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GREATER UTILIZATION, ON A SUSTAINABLE BASIS, OF WOOD INCLUDING COMMERCIALLY LESS-ACCEPTED SPECIES AND PLANTATION SPECIES AS A SOURCE OF INDIGENOUS BUILDING MATERIAL IN HOUSING AND CONSTRUCTION*

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the United Nations Centre for Human Settlements (HABITAT)

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CONTENTS

I. The significance of wood, including CLAS and plantation species, for housing and construction in developing countries

1. An important objective of the Second Consultation on the Wood and Wood Products Industry is to promote greater use of wood, particularly CLAS and plantation species, in housing and construction, inter-alia, as a means of improving access of low-income groups to shelter, and thus to better living conditions. Ensuring the availablity of indigenous building materials, that are durable and can be afforded by the low-income groups, is also, a central concern of the Global Shelter Strategy.1/ The Strategy lays special emphasis on the exploitation of local resource endowments, particularly, of renewable resources, by using labour-intensive, optimum-scale that can make full use of local factor inputs and proximate markets.

2. Several building materials have been identified which, if effectively promoted, can significantly ease the current shortage of building materials, notably, fired-clay bricks and tiles, soil blocks, low-strength binders, and timber. Of all the locally available building materials, wood, in particular, the renewable plantation species and the commercially less-accepted species (CLAS), offer many advantages, and if properly managed and exploited, can serve as an abundant source of a locally available building material.

3. The merits of wood, as a building material are, first and foremost, technical. It has high structural resistance and resilience in relation to weight. In addition, wood has excellent thermal efficiency and sound insulation qualities. Processing of wood requires less energy, per unit weight, than other comparable materials. Due to technological innovations, the durability of wood can now be ensured; indeed, low-cost techniques are now widely available to ensure resistance of wood against bio-degradation. Similarly, architectural and design techniques and protective linings now permit adequate resistance of timber constructions against fire much in the same way as competing materials will survive a fire attack.

4. In its natural state, as well as with minimal processing, wood can be used to construct an entire building: both in sub-structure and superstructure, in flooring, walling as well as in roofing. Wood is relatively easy to work with, and secondary processing for basic use as structural or roof-cladding material can be attained with rather rudimentary equipment. Wood can easily lend itself to prefabrication techniques for mass housing. Considerable scope, in fact, exists to speed up construction and to reduce costs by large series of basic components such as door frames, timber posts and beams, purlins and rafters, and components for roof trusses. Prefabrication of walling components such as panels have proved to be commercially viable in many developing countries, e.g. in Kenya, Mexico, Zimbabwe, and in the Philippines.

1/ The Global Strategy For Shelter To The Year 2000, UNCHS, 1990, HS/185/90/E.

5. One special technical merit of wood as a material for shelter construction is that in most developing countries there already exists some basic local infrastructure: chain-saw operators felling timber, saw-millers dealing in primary processing, and joinery workshops dealing in secondary processing albeit with relatively simple equipment and techniques but, nevertheless, yielding valuable components for timber construction. Similarly, in almost all building sites, basic carpentry skills are already available. There is also some local knowledge and practice of seasoning of timber and preservative treatments even though much scope exists for introducing new techniques to improve efficiency and effectiveness.

6. From the socio-economic point of view, wood offers several advantages over other comparable building materials. In the backdrop of continued import depencence of building materials industries, in most developing countries, timber construction, using locally available species, requires little dependence on foreign exchange, and its labour-intensive character provides opportunities for employment generation and rural industrialization. It is also to be noted that developing countries are facing increasingly stiffer competition from temperate species of the industrialized countries in Europe and North America in exporting their timber for use in construction. On the other hand, domestic housing and construction should provide an important market for plantation species and CLAS from natural forest.

7. From a financial point of view, timber construction in housing has proven to be cost-effective over other construction tecnniques using predominantly indigenous materials. In Colombia, Ecuador and Peru, timber-based house construction has led to cost reduction between 10 and 18 per cent over traditional construction using blockwork, cement and steel. Cost comparisons for Andean Pact countries indicate even higher cost reduction potential of timber construction. In Yangoon City, traditional timber-frame structures with brick-filled walls achieve 25-28 per cent savings over reinforced concrete structures, and 10-16 per cent over masonry structures.2/

8. In considering wood as a cost-effective building material, special attention must be given to the yet untapped potential of CLAS and certain plantation species, in countries endowed with these resources, to serve as a sustainable source of indigenous material in meeting the construction requirements of shelter and physical infrastructure development. For a variety of reasons, these species - more than the commercial timber species - hold the key to a successful strategy for greater utilization of wood in housing and construction.

