Document: BFTF 22-058
Draft: FIRST
Date: 07 October 2002
Meeting: Los Cabos, Mexico

Economic Impact of Prescriptive Building Codes in APEC Economies

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August 2002

for the APEC Business Advisory Council

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Contents

SUMMARY

- Prescriptive building codes which specify particular timber species, sizes and grades have little overall impact on the volume of timber used in construction although they do affect the competitive position of wood products suppliers. Fire regulations, however, often discriminate against wood products generally because they are combustible, and are usually based on cultural expectations or experience rather than scientific data. This analysis only considers the impact of prescriptive fire regulations.

- An analysis of the opportunity costs of prescriptive building codes to wood product suppliers and consumers indicates a significant impact for some economies:

Opportunity cost of prescriptive building codes
(US$ million)

Economy	Cost to wood products suppliers[1]	Cost to consumers[2]
Japan	3630	900
People's Republic of China	4920	936
Republic of Korea	265	34
Chinese Taipei	68	10
Singapore	10	1

1 Total opportunity cost/annum of prescriptive building codes to wood products suppliers.
2 Total opportunity cost/annum of prescriptive building codes to consumers

- The potential impacts for Japan and the People's Republic of China (PR China) are the most significant. In addition to the large size of the economies of the two countries, both markets are receptive to new building systems. In the case of Japan, there is considerable experience in the use of wood in construction, whereas in PR China, the rapid growth of the economy is accelerating the adoption of new building systems and building codes and standards.

- The Republic of Korea and Chinese Taipei represent a second order of importance in terms of the opportunity cost of restrictive building codes. This is partly due to the smaller size of their economies compared with Japan and PR China, and also to the greater population densities of these economies, which favours high rise residential construction, and thus lower potential use of wood-based materials. It also reflects traditional cultural values which see wood as a substandard material for housing.

- The high population density of Singapore prevents any significant growth in wood framed houses because most construction activity is in high rise construction.

- There are limitations to this analysis in that it does not investigate the impact of removing prescriptive building codes on other sectors of the economy, or on wood products suppliers from specific economies. Timber frame systems, for example, favour certain products and materials (wall linings, etc) in association with the timber-based structural components of the house. The adoption of wood based framing systems may also displace other structures such as steel, concrete, and brick and the materials associated with these systems. This level of detail was beyond the scope of this analysis and requires a more detailed analysis, such as using a General Equilibrium approach.

- Continuing globalisation will contribute to a gradual interchange of knowledge between countries in terms of building methods and materials. With the gradual move towards performance based codes, the door will be open for greater competition among suppliers, and should translate to better prices and options for consumers in each market.

1 INTRODUCTION

A paper outlining the impact of building codes and product standards on APEC economies was presented to the APEC Business Advisory Council in May 2001. This paper was based on a 1999 study of non-tariff measures in the forest products sector[2] that identified a number of issues in relation to building codes and product standards as barriers to trade between APEC economies. This study concluded that the use of restrictive product standards within national building codes, along with difficult and expensive product compliance routes for foreign suppliers, distorted trade in building products and systems. These impediments to trade restrict the availability of competitively priced building materials, thereby impeding the availability of affordable housing materials, the uptake of new building technology, as well as placing a burden on the end consumer.

A number of situations were identified that may unnecessarily restrict the use of wood in building materials and systems:

- Building codes which prescribe against the use of wood (e.g. fire, height, zone)
- Prescriptive product standards which unnecessarily inhibit particular suppliers of forest products (e.g. by species, grade, glue, treatment)
- Absence of building codes for forest products, which restricts the use of wood in buildings
- Unnecessarily restrictive cost of approval/compliance to another country's codes and standards

An indicative illustration of the economic impact of prescriptive building codes in Japan indicated that there are considerable costs to timber suppliers (domestic and foreign), and to final consumers, that can be attributed to the presence of prescriptive building codes[3].

The objective of this report is to estimate the economic impact of prescriptive building codes that restrict the use of wooden building materials and systems in selected APEC economies.

This report is structured as follows. In the next section, the methodology for determining the opportunity cost of prescriptive building codes is described. In section 3, the results of the analysis for each selected economy are presented, and then discussed in Section 4. The Appendix includes a general discussion of issues regarding the use of wood in each market, including other APEC economies.

The estimation of economic impact is presented for the following APEC economies: People's Republic of China, Japan, Republic of Korea, Chinese Taipei and Singapore. Additionally, a discussion of issues relating to the use of wood in the residential construction market is presented for these economies plus the following APEC economies: Chile, Indonesia, Malaysia, Mexico, Thailand, The Philippines and Vietnam.

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[2] APEC 1999: Study of Non-tariff Measures in the Forest Products Sector. ***Forest Research***, Rotorua New Zealand.
[3] ***Forest Research*** 2002: The economic impact of prescriptive building codes in APEC economies – an indicative example. Prepared for ABAC.

2 METHODOLOGY

Building codes can be prescriptive in many ways, by specifying particular timber species, sizes, grades or other materials. The specification of species, sizes or grades of timber does little to affect the amount of timber used overall, although it may affect the competitive position of different suppliers. Fire regulations, on the other hand, often discriminate against timber simply because it is combustible. This affects the use of timber regardless of origin. Performance-based regulations overcome this by specifying fire ratings of building components, rather than requiring the walls or floors separating different tenancies or ownership in a building to be made on non-combustible materials. Hence this analysis considers only the impact of prescriptive fire regulations.

In many APEC economies, the adoption of performance-based fire regulations is happening or has happened. The effects of such changes are usually slow to appear because of "cultural inertia". This is because the practices defined in fire regulations are usually based on cultural expectations or experience (e.g. the Great Fire of London, wartime conflagrations etc.), and the fire regulations, in turn, tend to establish those cultural expectations. Thus, the realisation of the benefits calculated in this report might not be achievable through the amendment of building and fire regulations alone. It will need to be realised through extensive marketing campaigns from wood product manufacturers and suppliers in competition with non-wood building product suppliers.

The estimate of the impact of prescriptive codes is based on several assumptions, and basic statistics. The quantities determined for each APEC economy are:

A Housing starts per annum
B Average value per housing unit, US$
C Proportion of units that are high rise, medium rise and low rise respectively.
D Proportion of those housing units which currently have timber as the primary structural material.
E The potential proportions which could have timber as the primary structural material if prescriptive barriers were removed.
F Proportion of the value of the unit due to timber structural components.
G Proportion of housing units which currently have wood non-structural components.
H The potential proportion of housing units which could have wood non-structural components if prescriptive barriers were removed.
I Proportion of the value of the unit due to wood non-structural components.

