products literature. These projections are reviewed briefly here without verifying or otherwise endorsing the trends or specific conclusions reached by the original authors. The intent is to bracket the range of projected trends as contained in these independent analyses.

FAO PROJECTIONS

In 1988 the United Nations (FAO 1988) published outlook projections for major forest products to the year 2000, including consumption figures for most forest products and production estimates for selected commodities. Historical data for 1975 are displayed together with forecasts for 1986, 1990, 1995, and 2000. In the FAO review the People's Republic of China and the Republic of China (Taiwan) are treated as a single country.

Since the projections do not, unfortunately, distinguish between hardwood and softwood products, for either production or consumption, the information below is of a general nature and inferences for hardwood products can only be conjectural.

The projections for total roundwood consumption, including both industrial and fuelwood (hardwood and softwood), are shown in Table 4.1. Total roundwood consumption is projected as increasing to over 2 billion cubic meters in 2000, from 1.6 billion in 1987. Consumption by the Asian Importer subregion was projected to increase from 659 million cubic meters to almost 836 million; in the Asian Exporter subregion, from 231 million to over 297 million. Thus total consumption in the tropical Asian subregions was projected to increase by 27%.

As noted, Table 4.1 includes all roundwood consumption, both hardwood and softwood, used for both industrial and nonindustrial purposes. The major nonindustrial use is for fuelwood (heating and cooking), a practice still common in much of the tropical developing regions of the world. Very little fuelwood enters into trade. Table 4.2 summarizes the FAO projections for industrial roundwood consumption, which excludes fuelwood.

The consumption of industrial roundwood is projected to increase in the Pacific Rim from 848 million cubic meters to over 1.1 billion, an increase of 30%. Comparing Tables 4.1 and 4.2 indicates that for the Pacific Rim region only 54% of total roundwood consumption in 2000 is projected to be industrial roundwood. For 1986, this ratio was 52%.

Industrial roundwood consumption represents the following share of consumption for the year 2000 as projected by FAO: North America, 84.7%; Central and South America, 34.4%; Asian Exporters, 25.6%; Asian Importers, 38.1%; and Oceania, 69.3%.

For the tropical Asian hardwood producer countries in both subregions, sawnwood and veneers/panels are the most important and traded products. Table 4.3 summarizes the FAO projections for the production of sawnwood and sleepers in the Pacific Rim. Total Pacific Rim production of sawnwood is projected as increasing from 280 million cubic meters in 1986 to over 341 million in 2000, an increase of 61.6 million (22%). For the Asian Exporter subregion, production was projected to increase from 14 million to over 24 million, or 74.4%. Major increases were projected for Malaysia, Indonesia, and the Philippines.

Sawnwood production in the Asian Importer subregion was projected by FAO as increasing from 104 million to 128 million cubic meters (22.3%). Significant increases were projected for China, India, and Japan. Projected production changes for other subregions were: North America, 16.8%; Central and South America, 23.5%; and Oceania, 22.1%.

Thus the major hardwood sawnwood producers of the Asian Exporter subregion are expected to sustain the greatest increases in the Pacific Rim, depending, of course, on the trends in total harvest, the drain for fuelwood, and competition.

The projections for wood-based panels (primarily plywood) are summarized in Table 4.4. Total production for the Pacific Rim is projected to increase from 66.3 million cubic meters to over 112.3 million, or 31.8%. For the Asian subregions, the total projected increase is 23.3 million cubic meters, or 104.4%. For the Asian

Table 4.1 Roundwood consumption projections, 1986-2000 (1,000 cubic meters).

Country/Region	1986	1990	1995	2000	1984-90	1990-95	1995-2000
Canada	180,691	180,011	200,494	223,146	1.9%	2.2%	2.2%
United States	466,943	461,021	502,955	548,069	1.3%	1.8%	1.7%
North America	647,634	641,032	703,449	771,215			
Chile	15,200	15,296	16,905	18,628	1.9%	2.0%	2.0%
Colombia	17,522	18,553	19,944	21,230	1.5%	1.5%	1.5%
Ecuador	8,687	9,137	9,983	10,835	1.8%	1.8%	1.7%
Mexico	21,241	22,711	24,729	26,641	1.7%	1.7%	1.5%
Peru	7,735	8,712	9,592	10,471	2.0%	1.9%	1.8%
Central-South America	70,385	74,409	81,153	87,805			
Burma	18,949	20,175	21,864	23,558	1.7%	1.6%	1.5%
Indonesia	157,365	166,561	182,274	198,287	1.7%	1.8%	1.7%
Malaysia	19,249	23,591	27,038	30,805	2.2%	2.8%	2.6%
Philippines	35,324	37,559	41,109	44,609	1.6%	1.8%	1.6%
Asia (Exporters)	230,887	247,886	272,285	297,259			
China	280,650	299,457	331,113	366,554	1.9%	2.0%	2.1%
Hong Kong	818	895	958	1,064	1.0%	1.4%	2.1%
India	250,267	265,814	287,844	309,659	1.6%	1.6%	1.5%
Japan	74,053	80,272	87,102	94,583	1.3%	1.6%	1.7%
South Korea	16,008	16,678	18,515	20,416	1.9%	2.1%	2.0%
Singapore	90	351	403	464	2.5%	2.8%	2.8%
Thailand	36,904	37,913	40,374	42,818	1.1%	1.3%	1.2%
Asia (Importers)	658,790	701,380	766,309	835,558			
Australia	13,412	13,085	14,194	15,405	1.5%	1.6%	1.7%
Fiji	245	228	243	258	1.0%	1.2%	1.2%
New Zealand	8,347	8,777	9,765	10,865	0.8%	2.2%	2.2%
Papua New Guinea	6,223	7,076	7,809	8,574	2.1%	2.0%	1.9%
Solomon Islands	287	347	404	464	3.4%	3.1%	2.8%
Oceania	28,514	29,513	32,415	35,566			
Total Pacific Rim	1,636,210	1,694,220	1,855,611	2,027,403			

Exporter subregion, production is projected to increase from 7.9 million to 13.4 million. Indonesia should have the largest absolute increase, with major gains in Malaysia and the Philippines.

Wood panel production by the Asian Importer subregion is projected as increasing from 14.5 million cubic meters to 32.3 million, a gain of 17.8 million or 122.8%. Major gains in China, Japan, Korea, and Singapore were anticipated, perhaps not fully reflecting the subsequent curtailment of log exports from Indonesia.

CINTRAFOR PACIFIC RIM ASSESSMENT

Recent econometric projections for timber production and solid wood trade in the Pacific Rim have been published by the Center for International Trade in Forest Products (Cardellichio et al. 1989). These projections also extend to the year 2000, and utilize the CINTRAFOR Global Trade Model (CGTM), a substantially revised and enhanced model based on the IIASA Global Trade Model.

Projections of production, consumption, exports, imports, and bilateral trade flows from the CINTRAFOR Pacific Rim Assessment (PRA) were made for hardwood saw/veneer logs, hardwood pulpwood, hardwood sawnwood, hardwood plywood, and the production of reconstituted panels. The definition of subregions of

Table 4.2 Industrial roundwood consumption projections, 1986-2000 (1,000 cubic meters).

Country/Region	1986	1990	1995	2000	1984-90	1990-95	1995-2000
Canada	174,451	173,525	193,756	216,194	1.9%	2.2%	2.2%
United States	364,991	355,437	394,460	436,976	1.5%	2.1%	2.0%
North America	539,442	528,962	588,216	653,170			
Chile	9,029	8,980	10,380	11,998	2.6%	2.9%	2.9%
Colombia	2,673	3,041	3,499	4,024	2.1%	2.8%	2.8%
Ecuador	2,449	2,430	2,572	2,712	0.9%	1.1%	1.1%
Mexico	7,062	7,679	8,764	10,001	1.6%	2.6%	2.6%
Peru	1,210	1,297	1,398	1,507	1.1%	1.5%	1.5%
Central-South America	22,423	23,427	26,613	30,242			
Burma	2,793	2,968	3,235	3,515	1.9%	1.7%	1.7%
Indonesia	27,984	29,983	35,778	42,615	2.4%	3.5%	3.5%
Malaysia	11,256	15,210	18,188	21,733	2.5%	3.6%	3.6%
Philippines	5,329	5,977	7,075	8,353	1.2%	3.4%	3.3%
Asia (Exporters)	47,362	54,138	64,276	76,216			
China	106,521	120,785	143,000	169,182	3.2%	3.4%	3.4%
Hong Kong	503	606	691	787	2.1%	2.6%	2.6%
India	23,976	25,933	29,493	33,542	2.1%	2.6%	2.6%
Japan	72,989	79,410	86,221	93,683	1.3%	1.6%	1.7%
South Korea	9,830	10,036	11,742	13,748	2.5%	3.1%	3.2%
Singapore	97	339	393	455	2.6%	2.9%	2.9%
Thailand	4,626	4,990	5,772	6,672	1.9%	2.9%	2.9%
Asia (Importers)	218,542	242,099	277,312	318,069			
Australia	10,532	10,352	11,389	12,540	1.7%	1.9%	1.9%
Fiji	208	194	207	221	0.9%	1.3%	1.3%
New Zealand	8,297	8,726	9,716	10,818	0.8%	2.1%	2.1%
Papua New Guinea	690	797	870	946	2.0%	1.7%	1.7%
Solomon Islands	77	87	103	121	2.7%	3.4%	3.3%
Oceania	19,804	20,156	22,285	24,646			
Total Pacific Rim	847,573	868,782	978,702	1,102,343			

the Pacific Rim used is different from that of the current study. The Asian subregion used in the PRA also included the Middle East. China was combined with North Korea and Mongolia; Taiwan with Hong Kong and Macao; Singapore with West Malaysia; and Brunei with East Malaysia (Sabah and Sarawak). India is essentially the Indian subcontinent, including India, Bangladesh, Bhutan, Nepal, Pakistan, and Sri Lanka.

Results from the CINTRAFOR PRA for hardwoods are shown graphically in Figures 4.1-4.7.