9. FAO estimates that selective harvesting of commercial species in the tropical forests has led to the utilization of only 5.4 per cent of the standing volume.3/ An important result of greater exploitation of CLAS from

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2/ See Annex 1.

3/ O.P. Hansom, Promotion of Commercially Less-accepted Species, UNIDO, ID/WG.395/1, 1983.

tropical forests would be the increase in volume and value extracted per hectare, reduction in the unit cost of extraction, and, most importantly, the lengthening of the lifetime of the natural forest.

10. The growing volume of industrial plantations, which now occupy an estimated 48 million hectares and is annually growing at a rate of about 2 million hectares[4/] (and in tropical regions, even larger areas can be brought under coniferous plantations of rapid growing species to keep pace with the rising demand), can, with proper forestry and timber conversion practices, serve as a renewable source of an indigenous construction resource in many developing countries, particularly, in Asia but also in Brazil and Chile. While the supply of softwood from coniferous species (which constitute around half of 35 million hectares of industrial plantations in Asia) has to meet the demand from competing industrial sectors (e.g., paper, matchbox, packaging industries etc.), the extensive rubber and coconut plantations in India, Indonesia, Malaysia, Philippines, Thailand and Sri Lanka can yield significant quantities of rubber wood and coconut wood to service the domestic construction market. In the Philippines alone, the annual yield of coconut stem is around 6 million cubic meters, in Sri Lanka, some 430,000 cubic meters, and about 32,000 tonnes in Malaysia.[5/] Similarly, overmatured trees from rubber plantations (Malaysia alone has about 2 million hectares under rubber plantations) can ensure a regular supply of timber that can be used for joinery, roof trusses, flooring, and in laminated sections after seasoning and preservative treatment using simple dip diffusion methods.

11. Even though the marketing channels for CLAS and some of the plantation species (e.g. rubber wood, coconut wood etc.) are yet to be fully established in most developing countries, the distinct price advantage of these species over the commercial species is quite clear.[6/] For one, the dwindling supply of the commercial species of tropical hardwoods, their export potential, and the demand for these species exerted by the upper end of the market, raise their price in the domestic market to a level that can hardly be afforded by the low-income groups for their shelter needs. In contrast, both logs and sawnwood yielded by CLAS and the plantation species are available in relative abundance and they almost exclusively cater to the domestic market. Specifically, if the CLAS are grouped, these can be used by proximate markets reducing transportation costs. All these factors make CLAS and plantation species particularly suited to meet the construction needs in developing countries.

4/ A.J. Ewing and R. Chalk, The Forest Industries Sector: An Operational Strategy for Developing Countries, the World Bank, Washington, D.C., 1988, p.18.

5/ UNCHS Consultant's Report (Unpublished), 1990.

6/ O.P. Hansom, op. cit, p.23.

12. Recent studies indicate that the strength properties of several commercially less-accepted species compare well with the commercial species. In Sri Lanka, CLAS such as Alstonia, Seligna, Ginisapu etc.(which are known to have a commercially viable standing volume in natural forests) exhibit bending and compressive strengths comparable to, and sometimes, in excess of those exhibited by commercial species such as Teak, Mahogany, Jack, Palu etc. Similarly, in the Philippines, plantation species such as Pine and Bagras exhibit strength properties comparable to those of Apitong and Lauan, conventionally used in construction. What is, perhaps, more important, is that the minimum strength of most of the CLAS and plantation species are well above that demanded by the strength requirements of low-rise construction.