The impact is calculated from the expression:

$$\mathrm{OC} = AB\left[\sum_{i=h,m,l} C_i F_i\left(E_i - D_i\right) + \sum_{j=h,m,l} C_j I_j\left(H_j - G_j\right)\right]$$

Where OC is the total opportunity cost to wood products.

Also there is an estimation of the total cost to consumers of the residential market (buyers of new houses) assuming that the overall cost of a wood frame house is 10% cheaper than one using alternative materials. The formula used to estimate this cost is:

$$CC = 0.1AC \sum [C(E - D)]$$

where CC is the cost to consumers.

The statistics required for the calculations are:

Population density, housing starts per annum, and average value per house unit.

Table 1: Basic Statistics Required

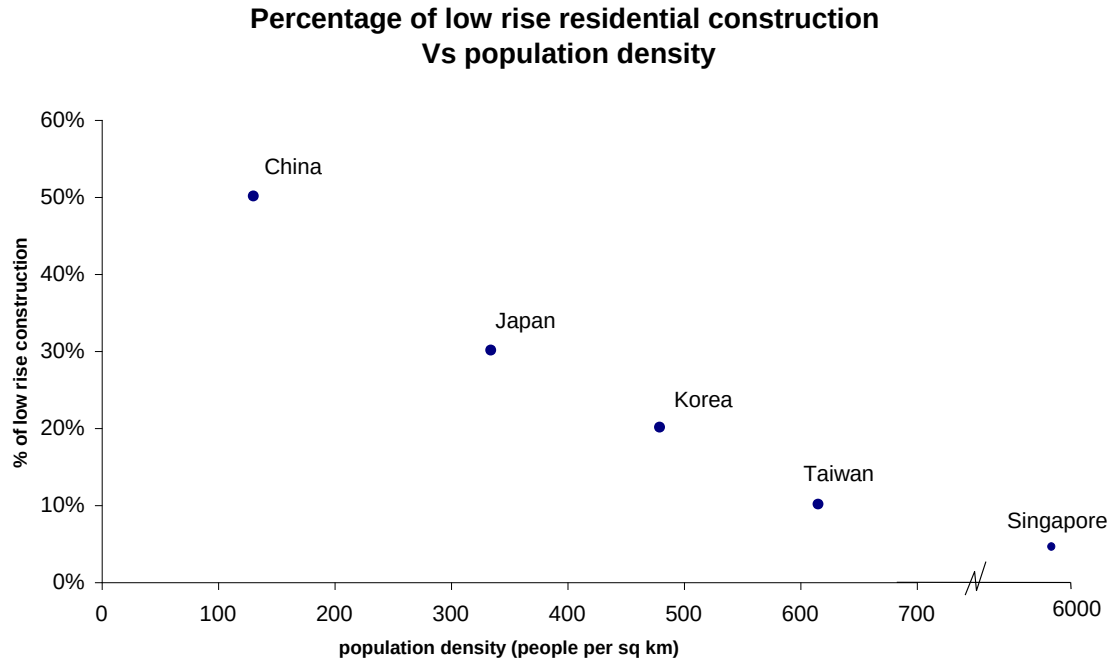
Country	Population density[1] (people per sq.km.)	Housing starts per annum[2]	Average house value[3] (US$)
PR China	131	10,000,000	30,000
Japan	335	1,200,000	100,000
Republic of Korea	480	430,000	80,000
Chinese Taipei	616	60,000	100,000
Singapore	5645	20,000	100,000

[1]: World Bank; [2]: various; [3]: various, ***Forest Research***.

Proportion of high, medium and low rise construction

From population density an estimate has been made of the proportion of houses that are low rise, medium rise and high rise. After gathering some basic variables about percentage of low-rise residential construction in the key markets selected, a relationship was established between population density and the percentage of low-rise residential construction (see figure 1). That relationship was used to make assumptions for countries where some of the information was not available.

Figure 1



Source: various, *Forest Research*.

Proportion of buildings that currently have a timber structure
These are estimates based on what is known of the traditions in the various economies, and their access to structural wood products. In Japan, for instance, there is a strong tradition and preference for timber construction and the country has large timber resources. The People's Republic of China on the other hand, has limited timber resources, and the only timber seen in older housing is in roof framing.

Potential proportion of buildings that could have timber structures
This is an estimate, considering the likelihood of that economy being able to access the additional structural timber needed, the possible impact of efforts by North America to educate economies in 2x4 construction, and the wealth of the economy (which implies a market for second or holiday homes).

Proportion of value due to timber structural content
Typically, house construction costs are one-third labour, one-third materials and one-third fittings, appliances, drapes, landscaping and general finishing. With lesser wealth (GDP) of an economy compared to New Zealand, we would expect the proportion of value in materials to rise and fittings etc. to reduce.

Proportion of non-structural wood content
These are estimates made on the same basis as for structural components.

Estimates for commercial/industrial construction

This is purely a guess-estimate, assuming that commercial/industrial construction will be of a similar value overall, to housing construction but it will have a lower timber content.

3 OPPORTUNITY COST ANALYSIS FOR SELECTED APEC ECONOMIES

3.1 Country: People's Republic of China

Building codes and standards issues

- PR China is currently drafting standards for the design and construction of timber structures. The starting point was a design code of Russian origin covering the use of round and large section sawn timbers. Over the past two years both Canada and USA have assisted in the formulation of standards which include light timber frame construction. These standards include North American species, grades and sizes of dimension lumber but do not yet include provision for radiata pine, other standard lumber sizes or design criteria by which engineered wood products may be used in house construction. These developments should increase the use of lumber and wood-based products in PR China but only for those of North American origin.
- Fire regulations require buildings to have largely passive fire resistance and are unsympathetic to the use of timber framed construction except in physically isolated circumstances, single family dwellings and definitely not for any public structures such as auditoriums. Thus prescriptive fire regulations are the major concern at present. The other issues affect the balance of trade between competing suppliers.

Products and Suppliers affected

- All lumber and wood-based building products that do not come under the description of non-combustible.
- Building products that would normally be used in timber framed construction are also affected.

