THE NEEDS AND PROSPECTS FOR TIMBER CONSERVATION

by

W.E. Hillis
Coordinator IUFRO Division 5 (Forest Products)

INTRODUCTION

Society is gradually realising its dependence on forests and the many contributions forests make to standards of living. Its understanding of the complexities of forest management is being developed but there is still a great need for a holistic approach to forests and their use in relation to the whole framework of societies, both regional and global. More consideration must be given to the current and potential uses of wood in relation to the non-renewable resources now being depleted and to the creation of situations that will minimise hardships for people beginning to suffer through shortages of forest products. The protection of wood and its products with preservatives can and must play a more important role to extend the availability of forest resources in providing the needs for wood and its products in all communities. There are many prospects where the wood preservation industry could assist the conservation of forest resources. Increasingly there is need for the application and extension of preservation technology to protect the new material obtained from changing resources and as well to preserve all products so that they meet changing requirements.

The Need for Forest Products.

We are all familiar with the many advantages of wood - it is the thirdmost important commodity for humanity, as well as being both energy-conserving and energy-producing, and importantly, it can be regarded as a renewable crop if society permits trees to be used for wood production.
Rarely is attention drawn to the controllable degradability of wood. If of low durability it can be made as durable as a number of other materials in many environments and yet, if need be, it retains the advantage of being inexpensively disposed of. This latter advantage could become important in the rehousing of populations in the future following disasters or when housing standards need to be raised.

In only 16 years the global population will increase from 4.7 billion to over 6 billion people and the population growth will not stop there. The unbalanced nature of this increase in many countries will create problems in providing the basic requirements of shelter and energy for cooking and heating. In industrialized countries there will be increased requirements of wood for new and replaced shelter, furniture and for paper, etc. The increased need for shelter in all countries will require more surface of the earth which will be increasingly in adverse conditions on land or water. Are there adequate supplies of forest products for these and other purposes?

Future Supplies of Wood

Using different projections of consumption, FAO has estimated that the removal of industrial wood from existing global forests will exceed the maximum sustainable yield of about 2.5 billion m3 between the years of about 1995 and 2010 (1). Subsequent to the preparation of the FAO report, investigations have shown the serious effect of acid rain on tree growth in Europe and probably elsewhere over the past 20 years. In addition some of the expected supplies from tropical countries are unlikely to eventuate. Even without these effects on supply, the world production of wood per capita, which peaked in 1976 (at 0.67 m3), has steadily declined (to less than 0.60 m3) so that attention to the amount of available resources is necessary.

A significant portion of the increased demand over the next few years will be supplied by tropical forests on which comprehensive information recently became available in FAO Forestry Papers Nos. 29 and 30 (1, 2). These papers point to the difficulties in gaining accurate comparable data from complex situations and advise caution in dealing with detailed figures.

The estimated recent and projected future demands for wood to supply wood products in the major regions are shown in Table 1. The total demands may be excessive as residuals from the sawlog estimates are used in variable amounts to provide some of the needs for fibre.
Nevertheless, still higher demands for the year 2000 have been estimated by some other observers. Consequently, it is unlikely that current forest resources can provide, on a sustained basis, the higher estimates of global needs of forest products for the year 2010 at present rates of consumption and at present conversion yields (1).

The recent availability of forest products differed from region to region (Table 2) and international trade has been able to even out these imbalances. The expected needs will be higher in the year 2000 (Table 3) and the proportion and amounts of the supplies of industrial softwood and hardwood from different regions will change and increase (Table 4).

A number of claims have been made of the potentially large supplies of wood from the forests of tropical countries. Many of these forests because of ecologically sensitive situations are in a sense non-renewable and also, the areas of productive forests are much less than often claimed. In 1980 there were in the tropical regions about 1.2 billion hectares of closed forest (97% hardwoods) but only 670 million hectares of productive closed

forests over 60 years of age (considered to be the minimum harvesting age), untouched and accessible for use. The amount of forest products available from these forests is uncertain. Less than 15 thousand billion m3 total growing stock exist in the productive closed forests but they have growth rates mainly below 2 m3/ha/yr and an average productivity of less than 0.2 m3/ha/yr.