13. A particular advantage of CLAS and plantation species is their suitability for use in pole construction, particularly for low-income shelter. Thinings from softwood plantations and logs from a variety of commercially less-accepted species can be used for pole frame construction to erect structures on flat land, on hillsides, over streams and ravines, or on marshy and swampy grounds, wherever low-cost shelter projects are undertaken. Because of its versatility, pole frame construction for housing has been standardized in New Zealand using treated roundwood of Radiata Pines.7/ Pole frame construction using CLAS has also been popularised in Papua New Guinea.8/

14. Together with CLAS and plantation species, certain species of bamboo merits close consideration as one of the fastest growing and highest yielding renewable natural resource that can be harnessed for housing and construction in developing countries. The ease with which it can be worked with, its versatility, strength, and the short harvesting cycle of about 5 years, makes it particularly suited for low-cost housing as demonstrated in a number of countries of Asia, South America, and Central America, most notably, in Costa Rica, where the National Bamboo Project, supported by UNCHS and the Government of the Netherlands, has established a replicable programme of bamboo house construction, mainly, through community and self-help, at costs that can be afforded by the low-income groups.9/

15. Another potential raw material for the building materials industry is the waste generated by the primary wood processing industries through logging operations and by the saw mills. It is estimated that logging wastes in the form of damaged residuals, tree tops and branches, high stumps and abandoned

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7/ Construction of Pole-system Housing: Timber and Wood Products Manual, TRADA, Wellington, 1976.

8/ Pole Buildings in Papua New Guinea, Forest Products Research Centre, Department of Forests, Papua New Guinea, 1975.

9/ World Resources, 1990-91 The World Resources Institute, Washington, D.C., 1990, p.80.

logs can be as high as 0.8 cubic meter for every cubic meter of log removed from the forest. Mill wastes are around 0.5 cubic meter for every cubic meter fed into a sawmill or a plywood mill.[10]

II. Existing barriers to greater use of wood, including CLAS and plantation species in housing and construction

16. Even though promotion of commercially less-accepted species, and greater utilization of wood in construction, have been debated over the years and some of the member governments have made noteworthy efforts in this direction, the full potential of wood, particularly, CLAS and plantation species, as a sustainable source of indigenous building material is yet to be fully realized. A host of factors have contributed to this situation which can be broadly grouped as: (a) prejudices against use of wood in housing and construction, (b) lack of adequate technical information and regulatory instruments necessary for proper use of the material by the industry, (c) lack of appropriate technology and inadequate industrial infrastructure, and (d) ineffective government policies. Acting together, these factors constitute an effective barrier against greater utilization of wood in housing and construction. Further analysis under this section elaborates on the nature and operation of these factors.

(a) Prejudices against use of wood in housing and construction

17. Despite the long history of use of wood in construction, in both developed and developing countries, and the accepted use of wood in house construction in some industrialized countries in Europe and North America, prejudices still exist in the developing countries with regard to wide adoption of wood in construction. These prejudices are not only restricted to end-users but extend to specifiers, stockists, and agencies engaged in housing finance. Primarily, these prejudices relate to the fire-resistance and durability of wood. Even though in industrialized countries, the wide acceptance of wood in construction is the result of established fire-safety practices - ranging from appropriate architectural and design provisions to protective linings in hazardous areas - and preservative treatments with assured life expectancy (for example, pole frame houses in New Zealand using Radiata Pine poles treated to NZ TPA specification have an assured life expectancy in excess of 80 years,[11] such practices are absent or are unreliable in most of the developing countries, specifically the use of treated timber for foundations. The result is that in many developing countries, banks and insurance agencies are reluctant to finance timber construction or charge higher premium for such construction. This is a crucial problem which must be resolved through the introduction of improved practices if CLAS and plantation species are to be successfully promoted for construction. Most demonstration projects

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10/ Logging and Processing Residues: Their Potential, Industrial Forestry Task Force, Forestry Development Centre, UPLB, Philippines, 1989.

11/ TRADA: ibidem.

organised by government agencies have failed to create a favourable impact for lack of good practices and for their inability to demonstrate the competitive position of timber in construction in relation to other building materials that it can replace. The demonstration of cost-effectiveness of timber in construction is very important and this should be done using a methodology that is accepted by the industry and is replicable in other projects.

18. Prejudices also arise because of uncertain quality of timber and when the supply of particular species is irregular and unreliable. Stockists and sawmillers are usually hesitant to stock lesser-known species, unless these have established end-uses and their regular supply is assured. The reasons for the failure of CLAS and plantation species to effectively penetrate the construction market are the excessive reliance placed on its price advantage alone, and the negligence to stock timber for construction, the more so lesser-known species, which have greater resemblance to established species or those that possess special properties which make them attractive for particular end-uses.