Data for world output of nonconiferous (hardwood) products are shown in Figure 4.1. Growth rates tend to be much more rapid than for coniferous products. Nonconiferous sawnwood output increases 1.7%/yr between 1987 and 2000 (compared with 0.6% for coniferous sawnwood). Nonconiferous veneer and plywood register increases of 1.0%/yr (compared with 0.4% for coniferous). In spite of the smaller output base (1987 world production of nonconiferous sawnwood is only 126.1 million cubic meters compared with coniferous production of 335.3 million), much faster growth rates in the nonconiferous sector imply that the absolute increase in output volumes will be greater for nonconiferous solid wood products. For sawnwood, nonconiferous output increases 30 million cubic meters, far exceeding the 25 million cubic meter gain in coniferous output.

Table 4.3 Sawnwood and sleeper production projections, 1986-2000 (1,000 cubic meters).

Country/Region	1986	1990	1995	2000	1984-90	1990-95	1995-2000
Canada	53,210	52,619	59,030	66,186	1.8%	2.3%	2.3%
United States	95,330	90,172	98,389	107,299	1.1%	1.8%	1.7%
North America	148,540	142,791	157,419	173,485			
Chile	2,287	2,110	2,431	2,799	2.4%	2.9%	2.9%
Colombia	721	798	902	1,020	1.7%	2.5%	2.5%
Ecuador	1,258	1,205	1,264	1,324	0.6%	1.0%	0.9%
Mexico	2,141	2,133	2,427	2,760	1.4%	2.6%	2.6%
Peru	535	575	622	673	1.0%	1.6%	1.6%
Central-South America	6,942	6,821	7,646	8,576			
Burma	483	599	650	705	1.8%	1.7%	1.6%
Indonesia	7,057	7,623	8,948	10,499	2.0%	3.3%	3.2%
Malaysia	5,491	7,345	9,195	11,505	3.1%	4.6%	4.6%
Philippines	978	1,206	1,443	1,725	1.1%	3.7%	3.6%
Asia (Exporters)	14,009	16,773	20,236	24,434			
China	53,210	52,619	59,030	66,186	1.8%	2.3%	2.3%
Hong Kong	248	307	357	415	2.3%	3.1%	3.1%
India	17,460	17,309	19,290	21,486	1.6%	2.2%	2.2%
Japan	28,762	30,393	31,674	32,991	0.4%	0.8%	0.8%
South Korea	3,563	3,636	4,180	4,802	2.1%	2.8%	2.8%
Singapore	206	255	301	355	2.9%	3.4%	3.4%
Thailand	1,027	1,106	1,307	1,543	2.1%	3.4%	3.4%
Asia (Importers)	104,476	105,625	116,139	127,778			
Australia	3,194	3,401	3,678	3,976	1.3%	1.6%	1.6%
Fiji	88	86	91	96	0.7%	1.2%	1.2%
New Zealand	2,412	2,316	2,569	2,848	0.4%	2.1%	2.1%
Papua New Guinea	117	136	147	160	1.9%	1.7%	1.6%
Solomon Islands	17	24	29	36	3.5%	4.4%	4.4%
Oceania	5,828	5,963	6,514	7,116			
Total Pacific Rim	279,795	277,973	307,954	341,389			

It follows that the output of nonconiferous sawlogs will increase more rapidly than that of coniferous sawlogs. Nonconiferous output is projected to rise at 1.4%/yr, implying that the harvest will increase from 306 million cubic meters in 1987 to 368 million in 2000.

As with coniferous markets, the most rapid growth is projected for the pulpwood sector. The PRA forecast shows nonconiferous pulpwood production increasing 3.5%/yr. This rate far exceeds that of coniferous pulpwood (2.0%) as the mix of pulp processes adjusts to utilize more lower-cost hardwood furnish. Since the share of residues in the nonconiferous furnish is fairly small, 89 million cubic meters of the 95 million increase must be provided in roundwood form.

Projections for hardwood sawlogs are displayed in Figure 4.2. With the exception of Australia, production of hardwood sawlogs is projected to increase or remain stable. The major increase would be for the United States, with major gains in both the South and North. Production in West Malaysia will be constant, with only small gains in East Malaysia and Papua New Guinea.

Table 4.4 Wood-based panel production projections, 1986-2000 (1,000 cubic meters).

Country/Region	1986	1990	1995	2000	1984-90	1990-95	1995-2000
Canada	6,209	6,659	8,086	9,792	3.4%	4.0%	3.9%
United States	34,908	35,957	43,390	52,212	2.9%	3.8%	3.8%
North America	41,117	42,616	51,476	62,004			
Chile	239	229	289	364	4.4%	4.8%	4.7%
Colombia	113	145	187	240	4.0%	5.2%	5.1%
Ecuador	171	191	220	254	2.6%	3.0%	2.9%
Mexico	844	929	1,209	1,569	3.4%	5.4%	5.4%
Peru	42	50	60	71	2.8%	3.5%	3.5%
Central-South America	1,409	1,544	1,965	2,498			
Burma	15	21	26	33	5.5%	4.7%	4.6%
Indonesia	5,751	4,862	6,314	8,176	3.7%	5.4%	5.3%
Malaysia	1,529	1,959	2,798	3,984	5.3%	7.4%	7.3%
Philippines	562	677	904	1,204	2.3%	6.0%	5.9%
Asia (Exporters)	7,857	7,519	10,042	13,397			
China	3,109	4,091	5,603	7,652	6.4%	6.5%	6.4%
Hong Kong	12	16	22	29	5.0%	6.0%	6.0%
India	442	525	659	825	3.9%	4.7%	4.6%
Japan	8,950	11,077	13,882	17,348	3.6%	4.6%	4.6%
South Korea	1,183	1,978	2,873	4,161	6.2%	7.7%	7.7%
Singapore	489	774	1,094	1,540	6.6%	7.1%	7.1%
Thailand	313	377	528	737	4.8%	7.0%	6.9%
Asia (Importers)	14,498	18,838	24,661	32,292			
Australia	923	1,035	1,229	1,455	3.2%	3.5%	3.4%
Fiji	9	13	15	18	2.6%	3.3%	3.3%
New Zealand	407	397	474	564	1.4%	3.6%	3.6%
Papua New Guinea	19	27	34	43	5.9%	4.8%	4.7%
Solomon Islands	17	24	29	36	3.5%	4.4%	4.4%
Oceania	1,375	1,496	1,781	2,116			
Total Pacific Rim	66,256	72,013	89,925	112,307			

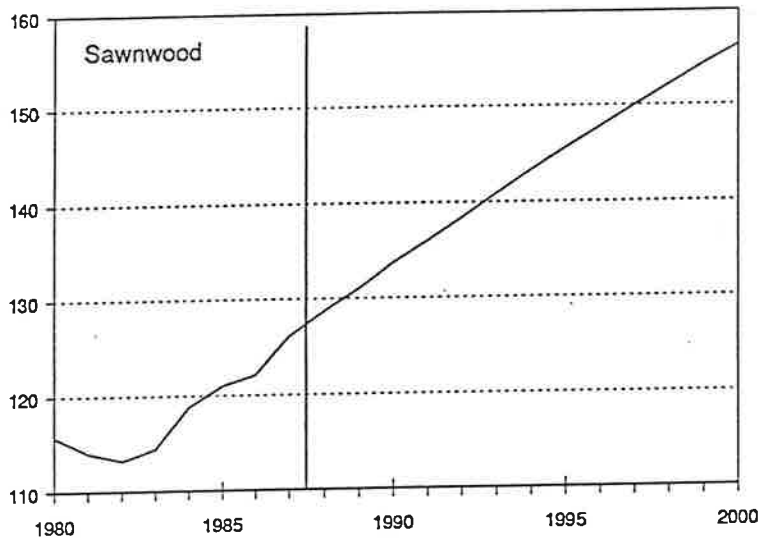
Projected exports of hardwood logs are shown in Figure 4.3. East Malaysia remains the major exporter, with slight increases in Papua New Guinea exports. Japan is projected as the major importer, with 14 million cubic meters sustained to 2000.

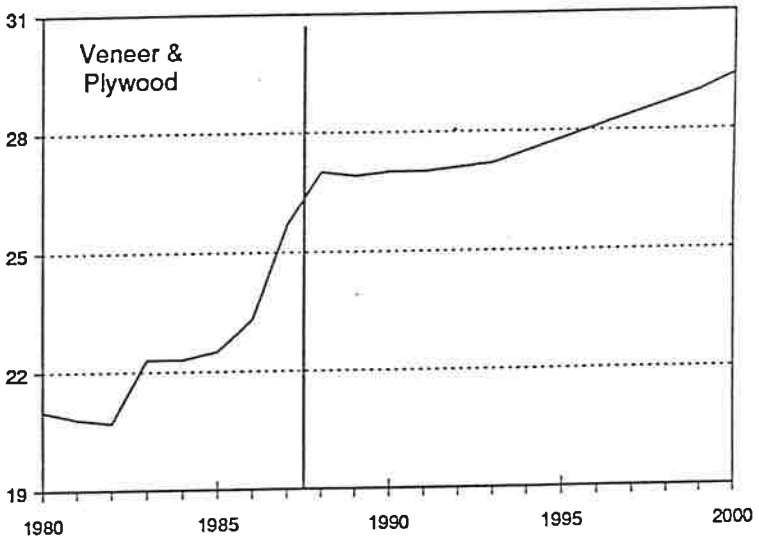
Projections of hardwood sawlog prices are shown in Figure 4.4. Projected increases for the United States are 4.5% in the South and 3.5% in the North. For Asian producers, prices are expected to increase but somewhat more slowly. Prices for West Malaysia would increase 2.6%/yr, for East Malaysia 1.7%, and for Indonesia 1.7%.