Furthermore, only a small proportion of the many thousand hardwood species present in tropical forests are used commercially. Few trees of the secondary tropical species yield logs of suitable shape or size for economic conversion to solid wood products even when accessible for harvesting. Big losses occur on conversion and the lumber from secondary species faces marketing problems so that these and other obstacles result in considerable wastages. There is, however, increased attention being given to the greater utilisation of secondary species by local populations necessitating the need to raise the resistance of these species to counter the severe hazards presented in tropical climates.

Renewal of forests in the tropical regions is rapidly falling behind deforestation (Table 5). However, high growth rates exceeding 30 m3/ha/yr have been achieved in a few of the plantations that have recently been established, but the quality of the wood from these sources will differ from that obtained from slow-grown trees of the same species.

An estimated 70% of the world's coniferous wood is in the taiga regions of Siberia and the Soviet far-east which contain most of the timber resources of the USSR exceeding 75 billion m3 and having an annual increment of 575 million m3. These vast resources, which are being harvested at well over 1 million ha/yr have very slow growth rates, difficulties in regeneration, poor accessibility (for about one-third of the area) and remoteness. Currently more than 300 million m3 of industrial wood are cut annually and mainly in the Ural region in the east of the USSR.

Fewer and fewer countries will be able to export wood to an international market which will increase in size from the current $55 billion annually. To meet the increased demand it will be necessary, in the short term at least, to process the increasing proportions of species that are less desirable as raw material (such as aspen) and found in the forests of some countries.

To provide wood for future demands it is evident more attention should be given to increased forest production, protection and the development of improved tree and forest systems. The faster-growing trees resulting from these studies will be harvested at short intervals and will supply higher proportions of juvenile wood and of sapwood to the industry.

One aspect receiving inadequate attention is the considerable benefits achievable in both the short and long term from developments in wood science and technology. In the short term the application of a number of these would result in increased yields from the resource to an extent which would exceed many of those resulting from the success of biological studies. The most effective improvements in wood production however will be achieved by integrating all activities from genetic selection to the marketing of the most suitable end-product and selecting from this spectrum the most suitable areas for development.

Future Types of Wood Raw Material

Increasingly there will be need for more complete use, for wood products, of trees from all types of forests and plantations with significant changes in the species used and in trees with a variety of rates of growth. As a result considerable changes in the nature of much of the raw material will take place.

Among the features of wood from tropical forests will be increasing proportions of non-durable sapwood, increasing proportions of discoloured and incipiently decayed wood and increasing supplies of low durability woods from secondary species. The established forests in the temperate regions will provide increasing proportions of logs from less favoured species, of decreasing diameters and of variable quality. These will be more variable, contain more sapwood, wetwood, knots and other unfavourable characteristics and wood of variable quality.

The fast-grown, short-rotation plantations established to meet increasing demands will provide small-diameter logs containing increasing volumes of juvenile wood, corewood, sapwood and less-durable woods with their different physical properties and chemical composition.

Future Market Requirements for Wood Products.

Markets will be increasingly influenced or controlled by the material aspects of

- cost
- performance standards rather than products standards
- international standards based on performance rather than origin or type of wood
- labour costs
- the appearance of the product
- the changing nature of products designed or promoted to meet present-day requirements for living or industrial use

  requirements to meet hazardous environments.

Also, the human aspects will involve

- technical people concerned with all materials and not solely wood
- customers seeking a high degree of predictability of quality and assurance of supply of a particular quality.

The important human link in the chain of requirements must not be

overlooked. Many of the current workforce handling wood have now neither the opportunity nor adequate knowledge to give detailed attention to maintain quality control for the production and the use of a variety of wood products. Consequently, for some uses, wood requires protection against misuse if long term damage is to be avoided. Also, labour costs will be minimised by the provision of products of uniform quality, appropriate sizes with low in-place maintenance costs.

The forest resource will be used more effectively with the increased understanding by the community of the characteristics, limitations and advantages of wood and its products.