(b) Lack of technical information and regulatory instruments

19. An important constraint that inhibits the confident use of wood in structural applications, by designers and specifiers, is the lack of reliable technical information relating to its strength and deformation characteristics. Most species have sufficient strength data to permit their use in shelter and load-sharing constructions, but in many cases it is insufficient for highly stressed members and timber engineering in its broader sense. Also, much work needs to be done to establish timber engineering design codes suitable for developing countries which would allow promotion of timber construction with the minimum of delay but at the same time would be formulated in such a way as to be able to be harmonized with international codes (e.g. EUROCODE 5) at a later stage.

20. The heterogeneity of tropical timber and the large number of disparate commercially less-accepted species pose a special marketing problem. In the context of promoting these species for the construction market, the practice of grouping these species together, based on strength or end-use criteria, is required to be established in developing countries. Visual stress grading is seldom practiced and even though machines for stress grading or proof lodging exist, these are expensive and relatively sophisticated for wide use.

21. The lack of technical information is compounded by inadequate efforts in most developing countries to diffuse available information to the industry in a manner and form that could be readily utilized by designers, specifiers etc. Simple, clear standards and codes of practice, suitably illustrated design manuals and detailing aids can facilitate the work of designers, field supervisors and craftsmen, thus creating a favourable atmosphere for use of wood in construction. Research institutes have come up with such design manuals, but such manuals (for example, the manual on use of coconut wood in

construction prepared by UNIDO),[12] have not been sufficiently popularised through workshops, short-term refresher courses etc. Government departments have done little to train or familiarise construction staff in timber construction practices to promote cost-effective use of wood available in local markets. Education of civil engineers and architects in timber engineering has also been neglected.

22. The lack of appropriate building legislation, supported by standards and codes of practice for use of timber in construction, is another serious constraint in promoting greater use of wood, particularly, CLAS and plantation species in housing and construction. In some countries, existing municipal building codes do not include timber as a building material and thus, effectively exclude its use in government-sponsored housing programmes. In most developing countries, the codes of practice are derived from code of developed countries (with which they had colonial links) and are unduly restrictive of the use of locally available species (particularly, coconut wood which is abundantly available in most of these countries) which could otherwise be profitably utilized in low-income housing.[13] An important consequence of inappropriate building regulations is that the banking and insurance agencies, which rely solely on these regulations, fight shy of financing or insuring timber construction thus effectively restricting both private and public initiative to promote timber in house construction.

(c) Lack of technology and inadequate industrial infrastructure

23. In the area of appropriate technology, and industrial infrastructure for processing of timber for construction, there are several gaps in most of the developing countries. Rudimentary technologies for both primary and secondary wood processing are used in most countries, leading to chronic low productivity and gross inefficiencies in the industry which, ultimately affect the economic viability of most enterprises. For example, even though some developing countries, notably, Venezuela and the Philippines have solved the problems of sawing high density CLAS of timber,[14] rudimentary practice using two-man ripsaw is still widely used in several Pacific Island countries resulting in extremely low recovery of dimension coco -lumber. In the area of secondary processing also, affordable, modern, small-scale technologies to process CLAS and plantation species into panels for wall-cladding and roof shingles are not easily available to small entrepreneurs. In advanced level

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12/ R.N. Palomar and J.O. Siopongco, Technology Manual on Coconut Wood as Construction Material, UNDP/UNIDO Regional Network in Asia-Pacific for Low-cost Building Materials Technologies and Construction Systems.

13/ H.P. Brion, Secondary Wood Processing in Asia and the Pacific, UNIDO, ID/WG.500/4(SPEC), 1990, p.51.

14/ Promoting Secondary-wood Species in Support of the Global Shelter Strategy, UNCHS, 1990.

of secondary processing such as for composite materials, e.g. wood-chip boards and wood-cement panels, because of investment constraints the existing machinery is usually at a scale that is not commensurate with the effective demand of the local market.

24. In the area of preservation and treatment against bio-degradation, an array of technologies - from rudimentary through small-scale to sophisticated - are available in the international market. However, in many countries, these technologies are not used in a cost-efficient manner by the small-scale sector of the secondary processing industries. Portable solar kilns, fabricated with locally available materials, can drastically reduce the seasoning cost of any timber,15/ but their adoption is still restricted to a few countries.

III. Final considerations

25. Section I of this paper outlines the rationale for greater utilization of wood, particularly, CLAS and plantation species, in construction. Section II, then, proceeds to analyse the key constraints that currently inhibit greater contribution of the wood processing industry to construction, in particular, to the shelter sector. The Consultation may like to focus its attention on these key constraints, and then, deliberate on the policies, strategies and practical measures that could be adopted by member governments and the international community to enhance the role of the secondary wood processing industry in the growth of housing and construction in developing countries.