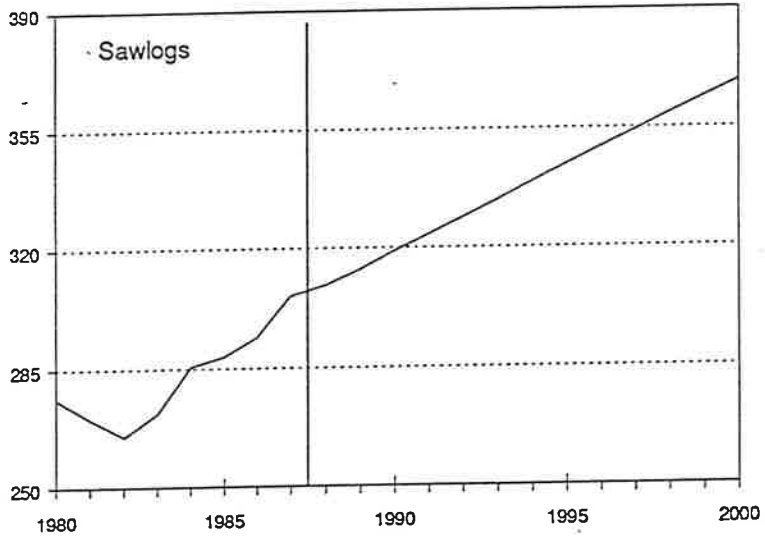
Projections of sawnwood consumption are shown in Figure 4.5. U.S. and West European consumption increases are significant. Also, major increases are projected for traditional major hardwood producing countries in both Latin America and Asia. China will also have major increases.

Hardwood sawnwood production is projected in Figure 4.6. Major gains are projected for the U.S. South and North, representing approximately 50% gains. Australian production is projected to decline, with a peaking in Indonesia. West Malaysia shows moderate increase, as does China. West European production is also projected to increase.

FIGURE 4.1 World output - nonconiferous products (mm cum)







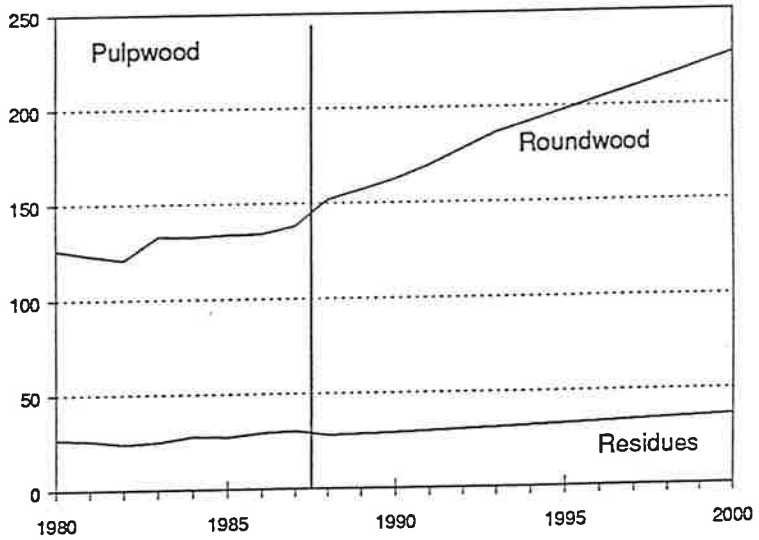
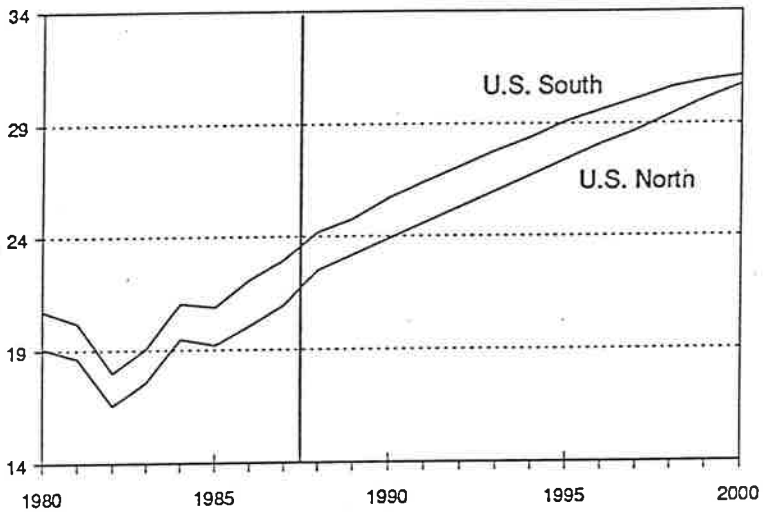
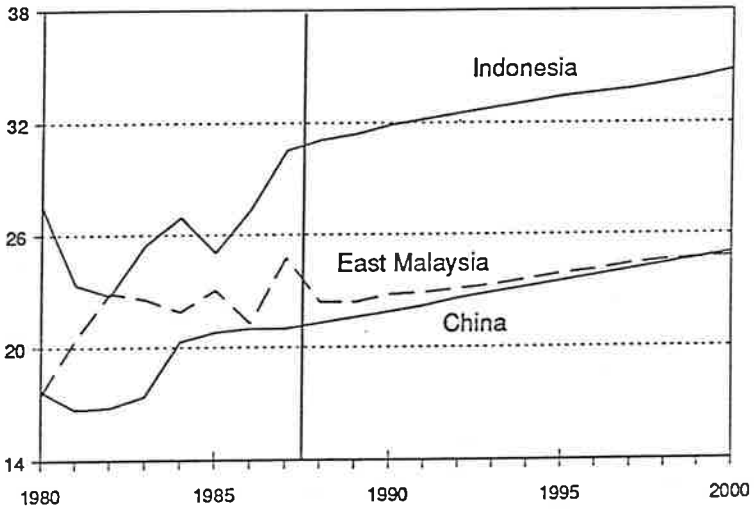
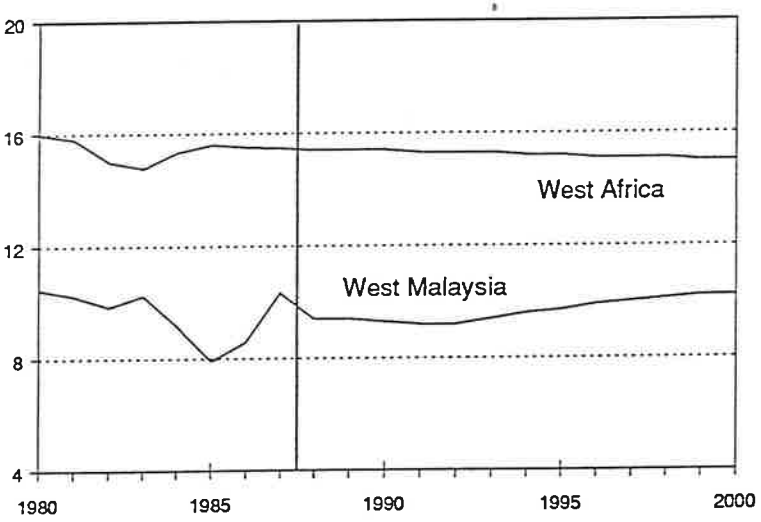


FIGURE 4.2 Nonconiferous sawlog production (mm cum)







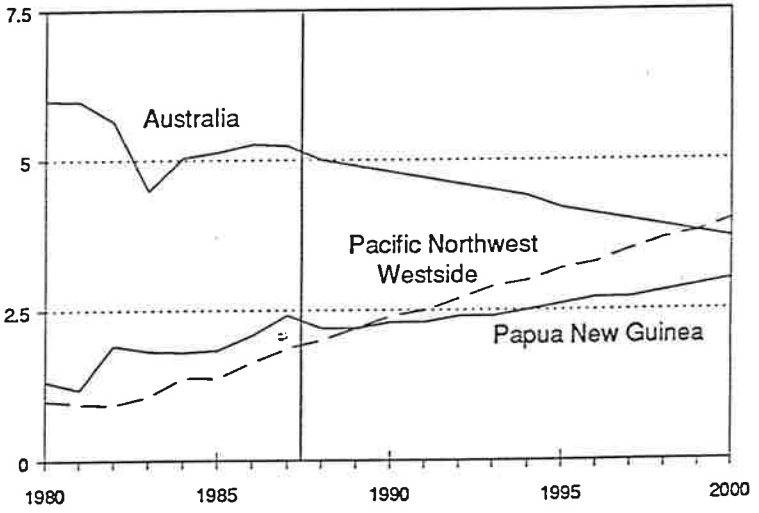
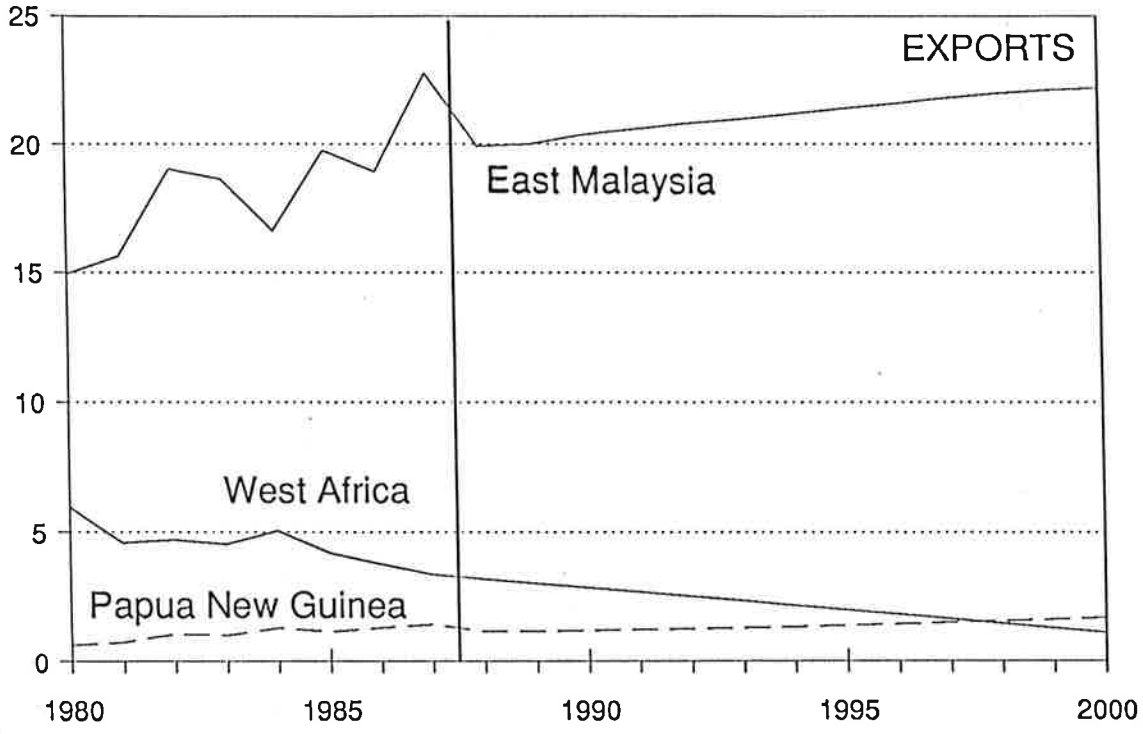