Future Developments

The shortages of forest products in many countries will worsen and necessitate increased international trade. In turn there will be a greater need for the remaining exporting countries to use more of the trees available for wood production so as to extend the life of their forest resources. Increasing transport costs will favour the export of value-added products acceptable in the customer's marketplace. The more comprehensive use of the forest resource will necessitate more conversion of small-size wood pieces, resulting from management of the forest or from the factory residues, into larger-sized materials with the required durability and stability for particular environments. This will necessitate the development of more versatile wood adhesives, or a larger range of adhesives, providing bonds that are durable in various environments, and that can be easily applied. These adhesives will need to resist degradation by micro-organisms and insects, be unaffected by wood preservatives, sufficiently flexible to accommodate changes in dimensions of wood particles with moisture changes, and maintain strength over long periods.

Greater attention to the preservation and protection of an increasingly wide range of wood and wood products is required so as to reduce loss, extend the service life of products and to meet increasingly hazardous environments, stringent marketing criteria and to be able to withstand the scrutiny of an increasingly aware public. The processor will need to protect logs and wood products during storage and transport so that high quality end-products can be obtained.

Research must be maintained and expanded to enable future preservation or protection of:

- new raw material with different properties coming from different species or changing resources which contain for example more sapwood

- new products (such as panel products and composite wood materials) to meet present day needs

- building materials used in hazardous climates (e.g., hot and moist) and situations to house an expanding high density population who could use treated wood inappropriately

- the infrastructure necessary to extract the mineral resources (e.g. iron ore, bauxite) found in harsh environments.

Also, more basic data are needed to assist decision-making when new situations are encountered in a rapidly changing world. Data are required on the penetration of preservatives into the wood substrate, the mechanisms of wood decay, the interaction of new preservatives with glues, etc. and with the environment.

Not only for the extension of their resources, timber exporting countries must also become aware of the environments in which their products could be exposed and of the potential disaster (e.g. 3) that could result from inadequate preparation, and inappropriate use, of their products. For example, wood products will be increasingly used in a wide range of climates that are subject to severe termite attack or soft-rot decay or surface damage by photodegradation. Furthermore, because of the greater dangers of misuse of modified wood products in overcrowded living conditions (such as burning arsenic-treated wood), there is increasing need for inexpensive biocides for wood protection that are suitable for such conditions.

The rapid destruction by the giant northern termite (Mastotermes darwiniensis), and drywood termites (e.g. Cryptotermes spp. 4,5), of building material placed on or above the ground without proper protection is causing considerable economic loss. Protection can be afforded by penetration to required retention levels of appropriate preservatives.

Attention has been drawn to the increasing importance of soft rot damage and the inadequate protection resulting from the selective penetration of components of CCA into the cell wall (6-8). Improved preservation technology for poles and posts is needed both of a remedial nature (9) and of an improved initial preservation not only to serve an important market but also to assist management of plantations in providing uses for thinnings.

An improved understanding of durability is obtained if a chemomorphological approach is taken. For example, the high silica content such as that found in several species growing in tropical countries is probably not, as commonly believed, responsible for durability to marine organisms such as Bankia spp. (10) but rather the durability is probably due to the organic extractives (11). Moreover with some woods the toxic components can be leached with running water so that surface

coatings or barriers are required to maintain extended durability under marine conditions.

If the most effective protection is to be achieved and maintained, the toxic substances must penetrate the capillaries in the cell wall, such as takes place during heartwood formation. There have been few studies on the total volume of the capillaries in the cell wall, their size and variations with species, with density or rate of growth. The limited evidence available indicates the capillaries accommodate 25% of the volume of the cell wall in undried sapwood and have cross-sections from 160-600 nm (see review 12) and are large enough to accommodate a number of extractive molecules with a linear form. The packing density of the cell wall and presumably the proportion of capillaries, would affect the capacity for water adsorption (13) and also for preservative molecules. There is evidence of variation of the packing density of cell wall in woods of different density (14). It is unknown whether the difficulties in removing "extractives" from the cell wall of heartwood with polar or swelling solvents is due to changes of the extractives in the cell wall, their reaction with cell wall components, or whether the "extractives" are trapped in the capillaries when these collapse in dried cell walls. The difficulties in obtaining useful bioassay results by soaking dried wood in solutions of toxic extractives could be partly due to difficulties in penetrating dried wood.