Country: People's Republic of China

A	Housing starts per annum	10,000,000	units
B	Average value per house unit	$ 30,000	US$

		high rise	medium rise	low rise
C	Percentage of residential buildings that are	30%	20%	50%
D	Current % of building with wooden structure	0%	0%	5%
E	Potential percentage of buildings with wood structure	0%	1%	10%
F	Percentage of building value due to wood materials if built with wood structure	20%	30%	40%
G	Present percentage of buildings with wood linings and finishings	1%	5%	50%
H	Potential percentage of buildings with wood linings and finishings	5%	10%	60%
I	Percentage of building value due to wood linings and finishings	5%	5%	10%

	high rise	med rise	low rise	total
Structural potential increment	0.00%	0.03%	1.00%	1.03%
Finishing potential increment	0.06%	0.05%	0.50%	0.61%
Total potential increment				1.64%

Total value of residential building industry	$ 300,000	million US$

Total value of potential increment per annum	**4,920**	**million US$**

3.2 Country: Japan

Building codes and standards issues

- Article 21 of the Building Standard Law of Japan (BSLJ) states that the principal parts of buildings exceeding 3,000 m^2 total floor area shall not be of wooden construction. Nevertheless it still allows construction of a large timber framed building – 54 m^2 or 60 m round single storey – and therefore should not be considered a serious barrier to the use of timber in buildings.
- Article 89 of the BSLJ Enforcement Order lists allowable stresses for timbers. It lists some non-Japanese species but it excludes some important commercial species such as radiata pine.
- Articles 107 and 108 of the BSLJ Enforcement Order list the fire ratings for building parts. However, only passive resistance is considered; i.e., there is no mention of the fire ratings for buildings with sprinkler protection.

Products and Suppliers affected

- Wood products for the construction industry such as structural timber, partition products such as panels and lumber and their suppliers result affected by these restrictions.
- Developers of medium rise multifamily complexes are affected, as well as consumers, in terms of choice, price and value of the options the market gives them.

Country: Japan

A	Housing starts per annum	1,200,000	units
B	Average value per house unit	100,000	US$

		high rise	medium rise	low rise
C	Percentage of residential buildings that are	50%	20%	30%
D	Current % of building with wooden structure	0%	0%	70%
E	Potential percentage of buildings with wood structure	1%	20%	80%
F	Percentage of building value due to wood materials if built with wood structure	20%	30%	40%
G	Present percentage of buildings with wood linings and finishings	5%	10%	50%
H	Potential percentage of buildings with wood linings and finishings	10%	20%	60%
I	Percentage of building value due to wood linings and finishings	5%	5%	10%

	high rise	med rise	low rise	total
Structural potential increment	0.10%	1.20%	1.20%	2.50%
Finishing potential increment	0.13%	0.10%	0.30%	0.53%
Total potential increment				3.03%

Total value of residential building industry	$ 120,000	million US$	

Total cost to suppliers of wood products	**3,630**	**million US$**

	Total cost for consumers	high rise	med rise	low rise	Total
D	Current % of building with wooden structure	0%	0%	70%	
E	Potential percentage of buildings with wood structure	1%	20%	80%	
	Difference	1%	20%	10%	
	Product	0.5%	4.0%	3.0%	7.5%

Total cost to consumers	**900**	**million US$**

3.3 Country: Republic of Korea (ROK)

Building codes and standards issues

- ROK restricts wood use in the construction of residential and commercial housing. The code prohibits the building of residential wooden structures that exceed 13 metres in height (9 metres to eaves) and 3,000 square metres in total floor area. Wood frame construction is also restricted by geographic location (e.g. quasi fire zones).
- ROK building codes prohibits the use of wood as structural components in major structures. Article 15b of Regulations Concerning the Structural Standards of Building, etc. of NBC stipulates that major structures of buildings over two floors in height be built only of non-combustible materials. Non-combustible materials are defined as steel, concrete, and masonry. Single story buildings for public use with a seating area in excess of 200 square meters and garages with floor space in excess of 30 square metres must also use only non-combustible materials in their major structures. Major structures are defined as walls, columns, floors, beams, roofs and main stairs.
- ROK building codes also require that the major structural components of multi-family structures are fireproof. This criteria effectively prohibits the use of wood in building multi-story, multi-family structures. Major structural components of multi-family structures include exterior walls and party walls between the households of common dwelling houses. Thus, for multi-story, multiple family dwellings, some other non-combustible material must be used for both the exterior walls and the common walls between families;
- ROK does not certify any wood products as part of a fire resistant assembly. Fire resistance is defined in the ROK building codes as determined by the fire chief. There is no allowance for wood assemblies used in structural applications which are required to have a fire rating;
- ROKs NBC fire prohibitions make no allowance for increased floor space or numbers of stories if a building has an automatic sprinkler;
- ROK building code definition of fire protection zones - which prohibit the use of WFC - could be interpreted as applicable to the entire country. Designations of fire protection zones are developed without the input of set-backs or other performance measures.

Products and Suppliers affected

- Wood products for the construction industry such as structural timber, partition products such as panels and lumber and their suppliers result affected by these restrictions.
- Developers of medium rise multifamily complexes are affected, as well as consumers, in terms of choice, price and value of the options the market gives them.

Country: Republic of Korea

A	Housing starts per annum		430,000	units
B	Average value per house unit	$	80,000	US$

		high rise	medium rise	low rise
C	Percentage of residential buildings that are	60%	20%	20%
D	Current % of building with wooden structure	0%	0%	0%
E	Potential percentage of buildings with wood structure	0%	0%	5%
F	Percentage of building value due to wood materials if built with wood structure	20%	30%	40%
G	Present percentage of buildings with wood linings and finishings	1%	5%	20%
H	Potential percentage of buildings with wood linings and finishings	5%	10%	30%
I	Percentage of building value due to wood linings and finishings	5%	5%	10%

	high rise	med rise	low rise	total
Structural potential increment	0.00%	0.00%	0.40%	0.40%
Finishing potential increment	0.12%	0.05%	0.20%	0.37%
Total potential increment				0.77%

Total value of residential building industry	$	34,400	million US$

Total value of potential increment per annum	**265**	**million US$**

3.4 Country: Chinese Taipei (Taiwan)

Building codes and standards issues

- Taiwan has similar concerns to PR China, Korea and Japan in that fire regulations restrict the size of timber framed buildings in built-up areas, and permit little more than single family dwellings, and then only in isolated situations where a fire in one building is not likely to spread to a neighbouring building. There is little reliance on active fire fighting.