FIGURE 4.3 Nonconiferous sawlog trade (mm cum)



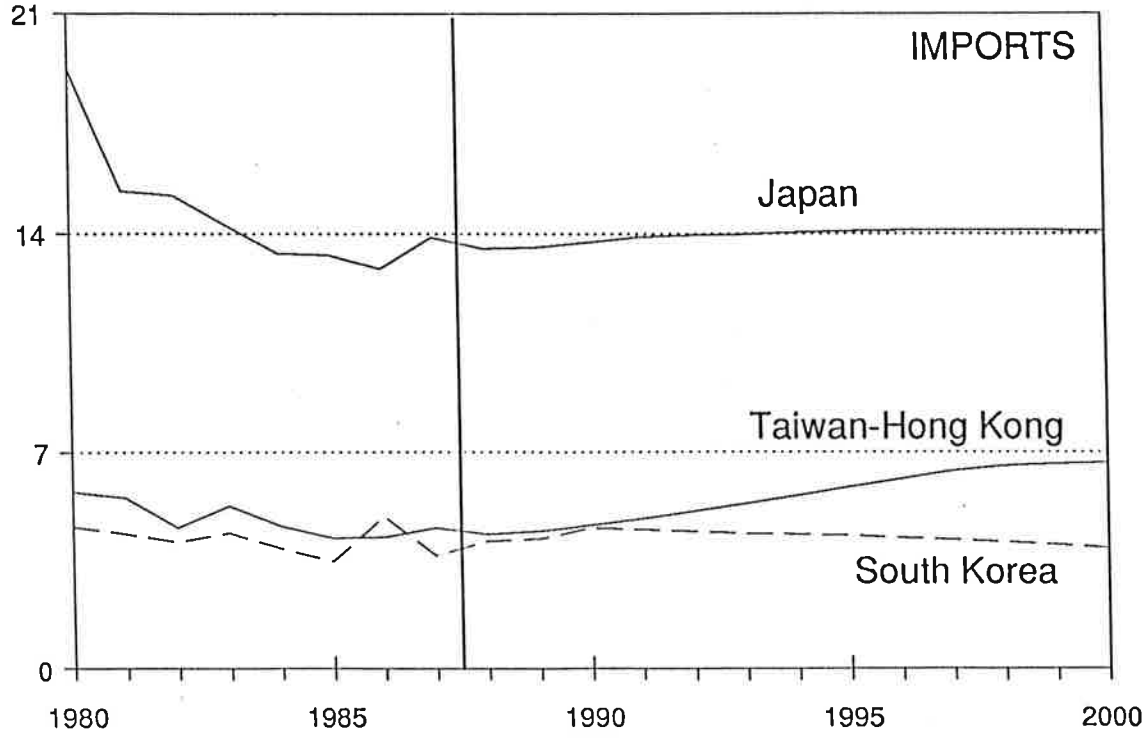
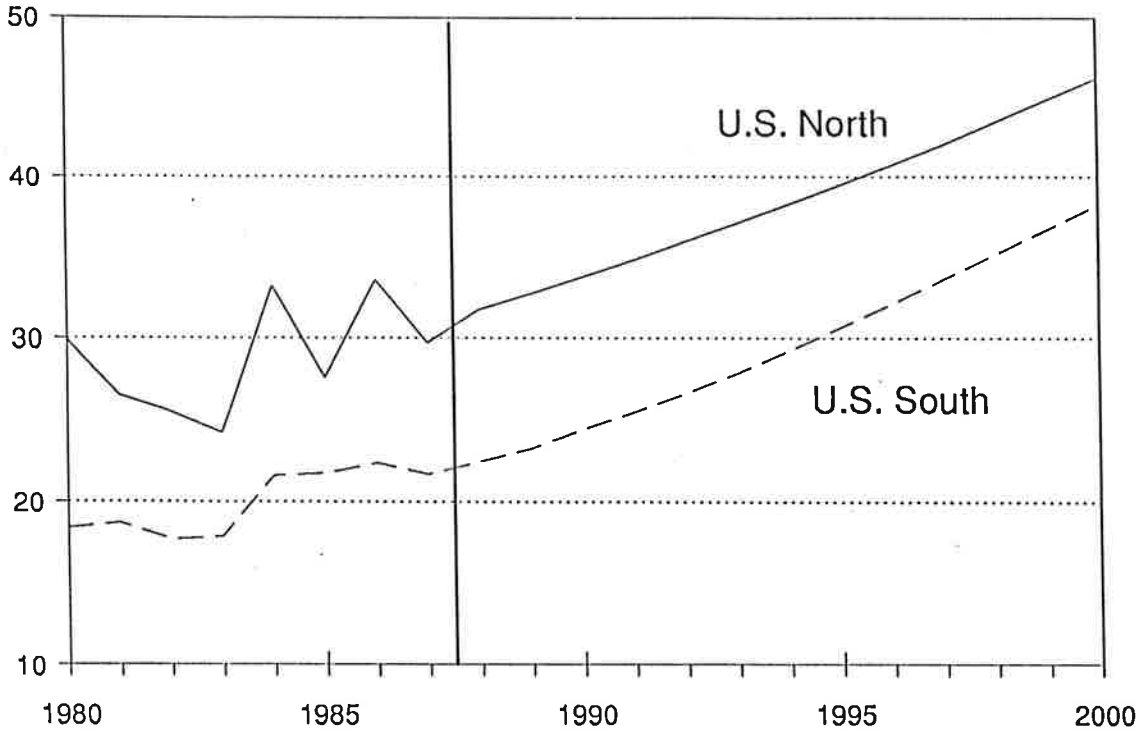


FIGURE 4.4 Nonconiferous sawlog prices (1980 USD/cum)