As the toxic part of the preservative molecule should penetrate the cell wall, the development of small-sized molecules composed mainly of toxic moieties will provide more effective preservatives. Just as research on reactive moieties have led to the spectacular development of chemotherapeutic agents with a wide spectrum of effects or with specific activities against particular micro-organisms so also could more effective, non-hazardous preservatives be developed. This approach has been taken to determine the active moieties in the extractives of some marine durable species (11). A similar approach has been developed following studies of extractives of durable species, particularly Dalbergia retusa, and the development of insecticides and pesticides (15). In another approach, a theory developed from basic research on the action of insecticides at the neurophysiological and biochemical levels has led to agents of highly selective, insecticidal activity but with low fish and mammalian activity (16, 17).

Obviously, adequate penetration of preservatives is the prerequisite for satisfactory protection. The poor penetrability of some woods presents a formidable problem to wood preservers. The answer may lie in the selection before treatment of the material destined for highly hazardous environments so that only penetrable material is treated in order to improve productivity in economic terms and to guarantee ultimate performance.

Attention has long been given by the industry to the preservation and protection of wood used above ground in buildings in temperate climates with changes in the substrate being recognised. For example, window frames were formerly made by craftsmen from selected material that was mainly heartwood. More recently the material containing high properties of sapwood has been used in mass-produced assemblies with decay-prone jointing and covered with more brittle types of paint so that prior preservative treatment of the wood is now required.

The protection of the exposed surfaces of wood and its products, is more difficult in tropical and subtropical countries where the long hours of direct sunlight, high temperatures and variable conditions of humidity can lead to rapid deterioration of building materials. There are prospects to develop compounds to capture the free-radicals which appear as key steps in the degradation of cell wall components during exposure to sunlight. As well the development of stable flexible coatings adequately penetrating, interlocking and stabilising the outer layers of the wood will further extend the life of building material.

Conclusions

Within a few years the global forest resources will be unable to provide a sustained yield of forest products if the present patterns of use continue. Existing resources can be conserved by extending the service life of forest products as well as by utilising a greater proportion of the forest resource in the form of composite products. Fast-grown plantations will replace some natural forests but will produce material with properties different from slow-grown timber. With all these continuing developments, wood preservation technology will play an increasingly important role. Its success will depend on increased understanding of the basic aspects of the fundamentals of wood decay and of preservative processes applied to wood and composite wood products.

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TABLE 1
ESTIMATED DEMAND FOR WOOD (in million m³)
TO SUPPLY INDUSTRIAL WOOD PRODUCTS[1]

Region	Product									Total		
	Sawnwood			Wood-based panels			Paper					
	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000
WORLD	864	988	1083	174	226	270	504	717	1000	1542	1931	2353
Developed Market Economies	467	515	540	134	170	195	389	529	708	990	1214	1443
North America	224	245	253	66	80	88	196	258	336	486	583	677
Western Europe	141	154	163	48	64	78	120	171	221	309	389	462
Oceania	13	13	15	2	3	3	8	11	17	23	27	35
Other	89	103	108	18	22	26	56	90	134	163	215	268
Developing Market Economies	87	131	171	10	18	29	48	81	148	145	230	348
Latin America	32	42	51	5	8	13	25	42	73	62	92	137
Africa	9	11	19	2	3	5	6	8	11	17	22	35
Near East	11	15	17	2	3	5	6	14	31	19	32	53
Far East	34	63	85	2	3	6	14	22	36	50	88	127
Centrally Planned Economies	310	344	378	30	38	48	67	104	157	407	486	583
USSR, E.Europe	268	292	317	27	34	42	48	70	109	343	396	468
Asia	42	53	61	3	5	6	20	34	48	51	92	115

(1) Calculated from data in FAO Forestry Paper No. 29 (1982) (1)

TABLE 2
FOREST RESOURCES AND UTILIZATION IN 1974 to 1976[1]