Products and Suppliers affected

- All timber building products and associated materials.

Country: Chinese Taipei

A	Housing starts per annum	60,000	units
B	Average value per house unit	$ 100,000	US$

		high rise	medium rise	low rise
C	Percentage of residential buildings that are	70%	20%	10%
D	Current % of building with wooden structure	0%	0%	4%
E	Potential percentage of buildings with wood structure	0%	3%	15%
F	Percentage of building value due to wood materials if built with wood structure	20%	30%	40%
G	Present percentage of buildings with wood linings and finishings	1%	10%	50%
H	Potential percentage of buildings with wood linings and finishings	10%	20%	60%
I	Percentage of building value due to wood linings and finishings	5%	5%	10%

	high rise	med rise	low rise	total
Structural potential increment	0.00%	0.18%	0.44%	0.62%
Finishing potential increment	0.32%	0.10%	0.10%	0.52%
Total potential increment				1.14%

Total value of residential building industry	$	6,000	million US$

Total value of potential increment per annum	**68**	**million US$**

3.5 Country: Singapore

Building codes and standards issues

- The vast majority of the population of Singapore live in high rise apartment buildings. Structurally it is possible to construct such buildings using a structural steel frame with timber walls and floors. However, such construction has not been attempted in Singapore.
- Fire regulations require divisions between different ownerships and tenancies within buildings to be separated by non-combustible materials. Also, fire escape passages and stairways must not have combustible finishes.
- The tropical climate of Singapore means that timber durability is a concern. Although building regulations do not specifically prescribe against timber, the expectation of low durability of timber means that it is seldom used for buildings apart from roof trusses and decorative finishings.
- Termite resistance is a concern in this climate, and there is ecological resistance to the use of preservative treated timber.

Products and Suppliers affected

All timber building products and associated materials

Country: Singapore

A	Housing starts per annum		20,000	units
B	Average value per house unit	$	100,000	US$

		high rise	medium rise	low rise
C	Percentage of residential buildings that are	80%	15%	5%
D	Current % of building with wooden structure	0%	0%	5%
E	Potential percentage of buildings with wood structure	0%	0%	10%
F	Percentage of building value due to wood materials if built with wood structure	20%	30%	40%
G	Present percentage of buildings with wood linings and finishings	5%	10%	50%
H	Potential percentage of buildings with wood linings and finishings	10%	20%	75%
I	Percentage of building value due to wood linings and finishings	5%	5%	10%

	high rise	med rise	low rise	total
Structural potential increment	0.00%	0.00%	0.10%	0.10%
Finishing potential increment	0.20%	0.08%	0.13%	0.40%
Total potential increment				0.50%

Total value of residential building industry	$	2,000	million US$

Total value of potential increment per annum	**10**	**million US$**

Table 2:
Opportunity Cost of Prescriptive Building Codes to Wood Products Suppliers
Summary of Results

Country	Annual value of residential building market (US$ billion)	Potential Increment(*)	
		Percentage (%)	Value (US$ million)
PR China	360	1.64	4,920
Japan	120	3.03	3,630
Republic of Korea	34	0.77	265
Chinese Taipei	6	1.14	68
Singapore	2	0.50	10

(*): Potential increase in value of wood materials in residential building markets if prescriptive building codes were removed.

4 DISCUSSION / INTERPRETATION OF RESULTS

Of the five countries analysed, PR China and Japan are the most significant in terms of the opportunity cost of restrictive building codes to wood products producers, and other factors associated with the residential construction industry. This is mainly due to the large size of the economy in these two countries, in addition to the adoption of innovation in building systems. In the case of Japan, there is a considerable amount of experience in the use of wood in construction, whereas in China the rapid growth of the economy is pushing the adoption of new building systems and building codes and standards.

The Republic of Korea and Chinese Taipei represent a second tier in terms of importance of opportunity cost due to restrictive building codes. This is due in part to the relatively smaller size of their economies compared with Japan and PR China, and also to the greater population density of these countries, which favours high-rise residential construction, and thus lower potential use of wood-based materials. Also it reflects traditional cultural values of these two economies which still largely perceive wood as a substandard material for housing construction.

Finally, Singapore represents the least important market in terms of opportunity cost to wood suppliers due to restrictions in the building code. This is mainly due to the very high population density of the city-state of Singapore, which prevents any grow in the market of low-rise construction which may use more wood. Also the high humidity favours non-wood building materials.

All these economies are at different stages in reviewing their building codes, generally moving from prescriptive codes toward performance based codes. The process may take several years to complete and fully implement, and the result will be a unique code determined by the unique circumstances of each country. However, the acceptance of performance-based codes will

gradually open up opportunities for suppliers of wood-based building materials, as well as for consumers in the residential building market.

Recent Developments in Building Codes

There is a worldwide movement toward the replacement of prescriptive building and fire codes with ones based on performance. That is, instead of prescribing the precise number and arrangement of protective measures which are required, the performance of the overall system against a specified set of objectives is presented.

Modern building codes have evolved well beyond their traditional areas of public health and welfare. Frequently building codes are vehicles for the implementation of environmental policy by incorporating requirements for energy and water conservation. Some address noise pollution with requirements for the acoustic transmission properties of partitions. Others address the preservation of historical structures and still others include quality of life issues such as prohibiting the mixture of certain buildings (i.e., zoning requirements). The latest in this growing list involves electromagnetic fields from electrical equipment and "sick building syndrome".

A number of groups are working through international committees such as the International Commission on Building Standards and Research to develop appropriate objectives for building codes which are compatible with the transition to performance codes. The process has shown that there are significant cultural differences among countries which impact in the decision making process, with no clear answers to standardisation.

For example, Chile is earthquake-prone and the country has one of the world's most restrictive building codes as far as earthquake engineering is concerned. Buildings must withstand earthquakes above eight on the Richter scale. In contrast, countries located outside earthquake prone areas do not have such restrictions in their building codes. In fire codes as well, where fire scenarios likely to occur are based on actual experience, and so vary from country to country. The frequency of these scenarios is accounted for in the analysis, producing a result that represents the risk of life loss by fire. For instance the weight given to an arson scenario in office building in Japan's fire code is lower than it is in England, reflecting Japan's lower rate of arson.[4]

Continuing globalisation forces will contribute to a gradual interchange of knowledge between countries in terms of building methods and materials. As consumers and developers gain more knowledge there will be market segments that develop naturally in each country to adopt new systems, such as the two by four wood frame construction system in Asian or Latin American countries. These changes will likely be gradual and any developments will be influenced by a variety of factors, one of which is the effect of building codes. With the gradual move towards performance based codes, this factor will tend to lose relative importance in explaining the use of building materials for the residential – and commercial – market in any given country, leaving the door open for greater competition among suppliers, which should translate ultimately in better prices and options for consumers in each market.