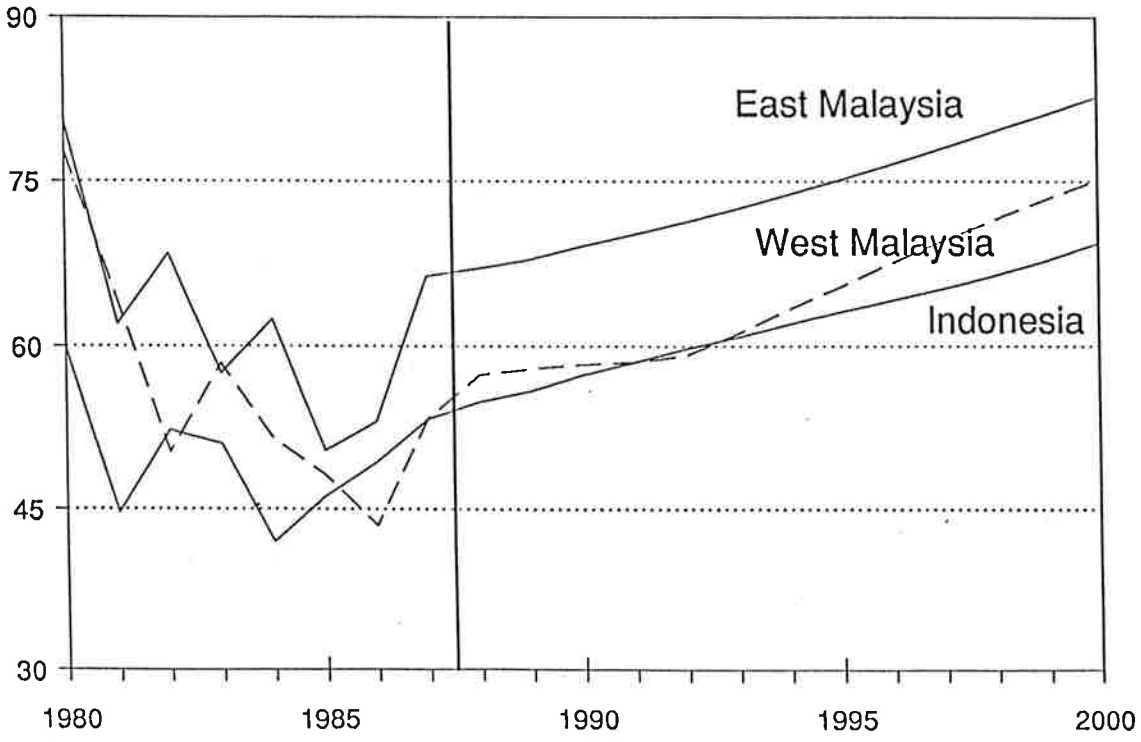
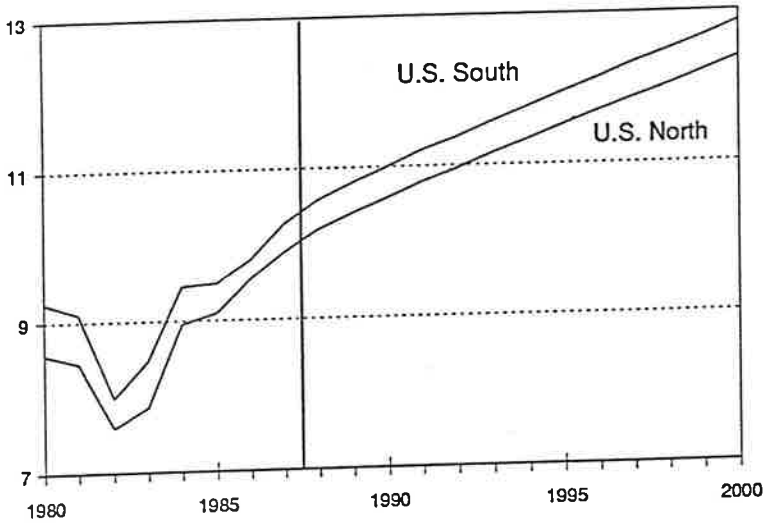
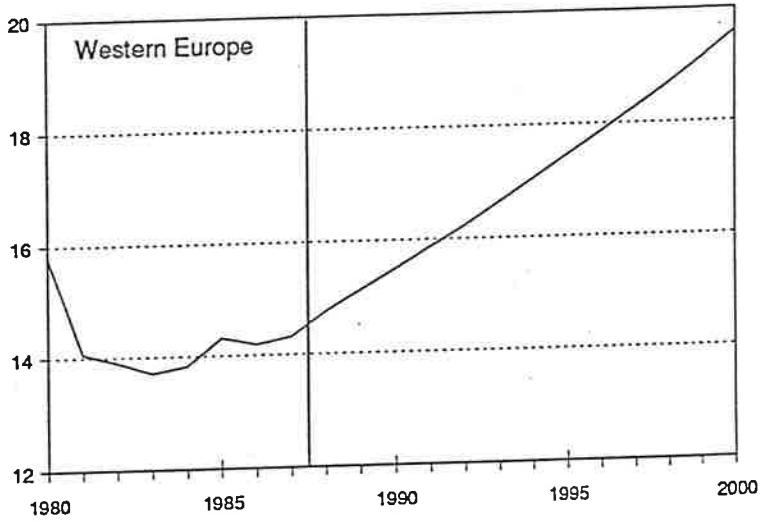
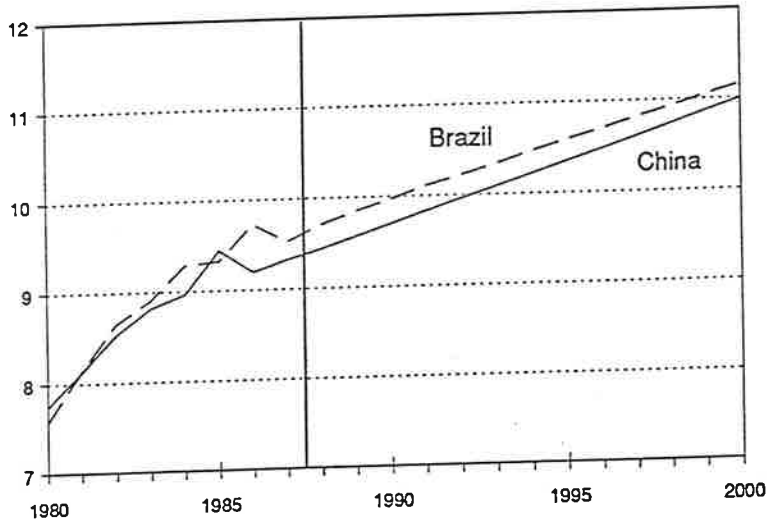


FIGURE 4.5 Nonconiferous sawnwood consumption (mm cum)







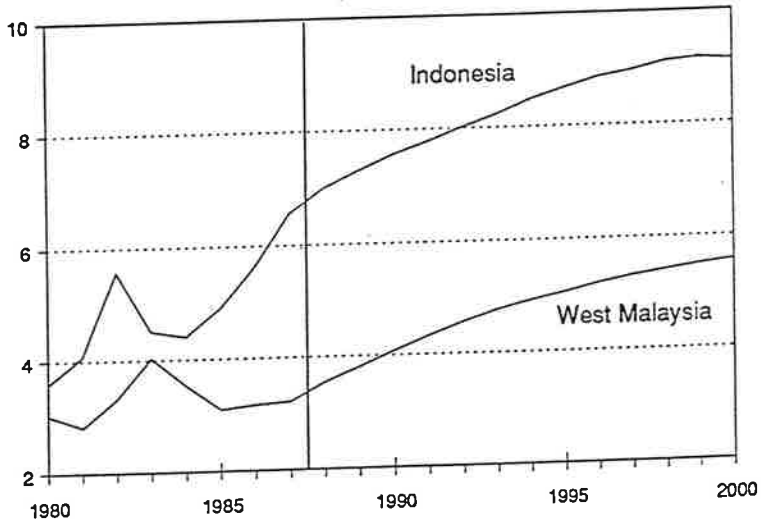
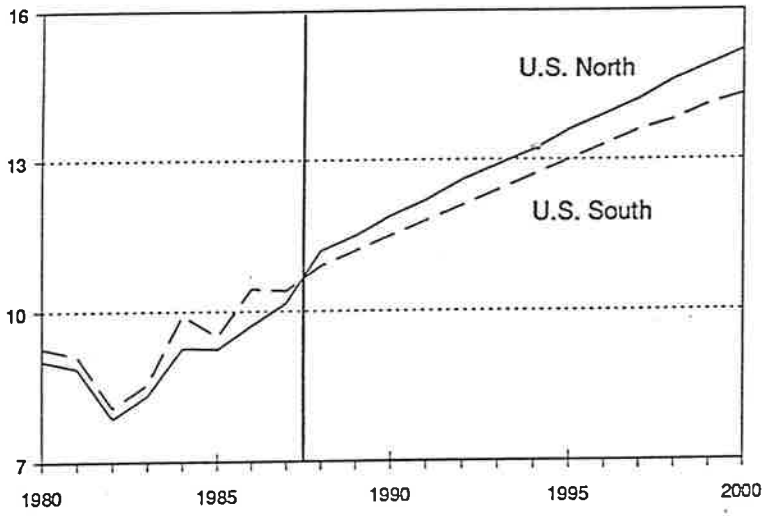
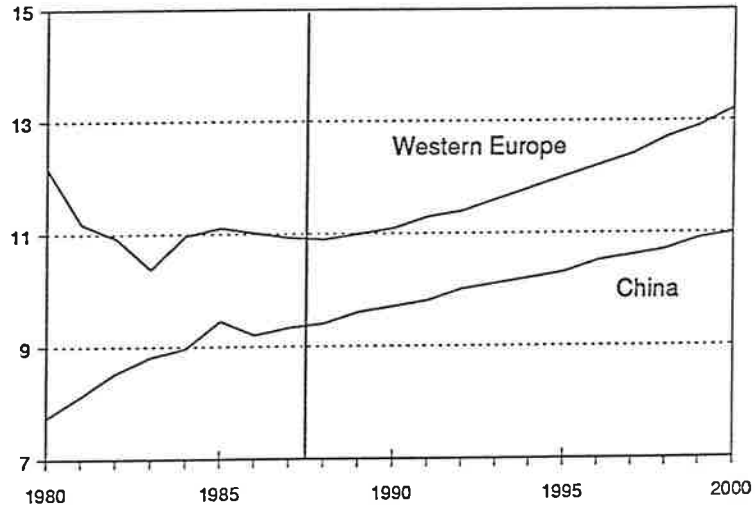
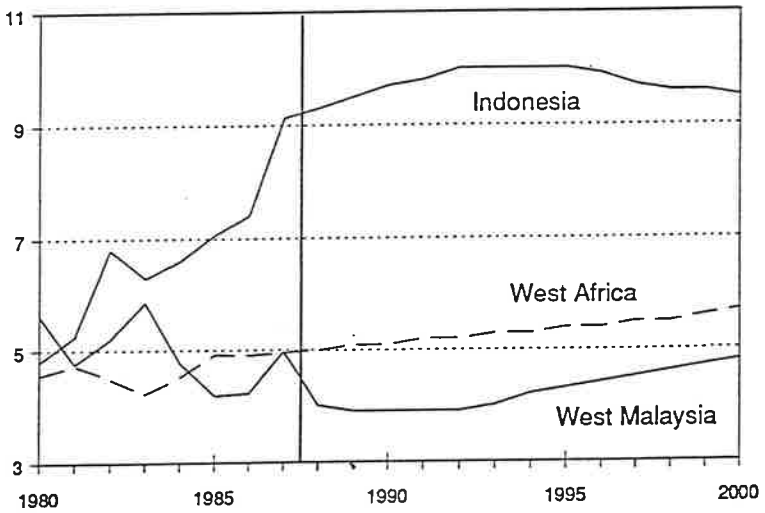


FIGURE 4.6 Nonconiferous sawnwood production (mm cum)