Region	Forest area 1975		Apparent annual consumption		Net trade		
	Closed forest	Other woodland	Industrial roundwood for processing	Forest products in roundwood equivalent[2]	Industrial roundwood	Processed wood (in roundwood equivalent)	Total (in roundwood equivalent)
	Million hectares		. . . . million m³. (Imports-; Exports+).				
WORLD	2 860	1 070	1 185	1 185			
Developed Market Economies	693	243	732	763	-44	-31	-75
North America	510	120	412	390	+22	+22	+44
Western Europe	108	18	208	250	-18	-42	-60
Oceania	50	100	17	18	+ 3	- 1	+ 2
Japan	25	-	86	95	-50	- 9	-59
Other	-	5	9	10	- 1	- 1	- 2
Developing Market Economies	1 222	642	109	100	+32	+ 9	+41
Africa	203	360	10	12	+ 5	-	+ 5
Latin America	695	180	47	47	-	-	-
Far East	310	35	46	32	+27	+14	+41
Near East	14	67	6	12	-	- 6	- 6
Centrally Planned Economies	945	185	344	322	+12	+22	+34
USSR, E.Europe	815	135	287	265	+12	+22	+34
Asia	130	50	57	57	-	-	-

(1) Adapted from FAO Forestry Paper No. 29 (1982) (1)
(2) Includes, in addition to wood for processing, roughly 10 per cent of miscellaneous industrial wood, e.g. pitprops, poles, pilings normally used in the round; more than half is consumed in centrally planned economies

TABLE 3
ESTIMATES OF WOOD REMOVALS AND UTILIZATION IN THE YEAR 2000 (1)

Region	Removal of industrial wood	Apparent consumption		Net trade		
		Industrial roundwood for processing	Forest products in roundwood equivalent	Industrial roundwood	Processed wood (in roundwood equivalent)	Total (in roundwood equivalent)
	. . . . million m³ . .(Imports-; Exports+)					
WORLD	2 085	1 930	1 930	-	-	-
Developed Market Economies	1 093	1 138	1 190	-78	-52	-130
North America	642	617	581	+10	+36	+48
Western Europe	320	325	384	-16	-59	-75
Oceania	58	41	30	+16	+11	+27
Japan	58	143	175	-86	-32	-118
Other	15	12	20	- 2	- 8	-10
Developing Market Economies	365	274	238	+44	+36	+80
Africa	60	28	21	+10	+ 7	+17
Latin America	124	108	98	+ 5	+10	+15
Far East	161	128	96	+29	+32	+61
Near East	20	10	23	-	-13	-13
Centrally Planned Economies	627	518	502	+34	+16	+50
USSR, E.Europe	531	444	428	+34	+16	+50
Asia	96	74	74	-	-	-

(1) Taken from FAO Forestry Paper No. 29 (1982) (1)

TABLE 4
SUPPLY OUTLOOK FOR INDUSTRIAL ROUNDWOOD IN THE YEARS 1980 AND 2000 FROM DIFFERENT REGIONS (1)

Amount supplied by	Softwood		Hardwood	
	1980 %	2000 %	1980 %	2000 %
North America	38.8	34.2	23.0	24.0
Western Europe	17.7	16.4	16.0	14.0
Japan	2.5	3.5	3.0	1.0
Latin America	2.2	4.4	7.0	9.0
Asia, Africa, Oceania	2.5	5.0	30.0	35.0
Centrally planned economies	36.3	36.3	21.0	17.0
<u>Interregional shipments</u> (in million m³)				
Sawlogs	22.7	32.3	24.8	18.8
Pulpwood	18.6	28.0	6.7	24.4

(1) Taken from FAO Forestry Paper No. 29 (1982) (1)

TABLE 5
ANNUAL RATES OF DEFORESTATION AND PLANTATION DURING 1981-1985
(in million hectares)

Tropical region in	Annual rates of deforestation			Plantation	Plantation: deforestation ratio
	Tree formations				
	Closed	Open	All		
America	4.3	1.2	5.6	0.5	1:10.5
Africa	1.3	2.3	3.7	0.1	1:29
Asia	1.8	0.2	2.0	0.4	1:4.5
Total	7.5	3.8	11.3	1.1	1:10

(1) Adapted from FAO Forestry Paper No. 30 (1982) (2)