[4] Bukowski, R. (1995) Fire Codes for Global Practice. Building and Fire Research Laboratory, National Institute of Standards and Technology, Maryland, USA.

There are limitations to this analysis in that it does not investigate the impact of removing prescriptive building codes on other sectors of the economy, or on wood product suppliers from specific economies. Timber frame systems, for example, favour certain ancillary products and materials (wall linings, etc) in association with the timber-based structural components of the house. The adoption of wood based framing systems may also displace other structures such as steel, concrete, and brick and the materials associated with these systems. This level of detail was beyond the scope of this analysis and requires a more detailed analysis, such as using a General Equilibrium approach.

APPENDIX

ISSUES REGARDING THE USE OF WOOD PRODUCTS IN THE RESIDENTIAL BUILDING SECTOR BY ECONOMY

Japan

In 2000, Japan's Regulatory Reform Committee finished its second three-year deregulation plan in several areas including building products and codes. As a consequence, the Ministry of Construction decided to move toward performance-based standards in the Building Standards Law (BSL). However, many aspects of the BSL relating to fire remain prescriptive, limiting wood construction and rendering wood-frame buildings more costly. Current standards also impose restrictions on large-scale wooden buildings and construction of "special buildings". They prescribe material requirements as well as size and distance limitations. For example for three-storey construction in quasi-fire protection districts, a size limit of 1500 m^2 severely restricts market access, while 3000 m^2 is the size limit for construction outside of quasi-fire protection and fire protection districts.[5]

Certain types of buildings are limited to either fireproof or quasi-fireproof construction. In addition, size and other limits are placed on certain types of wood frame buildings. For example hotels of wood frame construction are limited to two storeys or less, with the second storey limited to 300 m^2. In contrast, in North America for example, the building code allows hotels up to four storeys and areas up to 144,000 square feet (13,378 m^2).[3]

Japan housing starts were 1.2 million units in 2000, about the same as the previous 3 years, and down from the record 1.7 million units of 1990. Theoretically Japan now has sufficient houses to meet household demand (Existing houses now total 36 million units, whereas the number of households is 33 million)[6]. The houses to be built from now on will be better in quality and greater in space, to replace the old, narrow and deteriorating houses, most of which were built soon after the World War II using cheap materials. Most of such houses and buildings suffered damage at the time of the Kobe Earthquake in 1995. While there is a trend to increase the space of single family dwellings, another trend is the inability of people to buy detached houses due to the extraordinarily high cost involved. Many people must stay in high-rise concrete apartments, usually with confined space options.

Table 3: Wood use in Japan's house construction for the year 2000

Building system		Number of units	Percentage over total (%)
Wood	Post&Beam	476,700	38.8

[5] Ni-Ka online (2002) Canada's Comments and Proposals for the Regulatory Reform Committee (2000)
[6] Yamiguchi (2001) Softwood Product Markets in Japan. Softwood Export Council (www.softwood.org)

based	Two by four	79,114	6.4
	Pre-fab	175,069	14.2
	Total wood	730,883	59.4
Other non-wood		498,960	40.6
Total		1,229,843	100.0

Source: Softwood Export Council

Although the wood related industries in Japan are working hard to keep the ratio of wooden houses as high as possible, the share of non-wood houses, such as concrete buildings, steel posts and beams, etc., is increasing.

Since 1974, when a new building code recognised wood frame platform construction, Canadians and U.S. exporters of wood to Japan have marketed aggressively the 2x4 construction system, slowly progressing to current levels of about 80,000 houses built per year, representing about 6 percent of the total market, after 25 years of being introduced. Since the majority of wooden houses are still traditional Japanese houses, suppliers of wood to Japan should try to conform to traditional Japanese sizes, in addition to the 2x4 construction system.[5]

The primary reason suggested for the slow uptake of the 2x4 construction system is the lack of awareness by the public about alternative systems, combined with the deep traditional value of the post and beam construction system, which has several hundred years of history.
The 2x4 construction system took off in Japan after a series of measures taken by the authorities in the late seventies, including funding from the Government Housing Loan Corporation approving 2x4 construction, fire resistance tests approved for 2x4 houses lowering insurance premiums and facilitating bank loans. In addition to this, 2x4 construction also has greater resistance to earthquakes, as proved in the Kobe Earthquake, plus a higher degree of energy saving than any other building method, cost savings in construction, etc. Furthermore, an expected scarcity of skillful craftsmen required for the traditional Japanese construction should also stimulate the growth of 2x4 construction.

The current economic situation in Japan continues to have a negative effect on the construction and housing industry. Some large building materials manufacturers have been severely affected, declaring bankruptcy or asking for re-finance of loans. Analysts in the industry point to a lack of innovative products being launched in recent years and costly expansion during the bubble economic period in Japan as being factors behind the problems in the industry.

Chinese Taipei (Taiwan)

The Taiwan building code (TBC) is a modern code that is based on a combination of the Uniform Building Code (UBC) used in the western US, Japan Building Code, and local practice. Most buildings in Chinese Taipei can be roughly categorized into four types: mud brick residences, low-rise mix use buildings, mid-rise residential buildings, and high-rise office buildings. Mud brick residences are single-story unreinforced masonry buildings. They are 30 to 80 years old and not designed by engineers. A major issue for Chinese Taipei's building codes is resistance to earthquakes, as the island is one of the world's most active seismic zones. This

concern has been reinforced by the massive damage caused by the Ji Ji Earthquake occurred in September 1999[7].

Chinese Taipei authorities started a review of the building code in 2001 with an intent to recognise wood as a valid material for use in structural applications and to map out simple, effective technical guidelines to govern the design and approval of general wood / timber frame construction. To date, the use of structural wood in non-single family building (e.g., commercial buildings, low-rise apartments, and multiple family dwellings) has not grown significantly. Timber exporters report that this has been impeded by the review and approval process, in addition to insufficient technical guidelines. Officials participating in this review have stated their intention to make formal recommendations for code changes during the first months of 2002[8].