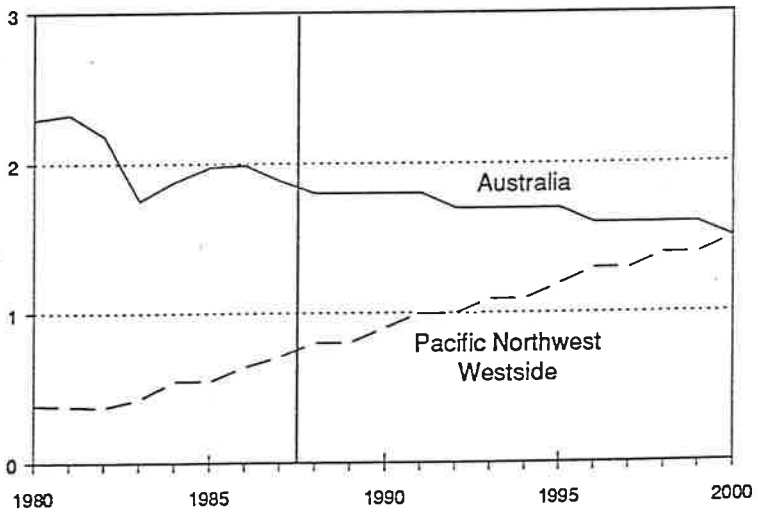
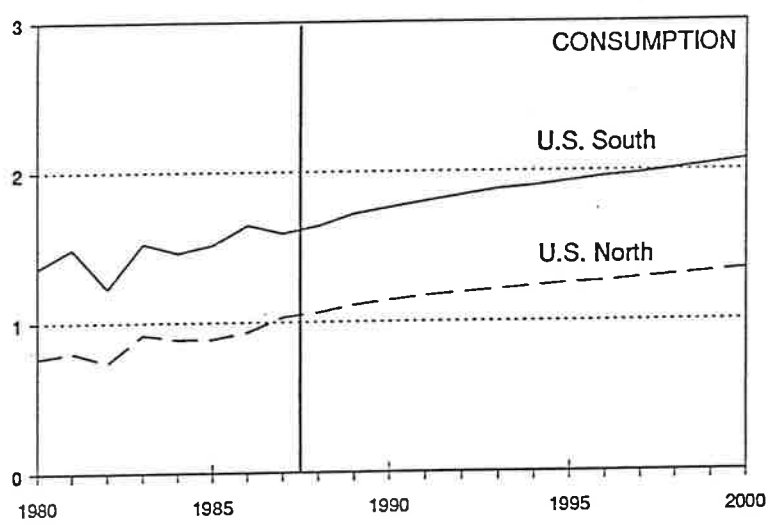
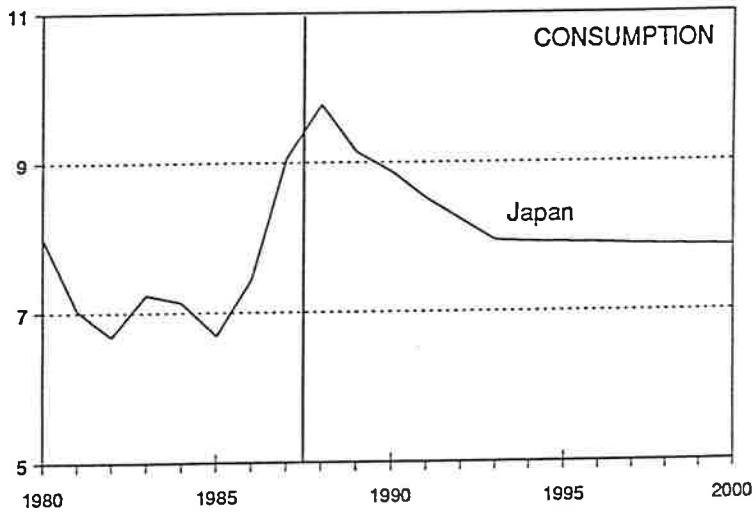
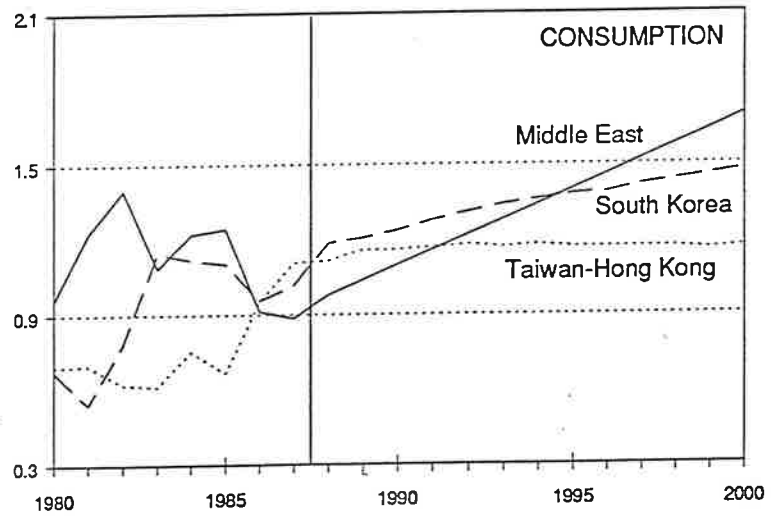
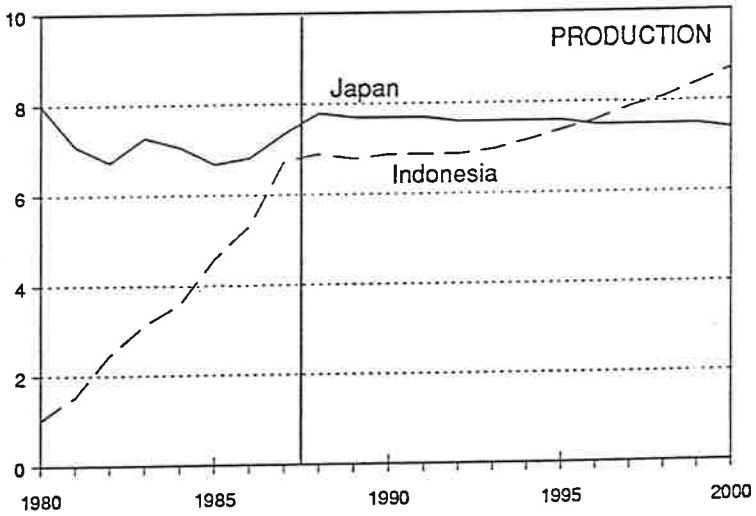


FIGURE 4.7 Nonconiferous plywood cons. & prod. (mm cum)









Projections for hardwood plywood production are shown in Figure 4.7. Consumption in the United States is projected to increase moderately in both the South and North. Relatively stable consumption is forecast for Taiwan and Hong Kong, with slight increases in South Korea. A gain of over 60% is forecast for the Middle East.

Consumption of hardwood plywood in Japan is forecast to drop significantly from almost 10 million cubic meters in 1988 to approximately 8 million by about 1993. Production is forecast to stabilize at about 7.5 million cubic meters after 1990, thus dampening the need for imported plywood.

Indonesian production of hardwood plywood, which increased rapidly thrnugh the 1980s, is forecast to continue growth at a much more moderate rate through 1995 and then experience another period of growth through 2000, reaching almost 9 million cubic meters per year.

PRICE FORECASTS

Price forecasts to the year 2000 were obtained using the CINTRAFOR Global Trade Model. Four categories of hardwood forest products were considered: sawveneer logs, pulpwood, sawnwood, and plywood. The CGTM is based on global trade flows and thus not capable of considering the Pacific Rim region independently.

The price forecast of hardwood sawveneer logs for the Pacific Rim region is presented in Table 4.5. Stumpage price increases are anticipated for each country considered. These increases range from 7 to 40%, with the largest increases in Malaysia, Indonesia, and Papua New Guinea. Hardwood stumpage prices were significantly higher in Japan, and to some extent TaiwanHong Kong.

The pulpwood stumpage price forecast (Table 4.6) ranged from a 2% decline to a 94% increase. Both Chile and New Zealand were predicted to experience large increases, partly because pulpwood prices in these countries were significantly lower than in other Pacific Rim countries. Stumpage price increases are expected to range from 11 to 35%, although a 2% decrease is predicted for Korea.

The price forecast for sawnwood is presented in Table 4.7. For the Pacific Rim region, it ranged from a 6% decrease in Japan to a 30% increase in Peninsular Malaysia. Malaysia as a whole is expected to experience the largest increases. One important factor is that the prices in Japan are expected to be from two to five times higher than in other Pacific Rim countries. This is a reflection of both the higher raw material costs and higher labor costs in Japan.

Hardwood plywood prices (Table 4.8) are expected to be relatively stable to the year 2000. However, the price of hardwood plywood in Japan is two to three times higher than for the other Pacific Rim countries. The lowest prices are forecast for Indonesia, reflecting its inherent competitive advantage in hardwood plywood production, the fact that it produces approximately 70% of the hardwood plywood in the world, and the influence of a cartel-like industry plywood association.

Table 4.5. Prices of nonconiferous sawlogs (1980 U.S. $/m^3).

	Historical								Forecast		
Country	1980	1981	1982	1983	1984	1985	1986	1987	1990	1995	2000
PNW West (private)	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	37.7	43.8	51.4
U.S. South	18.4	18.7	17.7	17.9	21.6	21.8	22.4	21.7	24.5	30.6	38.2
U.S. North	29.0	26.6	25.5	24.3	33.1	27.6	33.5	29.7	33.7	39.5	46.2
Canada East	30	30	30	30	30	30	30	30	34	39.8	46.5
Japan	178.6	144.4	116.1	131.5	146.8	152.4	201.1	246	248.7	254.8	262.4
Korea	139.3	108.6	94	79.3	92.6	84.6	75.5	83.4	86.1	92.2	99.8
China	63	65	93	93	93	67	70	70	72.7	78.8	86.4
Taiwan	114	90.5	83.1	80.2	82.5	72.6	91.3	108.3	111	117.1	124.7
East Malaysia	80.4	62	68.3	57.6	62	50.5	53.2	66.3	69	75.1	82.7
West Malaysia	77.7	64.1	50.4	58.5	51.6	48.2	43.5	53.5	58.3	65.3	75.1
Indonesia	59.8	44.7	52.4	51.1	41.9	46.2	49.4	53.4	57.4	63.1	69.2
Philippines	129	99.1	93.5	70.8	90.1	75.1	80.7	86.3	80	87.6	96.4
Papua New Guinea	72.4	56.5	56.6	45.8	51.9	43.7	46.3	65.7	68.4	74.5	82.1
Rest of Oceania	58	43	57	50	62	49	51	53	55.7	61.8	69.4

Source: CINTRAFOR Global Trade Model, November 1989.

Table 4.6. Prices of nonconiferous pulpwood (1980 U.S. $/m^3).