26. In the areas of national policies and strategies, the Consultation might wish to highlight the need for greater efforts to promote CLAS and plantation species, more funding for research and dissemination of technical information to the industry and as concerns individual countries that consideration be given to ensure that building codes are adopted which take into account the merits of wood as a building material.

27. The Consultation may wish to affirm that greater use of wood in construction is consistent with the environmentally sound management and the use of the tropical forest and to emphasize in particular the role of CLAS and plantation species could play in this regard. It may then wish to affirm that the following measures would be likely to increase the use of CLAS and plantation species:

(i) Improving the quality of technical information on the use of wood, and particularly of CLAS and plantation species, in construction;

(ii) Improving the methods by which information is placed at the disposal of designers, builders, specifiers, and end-users in the construction and wooden building components industries;

15/ Solar Seasoning Kiln for Sri Lanka, UNCHS Project Report (Unpublished), 1989.

(iii) Ensuring that there exist effective and clear wood construction standards or codes, which embrace such items as grading, dimensioning, preservation, fire safety, and ability to withstand earthquakes;

(iv) Improving the training of graders, designers, detailers, and others, such as management and certain governmental officials. Such training programmes should relate to the requirements of those working directly in the construction industry and those in the industrial sector who are producing wooden components for the construction sector. Key personnel in government and various support industries such as finance and insurance should also be trained in the evaluation of wooden construction techniques;

(v) Using carefully designed demonstration projects to illustrate the strengths of wood, and particularly CLAS and plantation species, as a construction material;

(vi) Improving information concerning potential commercially viable supplies of CLAS and plantation species, would be helpful in developing markets for these woods. Such information would also help to focus research and development activities on those woods which ultimately could be expected to have a significant market potential;

28. The Consultation may like to lay emphasis on three areas requiring institutional support. First, there is a need for supporting research effort in developing countries aimed at (i) establishing reliable design parameters for tropical species, particularly, CLAS and plantation species, (ii) developing low-cost techniques for seasoning and preservative treatment, and improving fire-resistance of wood construction, and (iii) popularising simple field-identification techniques for tropical species, particularly, CLAS. Secondly, effort is needed to ensure commercialization of research results. The value of product promotion has been amply demonstrated in the case of rubber wood in Malaysia, where it has been developed from a source of fuel-wood to a competitive material for furniture-making. Instead of relying solely on price advantage for marketing promotion of CLAS and plantation species, attention should be given to standardizing and grouping of species based on strength and specific end-use. Thirdly, achievements in the area of timber technology, in a number of timber producing developing countries, provide a promising basis for South-South co-operation. For example, rubber wood technologies developed in Malaysia can be gainfully used by such rubber producing countries as Ghana, Liberia, and Nigeria. Similarly, bamboo construction techniques developed in China, Colombia and Costa Rica and research work carried out in the Netherlands can accelerate low-cost shelter delivery programmes in a number of countries. North-South co-operation would benefit the developing countries in such areas as timber resource assessment, nomenclature, grading rules, standardisation and modularisation of dimensions.

Annex 1

Cost per unit floor area of different types of structures in Yangoon, Myanmar, with advantages and disadvantages

No.	Type of structure	Cost per unit area Kyats per sq. ft.	Advantages & disadvantages
1.	Masonry structure with load bearing walls	180 - 220	Walls are thick enough to carry loads and absorb heat duri g day time and transmit it indoors during the evening. Less earthquake resistant than other structures.
2.	Reinforced-concrete frame structure with brick filling walls	20C - 280	Good thermal performance, good earthquake resistance, most expensive of all types.
3.	Timber-frame structure with brick filling walls (brick nogging structures)	150 - 200	Good thermal performance, good earthquake resistance. Durability subject to quality of timber used.
4.	Timber-frame structure with timber walling	40 - 60	Good thermal performance, good earthquake resistance. Shorter life than masonry structure, about 80 years, flammable.
5.	Bamboo structure or mixed timber and bamboo structure	6 - 10	Good thermal performance, good earthquake resistance. Shortest life and highly flammable.

Source: Yangoon City and Regional Development Project, UNCHS (Habitat) unpublished report, 1985.