High density living due to the scarcity and high price of land for residential use inevitably means that most Chinese Taipei people live in high rise apartment buildings for which steel frame and reinforced concrete are the only practical building materials. Timber construction is thus limited for social reasons. However, in situations where low or medium rise residential buildings can be built, perceptions of vulnerability to fire and poor durability are significant reasons for the lack of interest in timber construction. The national code should help to overcome prejudices of this sort and should supplant regional codes which have been reported to often lack specifications for wood. Much timber is used in buildings but in non-structural situations as lining and finishing material and for non load-bearing partitions.[9]

The general demand for construction and interior design services has been impaired by the downturn in the global economy which began in mid-2000, although some wood segments have grown. The demand for structural wood products in the construction market has grown, particularly in the recreational and public sectors. Plywood has made strong gains due to depressed exporter prices and a growth in public works and home do-it-yourself (DIY) interior projects.

The use of wood in the construction sector is being influenced by consumer based changes, notably rising GDP per capita, an increasing number of affluent professionals, and rising concern about earthquakes and the environment. This has created an interest in wood frame housing. If construction code revisions put structural wood on a regulatory level playing field with concrete and steel by early- to mid-2002, developers will have a regulatory framework within which to develop multiple-family and commercial properties using structural wood (2x4 and post-and-beam). Demand for greater aesthetics in public and commercial building projects has already encouraged architects and builders to incorporate structural and engineered (glulam) wood into

[7] SGH Consulting Engineers, Ji Ji Taiwan Earthquake Report on Building Performance. 1999. www.sgh.com/taiwan99/intro.html
[8] USDA GAIN Report, Taiwan (Solid Wood Products) 2001
[9] ***Forest Research*** (1999) Draft Inventory of Non-Tariff Measures in the Forest Products Sector in the APEC Economies. For the Asia-Pacific Economic Co-operation Secretariat "Study of Non-Tariff Measures In the Forest Products Sector" CTI 17/99T

their designs. Exporters suggest that the success of projects already completed and now in progress may instigate broad-based market demand for these products.[10]

While wood products are not likely to eclipse other materials for structural use and will continue to face tough competition from other materials in furniture, flooring, and other applications, a strong appreciation of the value and beauty of wood, coupled with the means to pay for products, suggests that consumption of wood products is likely to grow in Chinese Taipei.

People's Republic of China

Although statistics on China's housing industry are variable, according to official estimates there are about 10 million housing starts per annum in China, of which wood framed housing accounts for only 100,000 units. Annual housing starts are likely to increase considerably in the medium term. The Ministry of Construction has set an ambitious target to build at least 8.4 billion square metres of real estate in the next 10 years, assisted by housing reforms and easy loans aimed at encouraging domestic consumption to boost the economy. A China Daily article (17/08/01) quotes that China is expected to build 2.71 billion square metres of urban housing over the next five years.

China's entry to the WTO and the successful bid by Beijing to host the summer Olympics in 2008 is also expected to create a residential property boom, creating a temporary imbalance in the property market, particularly in Beijing (China Daily 17/08/01).

The National Housing Reform Program was instigated in 1978. Initially, the main targets of change were the creation of a housing market, and rent reform and housing savings funds in the non-market housing owned by the work units. Since March 1998, housing reform has been (ambitiously) aimed at high quality, low cost, energy efficient, environmentally friendly and well managed housing.

In addition to the housing reform policy, the Chinese government has issued a series of programmes to ensure the adoption of housing reform and a smooth transition away from welfare housing allocations. These initiatives include the introduction of low cost mortgage programs. Work units have been forbidden to build or purchase more housing, while rents for those already in state-owned houses are to be slowly increased to market levels. A major aim is to improve the living standards of the population by renovating, modernising and privatising homes.

The average living space of China's population is relatively low by western standards, particularly for the urban population. A repercussion of housing reform is that the relative size of people's homes is expanding. One of the government's aims is to guarantee 23 square metres of living space for residents by the end of 2005 (China Online 23/03/01). They plan to achieve this by making housing more affordable, and encouraging the development of alliances among building firms to help them adopt more advanced technology and reduce building costs (China Daily 23/03/01).

[10] USDA GAIN Report. Taiwan, Solid Wood Products, Annual Report 2001.

Before 1999, government employees and workers in State agencies and State enterprises usually rented their apartments from their working places for very little as part of the State's welfare system. In 1999 the government urged individuals to buy apartments with loans or government subsidies as part of the nation-wide housing reforms. As a result of this policy, in Beijing for example, private purchases of residential housing now constitutes approximately 80 percent of total housing sales (China Online 29/01/01). In the past, institutional buyers constituted as much as 70 to 80 percent of total home sales. They were rarely deterred by high prices or lack of quality but were mainly concerned with location. As a result of the reforms, quality is expected to improve.

The volume of wood products consumed in the housing sector is small by North American standards, the vast majority of all new urban housing being built with reinforced concrete and bricks. In 1998 (the latest figures available) "timber"[11] comprised only 5 percent of the value of construction materials consumed in the Chinese construction industry (China Statistical Yearbook 1999). There are also regional differences in timber consumption, with the provinces of Guangdong, Jiangsu, Zheijiang, Shandong and Sichuan having the highest consumption levels.

It is important to note that most of the solid wood-based products are consumed in interior decoration and finishing, not in the structural components of buildings (Canada Housing and Mortgage Corporation, 1997). The volume of "timber" consumed nationally in construction was about 28 million m^3 in 1998 (China Statistical Yearbook).

Wood frame technology is little known in China, and almost all developments are reported to be of single-family or villa style houses. The first villa developments were in the early 1980s, to house expatriate employees of foreign joint venture companies. Wood frame construction developments have occurred in Shanghai, Dalian, Chongqing, Guangzhou, Shenzhen, and other communities with international business activity. Villa developments are priced in the mid-high to luxury end of the market (US$783 to 1807/$m^2$). A survey by the Shanghai Real Estate Research Centre, cited by Dickson Hall & Associates (2000), on the housing preferences of Shanghai residences, showed that only 6 percent of respondents preferred bungalow or villa style houses. The majority (81 percent) preferred condos in high-rises.

The building industry is reported to be rather fragmented, with a lack of transparency in implementation of building codes, and a lack of efficient monitoring and quality control. The government has recognised this problem, and is encouraging the consolidation of industries in the areas of design, construction, building materials and equipment.