	Historical								Forecast		
Country	1980	1981	1982	1983	1984	1985	1986	1987	1990	1995	2000
PNW West (private)	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	26.2	28.9	31.7
U.S. South	15.9	15.6	15.3	15.3	15.4	15.6	15.9	15.8	16.9	19.6	22.4
Japan	47.6	43.2	36.1	37	36.9	38.7	54.8	62.1	63.3	66	68.8
Korea	129.2	113.4	94.4	89.7	72.9	74.5	73.1	76.9	78.1	75	75
China	40	29.3	26	21.3	22.5	25.3	21.5	26.1	27.3	30	32.8
Taiwan	68.6	55.7	47.8	38.2	37.5	37.7	34.7	49.1	50.3	53	55.8
West Malaysia	18	18.3	18	17.7	18.2	13.9	17	17.1	18.3	21	23.8
Indonesia	11	10.1	11.7	10.7	13	20.9	18.8	27	28.2	30.9	33.7
Papua New Guinea	0	0	46.7	40.8	37.3	36.5	37.7	59.3	60.6	36.3	66.1
Australia	25.6	39.9	41.2	35.5	35.1	36.2	39	39.7	40.9	43.6	46.4
New Zealand	6.6	6.8	7.2	6.7	6.6	7.5	9	7.1	8.3	11	13.8

Source: CINTRAFOR Global Trade Model, November 1989.

Table 4.7. Prices of nonconiferous sawnwood (1980 U.S. $/m^3).

	Historical								Forecast		
Country	1980	1981	1982	1983	1984	1985	1986	1987	1990	1995	2000
PNW West (private)	0	0	0	0	0	0	0	0	258	264	264
U.S. South	120.5	111.1	108.8	127.9	129.7	134.7	145.3	163.4	161.9	168	175.1
U.S. North	120.5	111.1	108.8	127.9	129.7	134.7	145.3	163.4	161.9	168	175.1
Canada East	0	0	0	0	0	0	0	220.3	163.7	110.7	81.5
Japan	636.9	530.6	490.1	483.3	476.4	489.9	694.5	856	855.5	814.9	805.6
Korea	353.1	272.5	283.9	291.5	261.2	240.2	253.9	319.6	269.9	296	319.4
Taiwan	229.5	191.7	180.7	199.5	191.5	182.8	286.2	293.6	293.1	299.2	299.4
East Malaysia	198.1	154.4	152.3	144.3	145.1	135.7	153.7	180.8	180.3	199.1	224.6
West Malaysia	176	138.5	129	137	132	126.9	142.4	147.5	147.2	166	191.5
Indonesia	172.3	127.8	118.8	119.6	96.2	106.1	135.2	140.8	140.3	146.4	156.2
Philippines	244.2	210.9	187.5	175.1	171.2	155.3	187.4	214.9	214.4	220.5	227.6
Australia	0	0	0	0	0	0	0	239.2	238.7	244.8	245
New Zealand	0	0	0	0	0	0	0	328.2	327.7	333.8	334

Source: CINTRAFOR Global Trade Model, November 1989.

Table 4.8. Prices of nonconiferous plywood (1980 U.S. $/m^3).

	Historical								Forecast		
Country	1980	1981	1982	1983	1984	1985	1986	1987	1990	1995	2000
U.S. South	0	0	0	0	0	0	0	288.7	269.2	276.5	288.6
U.S. North	0	0	0	0	0	0	0	301.3	281.8	289.1	301.2
Canada East	0	0	0	0	0	0	0	310	290.5	297.8	309.9
Japan	738.8	581.7	550	532.2	501.6	492.8	653.5	950.8	931.3	938.6	950.7
Korea	369.7	333.5	279.4	280	273.4	272.9	266.6	286.6	267.1	274.4	286.5
China	0	0	0	0	0	0	0	264.4	244.9	252.2	264.3
Taiwan	422.1	372.6	355.4	365.2	388.4	405.6	532.6	541.7	522.5	529.8	541.9
East Malaysia	341.7	339.5	319.9	286.1	269.4	210.2	263.5	286.8	267.4	274.7	286.8
West Malaysia	314.7	273.5	243	230	215.6	202.6	216.6	299.1	279.6	286.9	299
Indonesia	227.5	183.5	222.1	229.2	187.7	185.3	215	218.2	198.7	206	218.1
Philippines	322.5	271.4	236.6	219.1	198.4	183.1	209.9	251.1	231.6	238.9	266.9
Australia	0	0	0	0	0	0	0	350.7	331.2	338.5	350.6
Rest of Oceania	0	0	0	0	0	0	0	373.2	353.7	361	373.1

Source: CINTRAFOR Global Trade Model, November 1989.

SUBSTITUTION OUTLOOK

The foregoing projections, while not absolute forecasts, tend to reflect favorably on the capacity of the hardwood forests (both tropical and temperate) to sustain a growing level of production and consumption. A major portion of projected increased output, however, is from the temperate hardwood forests of the U.S. South and North. Production capacity from the Asian tropical hardwood producers is more limited. West Malaysia and Papua New Guinea are likely to have modest increases in production, together accounting for not more than 3 million cubic meters in additional harvests. Increases in East Malaysia and Indonesia are more questionable, with possible increases of 8 to 10 million cubic meters.

As noted in the review of the PRA projections above, hardwood prices are anticipated to increase at faster rates than those for conifer logs and manufactured products. This will result in increasing pressures to consider substitutes—both wood and nonwood.

A major unknown in the optimistic projections for hardwoods, particularly for tropical hardwoods, is the effect of growing environmental pressures on governments to control timber harvesting and discourage trade in tropical hardwood products. Embargoes, import and export taxes, consumer and end-user campaigns, and other public policy instruments are gaining favor worldwide, in both producer-export and consumer-import countries. The strength of this movement, and the effectiveness in reducing harvests through outright bans or indirectly through higher production costs and prices, will be determined within the next few years.

For those countries with remaining accessible hardwood forests, the near-term outlook is good. Markets appear strong, and prices will help ensure adequate returns to those producers. The longer term is much less clear. Current inventories of mature, natural tropical hardwoods cannot sustain the present levels of harvest in most areas without substantial gains in reforestation and perhaps plantations of exotic species. Slow-growing tropical species will be difficult to replace in any reasonable time frame. But progress toward managed, higher-yielding hardwood plantations has been disappointing and slow. Rates of deforestation in most tropical areas of Asia continue to exceed reforestation and plantation establishment by a wide margin. Hence natural forests must continue to be exploited heavily to sustain current market positions.

More abundant and relatively lower-priced conifers in the Pacific Basin will certainly appear attractive to many traditional users of tropical hardwoods. Species characteristics and product technology will temper substitution prospects. However, price-driven incentives for technological change will influence conventional thinking about species adequacy and stimulate technology for many traditional hardwood applications. It would be foolish for tropical hardwood producers to be complacent about traditional markets.

Tropical hardwood producers have already undertaken aggressive marketing campaigns to offset the anticipated barriers to tropical timber trade. To some extent, efforts to substitute value-added processing for raw log exports are gaining favor. The apparent success of Indonesia in gaining a strategic position in tropical hardwood plywood production, and the likely gains in hardwood sawnwood production in lieu of basic log exports, are well known throughout Asia. Malaysian discussions of log export restrictions have yet to be translated into effective policy. Should this happen, the primary hardwood markets of the Pacific Rim will be in for another major shock, as traditional importers try to sort out alternatives for log supply and production options.

Finally, changes in the economies of Asia will have major impacts on domestic consumption, thus changing the comparative economics of log and product exports in relation to domestic production and consumption. These countries of Asia are among the most rapidly developing regions of the world. Domestic consumption, particularly of fiber products, will place traditional solid wood processing under greater competitive pressures.

CHAPTER 5. RECOMMENDATIONS FOR FURTHER RESEARCH

The review undertaken in this study has revealed areas where further detailed research would provide a better understanding of changing trade patterns in the Asian-Pacific region as part of the broader Pacific Rim and global timber economy. Such an understanding will be important as pressures on tropical hardwood producers increase, both with respect to environmental concerns for the tropical rain forest and with regard to the economic interests of the countries involved as they seek to stimulate economic growth and development.

The discussion below addresses general topics within the scope of research on forestry and forest products trade. However, the current focus on tropical hardwood trends and the potential for significant substitution away from tropical timbers in favor of temperate hardwoods, softwoods, and nonwood materials makes a clearer understanding of these issues important.

TROPICAL FOREST SUSTAINABILITY

Much concern has been expressed about the extent of the tropical hardwood forest, its changing composition, the rates of reforestation, and the long-term physical and environmental sustainability.

Harvest rates of Asian tropical producers in both the Exporter and Importer subregions have increased, largely through the exploitation of undisturbed natural forests. The dynamics of growth and yield for much of this tropical forest are not well known. But there is little question that the exploitation in much of tropical Asia is above sustainable rates based on stocks of natural forest and present reforestation and net growth.

A much more detailed examination of the dynamics of the forest base, growth and yield, and harvest rates in terms of long-term sustainability would contribute significantly to a better understanding of the future role of management, harvest regulation, and international trade in regard to tropical hardwood forests. Further, programs for forest sector development would be based on updated and perhaps more realistic estimates of sustainable timber harvest levels.

Such an assessment would also need to consider species mix and the role of both fast-growing and natural species plantations. Strategies for sustaining the forest harvest levels will require a stimulus for reforestation and plantation establishment where physically and economically feasible.

ROLE OF FOREST PLANTATIONS

Natural stocks of native tropical hardwoods will inevitably continue to decline. While considerable wealth can be extracted from the remaining natural stands, the productivity and economics of future forest management, including plantations, will be critical to sustained forest-based activities.

Current rates of deforestation exceed recent reforestation and plantation development. While the deforestation does not generally result from timber harvesting, the forest land base will most likely continue to shrink. The residual forest land will need to be managed for the greatest economic yields, and lands otherwise available for timber growing must be fully utilized to the extent economically justified.

Plantations cannot be expected to contribute significantly to timber harvests in the near term. Most plantations have been established since 1980, and are likely to provide yields quite different from the traditional natural forest—different in species composition, size and quality, and gross volumes. Local economies must anticipate such changes and develop plans based on the potential of plantations existing on an increasing scale throughout Asia. Studies and research on strategic planning for a plantation forest, and the transition to that type of forest over twenty to thirty years, are needed now if acceptable forest policies are to be developed and implemented. And the international trade implications need to be evaluated in terms of the likely changes in markets and comparative advantage resulting from such adjustments at the forest level.

ENVIRONMENTAL IMPLICATIONS OF TROPICAL TIMBER TRADE

Rates of deforestation in tropical Asia have raised worldwide concerns about the impacts on the global environment. While commercial timber harvesting and processing account for only one source of forest clearing, the highly visible export trade (particularly in roundwood) draws attention to this activity. International

trade policies in many consuming countries are under pressure, with strong public sentiment for reducing or eliminating tropical forest trade in order to "save" the rain forests. Import bans, tariff and nontariff barriers, taxes, and other means are being examined with the objective of reducing or eliminating tropical timber trade.

The implications of such environmental pressures are largely unknown with respect to the likely consequences for markets, competing wood products (substitution), local industries, economic consequences for producer countries, or the forest land base.

While some Asian Exporter countries have considered or have implemented bans on roundwood exports, this has been motivated more by the prospect of enhancing economic returns through higher in-country processing than by environmental concerns. Such efforts are unlikely to alter significantly the international environmental attitude toward harvesting the tropical rain forest. Pressures for reduced harvesting may well result in the long-term set aside of large portions of forest, thereby reducing the land base for sustaining timber harvesting and supporting either domestic production or international trade. A greater effort is needed to document and evaluate these developments.

EMERGING TRADE BARRIERS

The concerns about the long-term sustainability of the tropical hardwood forests will inevitably lead to greater national and international efforts to increase trade barriers as a protective measure, probably in the form of import restrictions. Quotas, outright bans, import taxes, and other means are likely tools for reducing the overall level of tropical timber imports if sufficient pressure is put on major importers. Differential tariffs on specific products, species, or exporter countries are certainly possible, with a trend toward larger penalties for tropical hardwood products.

Such pressures may come from environmentally motivated groups within those countries, or increasingly may result from international environmental organizations seeking to act through nationally based affiliates. Pressures may also be exerted by groups and organizations that stand to benefit from reduced tropical timber trade. This might well include other wood products producers/exporters who would be better positioned if faced with less competition from tropical hardwood timber. Also, nonwood building material suppliers or others offering substitute materials may use environmental concerns to enhance their comparative position whenever possible.

Likewise, growing trade barriers by exporter countries are evident, largely aimed at the export of unprocessed roundwood. Indonesia's development of plywood and sawnwood industries following its 1980 ban on roundwood exports has not gone unnoticed in other tropical countries. Although such export restrictions do not guarantee a viable, internationally competitive secondary processing industry, they are frequently justified in the name of economic growth and development, employment opportunities for domestic workers, and secondary income effects.

In general, this tendency for increased trade barriers for tropical forest products (by either importers or exporters) runs counter to international goals of trade liberalization and reduced barriers. To the extent that international trade is distorted, an overall economic loss results.

The extent of growing trade barriers, particularly nontariff barriers, is a matter deserving of greater research. This would include the documentation of trends, the identification of barriers, and the evaluation of such barriers in terms of national and international interests. Changes in trade flows as a consequence of such barriers should also be studied. Simulations of alternative trade barriers and policies through dynamic market and trade models could help identify the sensitivity of global and Pacific Rim markets to trade distorting policies.

BILATERAL TRADE FLOWS

General information on the levels of production, export, and import for most major forest products is reasonably available. However, such data are highly aggregated, with respect to both product and markets. It is typical to know estimated exports or imports in total but lack information about individual trade flows between trading partners. Changing export patterns for specific countries and the changing comparative advantage of one supplier over others are difficult to evaluate from total trade information. For example, total

exports for a particular product may increase, yet exports to a particular market may decline. And the exports to that market may well change dramatically among suppliers. The opposite is also obviously possible, where the general trend in imports masks important changes among suppliers or a specific importer country.

Bilateral trade information is obtained and compiled by the United Nations (and perhaps others), but this information is difficult to access. Hence it has not been utilized extensively in most analyses of tropical hardwood timber or other aspects of international trade in wood products. Limited use was made of bilateral trade data in the market analysis for the Economic Commission for Europe (ECE), and bilateral flows were estimated in the CINTRAFOR Pacific Rim Assessment project. This effort needs to be expanded both with respect to making historic bilateral trade flow information more accessible and usable in documenting trends and developments, and, perhaps more important, also for evaluating future market and trade development.

One limitation of most conventional bilateral flow analyses has been the partial scope of evaluation of two-way trade relationships between selected partners, especially within the structure of the broader timber economy. Evaluation of U.S.-Canada, U.S.-Japan, Indonesia-Korea, or other possible pairs increasingly requires explicit consideration of the interaction with other buyers and sellers of forest products. Expanded work on such bilateral trade relationships within the broader market or regional context would greatly enhance the understanding of tropical timber trends.

CROSS-ELASTICITIES AND SUBSTITUTION

A moderate amount of work has been accomplished to provide indicators of own-price demand elasticities for major groupings of forest products. Comparatively little information is available about cross-elasticities between competing products. As tropical hardwood products become scarcer and higher priced, the potential for substitution by conifers and other nonwood materials will be influenced not only by hardwood prices but by the technical and economic potential for utilization of alternatives.

The end-use requirements for tropical hardwoods in traditional markets generally dictate whether other materials (including conifers) are "acceptable" or "suitable" as substitutes. While product characteristics are reasonably well documented (physical properties, strength, etc.), the actual end-use requirements are less well understood. Whether alternative materials can technically substitute or not ultimately rests on the performance requirements of the final end use. Most end uses are probably less restrictive than has been traditionally assumed. As price differentials increase, the likelihood of serious consideration of the acceptability or adequacy of substitutes increases. Quantitative estimates of cross-elasticities for major competing products would permit more realistic estimates of market adjustments for tropical hardwood producers under pressures from higher prices and costs.

PRODUCT TECHNOLOGY AND SUBSTITUTION

Technically, substitution of other materials for tropical hardwood depends largely on the physical characteristics and quality of both products. In practice, both availability and tradition have influenced the choice between hardwood and softwood timber. However, examples can be found worldwide where both hardwoods and conifers are "traditionally" used for most end-use applications.

Structural use of sawnwood is a major consumption application. In North America, conifers constitute the greatest share of structural wood materials; in other regions, use of hardwood sawnwood is commonplace. Technological considerations such as density, moisture content and shrinkage, surfacing, decay resistance, and similar characteristics dictate how a particular species or species group will compete with alternatives. Availability (and price) obviously condition the choice of product for a particular use. Added research and understanding of major hardwood and softwood species and products, evaluated in terms of end-use characteristics, will be critical to a better understanding of market substitution.

A related technological need is the identification and evaluation of new composite products, perhaps combining softwoods and hardwoods into a single application. New technologies for overlays, gluing, drying, and machining will open new avenues for "market sharing" rather than direct competition or substitution.

TRANSPORTATION

Given the distribution of forests, the processing capacity of the global forest products industry, and final end-use markets, it is not surprising that transportation is significant in the overall comparative advantage of particular countries or even regions within countries. It can be critical at several stages of processing of forest products. Included here would also be requirements for road building or other primary access to undeveloped forest stands. Significant volumes of timber globally are considered submarginal because of access costs.

Transportation of semiprocessed or processed timber is also influenced by the question of quality and value. Bulk transportation may be adequate for logs but not for fine furniture. Mode of transportation, port handling charges, taxes, insurance, and credit are also significant costs influencing international markets. Port facilities, dockside draft, handling equipment, labor costs, and storage facilities all influence transportation costs. Producer cost (or mill return) is frequently quite different from the cost to the buyer or user.

Major changes in global transportation have affected the economics of the marketplace for wood products. Only limited analysis has been devoted to documenting such changes, as well as the impact on economic returns to the processor or grower of timber. Greater research on the significant role of transportation costs for tropical timber producers and the implications for market access is needed if future market patterns are to be understood and anticipated.

EXCHANGE RATES

The impact of exchange rates between major currencies is largely outside the control of individual wood products producers or consumers, even though the impact on global trade flows for wood products, including tropical hardwood timber, is potentially significant. Gains in manufacturing productivity or cost savings can be negated quickly by changes in major currencies. Comparative advantage largely rests on the net or realized price for producers. A major swing in exchange rates will affect markets just as rapidly as a change in producer prices. Bilateral trade flows, and market position, will adjust as producers seek higher realized prices and buyers seek the lowest delivered price.

Historic changes in exchange rates have been frequent and large. The extent to which such changes have altered trade flows and comparative advantage is unclear, in the context of changing resource and production activities in major producer regions.

VALUE-ADDED INITIATIVES

An additional topic in need of greater evaluation is the economics of value-added initiatives in wood-producing countries. At best, such efforts may be a form of protectionism, constituting a new kind of trade barrier to discourage exports of commodity or basic products in favor of domestic processing.

Whereas a country or region may have a true economic comparative advantage at one stage of production, it is not self-evident that a higher level of processing will enjoy the same advantage. Hence movements toward value added are generally seen as a public-sector responsibility, at least in the form of creating proper "incentives." While value-added processing can and should be evaluated in light of the contemporary economic and technological options open to wood producing countries, much more needs to be known about the comparative cost structures, transportation, and other facets of markets.

Value-added issues are generally related to developmental or income-distribution goals of the regions or countries involved. Forest products may be seen as the means to an economic objective unrelated to the overall efficiency and true costs of wood products production and distribution on a global basis. Individual countries may well view the role of governmental intervention in economic matters quite differently. What is an incentive from one perspective, however, may well be a subsidy from another. Such methods are sure to raise charges of trade barriers and unfair trading practices internationally. A firmer understanding of the economics behind comparative advantage for different stages of production would be very helpful in clarifying such trade disputes.

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