Wood supply from domestic sources is being increasingly restricted. The government has recently announced a ban on the use of materials and products which do not meet environmental conservation requirements in residential construction. In urban housing construction, wood

[11] China Statistical Yearbook (1999) does not define "timber". It is assumed to include solidwood products; sawn lumber; processed products such as doors, windows, flooring, cabinetry and componentry of solid wood, etc.

materials from natural forests at the upper and middle reaches of the Yangtze and Yellow Rivers or from rare wood species are banned from use in doors, windows and floors.

Republic of Korea (ROK)

The National Building Code currently restricts consumption of wood products in Korea. Wood structural components are prohibited in all buildings over a certain size. Only non-combustible materials are permitted in the structure of these buildings. A Korean building experts committee, supported by the USA industry, has drafted a new proposed building code for multi-storey, multi-family wood frame construction. Revision of the building code is expected to be enacted during 2002.

Specific aspects of the code which currently restrict consumption of wood products and impede imports are as follows:[8]

- Wood use in the construction of residential and commercial housing is restricted. Residential wooden structures are restricted to 13 metres in overall height (9 metres to eaves) and 3,000m^2 in total floor area. Wood frame construction is also restricted by geographic location, e.g. quasi fire zones.

- The use of wood as structural components in major structures is prohibited. Article 15b of Regulations Concerning the Structural Standards of Building stipulates that major structures of buildings over two floors in height be built only of non-combustible materials (defined as steel, concrete and masonry). Single storey buildings for public use with a seating area in excess of 200 m^2 and garages with floor space in excess of 30 m^2 must also use only non-combustible materials in their major structures (defined as walls, columns, floors, beams, roofs and main stairs).

- The major structural components of multi-family structures include exterior walls and party walls between the households of common dwelling houses. Thus, for multi-storey, multiple family dwellings, some other non-combustible material must be used for both the exterior walls and the common walls between families.

- Korea does not certify any wood products as part of a fire resistant assembly. The Fire Chief defines fire resistance in the Korean building codes. There is no allowance for wood assemblies used in structural applications which have a fire rating. Fire prohibitions in the National Building Code make no allowance for increased floor space or numbers of stories if a building has an automatic sprinkler.

- The definition of fire protection zones in the Korean building code could be applicable to the entire country. Wood framed construction is prohibited in fire protection zones.

In addition to the Building Codes there are other factors which discriminate against consumption of wood products. These include:

- Korean financial, insurance and other public and private institutions do not accept wood-framed construction as a viable construction technology, favouring traditional masonry and light-frame steel.

- The Korean government supports an industrial substitution policy of synthetic materials for wood, encouraging reduction of wood use, while encouraging use of non-wood materials.

In practice there are no building standards for small buildings (less than 3,000 m^2 and lower than 9 metre eaves height etc.) regardless of material. Such buildings are not inspected for compliance with a building code as there is no code. Inspections relate to planning and site requirements only. The building design is a matter for negotiation and agreement between the owner, and the designer and builder.

Housing starts in ROK are about 450,000 per annum, with wood frame comprising only 0.4% of this total. Recently the Korean steel industry gained approval from the government for light frame building technology. This could make the market more competitive in terms of new options for buyers, thus positively affecting alternative construction technologies including wood frame. Also, the renovation market targeting old apartments and office buildings has emerged as a new business for large developers since 2000. The Ministry of Construction and Transportation has provided a support plan to stimulate the renovation market.

The outlook for two-by-four construction systems is encouraging, as deregulation initiatives and building code revisions are favourable for single family and low-rise multi-family unit facilities. Several US wood producer associations are actively promoting the 2x4 wood frame construction system, including housing exhibitions and pilot programmes. It is estimated that there are 20 colleges and universities across the nation teaching the technology of wood frame construction, from only one university five years ago.

The use of engineered wood products such as composite lumber, I-joists and laminated veneer lumber (LVL) are growing along with the expansion of wood frame construction and the interior sector. Revision of the building code, a priority in the wood construction industry, is expected to be enacted during 2002. The proposed revision would allow wood frame construction of multi-unit buildings up to three stories. Also there are tests under way on fire resistance of structural systems for lightweight wood frame houses. Suppliers and wood producers associations, especially from the United States have, actively pushed these tests, as well as other marketing efforts. The results of these tests will be given as input for the building code revision.

Singapore

The highly densely populated island of Singapore offers few opportunities for wood frame construction systems, as the great majority of housing developments are high rise apartment buildings. An example of this is a new development which will convert the Bidadari Cemetery into a centrally located 12,000-unit high-rise apartment complex. The strong role of the

government through the Housing Development Board (HDB) in building flats for its growing population during the last 40 years has resulted in building more than 750,000 flats for 85 percent of the population. Currently, Singapore has one of the highest home ownership rates in the world at about 90 percent[12]. However, public housing is reaching saturation point and demand for HDB flats has slowed sharply.

The Building and Construction Authority (BCA) announced that it will introduce performance-based building regulations later this year[13]. This will improve opportunities for wood products in Singapore an may provide an example to neighbouring countries, such as Thailand or Malaysia, which have a greater potential for low-rise wood frame construction systems.

Other APEC economies with potential growth for wood frame systems

Chile

Although Chile is a net exporter of wood products it uses relatively low volumes for construction purposes. Concrete and masonry are the preferred construction materials due to cultural and traditional factors. Currently wood has a 15 percent share in the house frame market, mainly through prefabricated houses, which have grown quite rapidly in the last decade, as a cheaper and faster alternative to brick and concrete houses. However, there is a persistent poor image of wood as a material for construction. Consumers perceive wood as being weak, of poor quality and prone to destruction by fire. Therefore, a wooden house generally gives the impression of lower socio-economic status. It is widely accepted as a means for temporary constructions, or for a second holiday house. Some industry led initiatives in the last ten years have tried to change this image, with the arrival of companies building wood-frame houses following the traditional North American style. This effort however, has been insignificant in terms of market penetration and only aimed at the high end of the market. More recently, there have been some timber frame projects aimed at the low end of the market. These include different projects for low cost houses for the poor, which are normally built by the government in concrete and other non-wood materials. Due to availability reasons, wood is used more in the southern regions, where forest resources are abundant. However, because the majority of the population is concentrated in the metropolitan area surrounding Santiago, there is still a low awareness and lack of opportunity for an increased use of wood for house construction.

It is expected that promotional efforts by the local wood processing industry will progressively produce results and thus the use of wood in construction will be increased. The Instituto Forestal of Chile (Infor) is currently working on a project related to the resistance to fire of wood products in wood frame houses. Results of this and other projects will help to modify current restrictions in building codes and increase opportunities of wood for use in multistorey buildings, etc. [14]

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[12] www.singapore-window.org, several articles (2002).
[13] Building and Construction Authority of Singapore. www.bca.gov.sg
[14] INFOR (2002) Protección contra el Fuego: Investigación y Desarrollo Técnico Comercial para Fomentar el Uso de la Madera en la Construcción.

Indonesia

Indonesia is a large country, with a population of 211 million and a GDP per capita of US$ 860[15], making it also one of the poorest countries in Asia. It is a major producer of forest products, mostly based on hardwood species. The most important species are meranti, ramin and keruing. The country is a leading exporter of wood-based panels, particularly plywood. Indonesia comprises a vast range of different climates, cultures and socio-economic conditions that make generalisations difficult. The current economic situation of the country prevents an optimistic forecast in terms of housing development especially using imported materials. On the other hand, the current political instability has resulted in building codes revisions being of low priority, or if in effect, are difficult to monitor and control. For these reasons, the Indonesian building construction market remains a potentially interesting one for wood products, but not at the present time. Even so, some activity around policy reforms in the building area has been occurring, with partners from Australia having a noticeable presence.

Malaysia

Malaysia is one of the largest producers of tropical hardwood. The wood-based sector is dominated by primary processing activities of sawmilling, veneer and plywood production. Malaysia is the world´s largest exporter of tropical logs and sawntimber, and the second-largest exporter of tropical plywood. Malaysia has developed large remanufacturing and furniture industries, particularly using rubberwood[16]. Malaysia has a population of approximately 24 million with a GDP per capita of about US$ 3,700[17]. The fact that Malaysia is an emerging economy with a rising average income and with increasing demand for housing in the urban centres makes it a very interesting market for building materials. However, there is a preference for non-wood materials in large-scale urban development programs. The Eight Malaysia Plan (2001-2005) considers the construction of 780,000 new units aimed principally to the development of low and medium-to-low cost houses[18].

Mexico

Over the past few years a severe housing shortage in Mexico has dramatically increased. While population growth has actually slowed, the demand for housing has increased. This is because a large segment of the Mexican population is of the prime age for setting up new households. In addition to a shortage of existing houses, many of the existing units are in need of repair.

According to the Mexican Chamber of the Construction Industry (CMIC), a total of 710,000 new homes were built in the year 2000. About 310,000 of these were built through programs operated by Federal Government housing agencies (INFONAVIT, FOVI, FONHAPO) and 400,000 by non-government programs. It is now estimated that Mexico has a deficit of close to six million

[15] The Economist (2002) www.economist.com
[16] FAO (2002) Forestry – Country information. www.fao.org/forestry
[17] The Economist (2002) www.economist.com
[18] The Eight Malaysia Plan (2001-2005). www.epu.jpm.my/RM8/front_RM8.html

homes. Major housing construction companies are planning to build over 1 million new, low-end and middle income homes during 2001-2003.[19]

The majority of houses in Mexico are built with concrete, which is the traditional construction material. Wood products play an important role in construction in the form of timbers, posts, and roof beams, and Mexican consumers are beginning to appreciate the advantages of timber frame construction materials, such as reduced construction times and improved energy efficiency compared with concrete. However, large scale wood frame housing construction is still limited because of resistance from end-users, banks, insurance companies and developers. So consumers still lack knowledge about the quality of wood materials and their durability, as compared to traditional masonry/concrete buildings.

Thailand

Thailand has a population of 63 million with an income per capita of US$ 1,960[20]. Thailand´s primary sources of industrial wood are plantation forests, particularly rubberwood, and imports. The country produces significant quantities of sawn timber and wood-based panels. Imports of logs and sawnwood are important constituents of Thailand´s wood processing sector. Thailand is one of the world´s leading importers of tropical sawnwood.

After Thailand's economic crisis in 1997 led to a massive surplus in residential and commercial buildings from 1997-1999. The real estate industry began to recover in 2000 and continued to grow in 2001. The government has initiated a few measures to revitalise the real estate industry in anticipation of its impact on economic growth.

Thailand developers and consumers favour masonry and other non-wood materials in building house structures. While old-style wood frame houses (mostly seen in rural areas and constructed of tropical wood products) are less popular, a small market for modern-style wood frame houses (such as log homes) has developed, although demand is limited by the high construction cost.

The Philippines

The Philippines is a densely populated country with a low income per capita (US$ 862 in 2001[21]) and marked by a great disparity in incomes and ownership of assets. The construction industry is the largest consumer of wood, but a significant public sector deficit and weak private bank lending will limit spending this year with an apparent recovery expected only in 2003. The entry of non-wood construction materials in buildings and residential houses is also expected to displace the already declining use of wood by the sector.[22] Currently there is a backlog of housing units of around 3.9 million units. However, the funding constraints in the government's program of low-cost housing have caused slow progress in reducing the backlog. Also the

[19] CMIC (Mexican Chamber of the Construction Industry)
[20] The Economist (2002)
[21] The Economist (2002)
[22] USDA GAIN Report (2001) Philippines Solid Wood Products Annual.

government program primarily involves low-cost housing that utilises a minimum volume of wood products.

Vietnam

Vietnam's poverty and weak institutional base makes it a difficult market for suppliers of wood products for the domestic construction sector, regardless of building code issues. Vietnam is a net importer of wood products, importing a total of US$ 133 million in 2000[23]. Although accurate wood products import data are not available, estimates for 2001 of wood product imports were about 470,000 m^3, a slight drop on the previous year. Myanmar, Laos, Indonesia, Malaysia, and New Zealand are the key wood suppliers to Vietnam. Before Laos banned log exports in 2001, it was the largest log supplier to Vietnam. Following the ban, Laos is now the largest supplier of semi-processed wood and, unfortunately, of illegally logged material. In addition to the ban in Laos, it is expected that Indonesia and Malaysia will also ban exports of logs. Vietnam is also an importer of particleboard, plywood, and laminated wood. It is estimated that Vietnam imported (in 2001) more than 200,000 m^3 of manufactured wood products from Indonesia, Malaysia and Australia.

[23] FAO (2002) country information. www.fao.org/forestry