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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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MEASURES TO STRENGTHEN AN ENVIRONMENTALLY SOUND SUSTAINABLE SUPPLY OF TIMBER RESOURCES*

Prepared by the
UNIDO Secretariat**

* This document has not been edited.
** Based on the work of A.J. Leslie, UNIDO Consultant

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The cause for concern

1. The supply of timber for the secondary wood processing industries is governed by the supply of raw material from the world's forests to the primary forest industries. The current annual removals from the world's forests to satisfy the demand of the world's forest industries amount to somewhat less than an average 0.5 m3 per hectare. Therefore as the World Bank has noted, there is no imminent shortage of industrial wood.

2. This cannot be taken to mean that the supply is assured for all species of importance or interest, or that local supply will be adequate in all regions. The availability of some species will continue to decline, reaching before too long, the point at which they virtually disappear from the timber catalogues. The true Rosewood and Mahogany as well as Afromorsia and Ramin are notable candidates for that list. Overcutting and the clearance of forests for agriculture are solely responsible for this fact. Some regions in which the local wood supply-demand balance is already in deficit, will stay that way. In some the gap will continue to widen, while others will gradually slide into deficit. In a few, the present deficits will be reversed as their plantation and re-growth resources mature.

3. However the recorded removals are only part of the drain from the forests occasioned by industrial wood operations. Each tree felled for its industrial wood value yields logs and pulpwood which, if removed, enter the recorded removals which residual roundwood does not. Nor do logs and pulpwood which, for various reasons, are left in the forest. Yet it is the felled tree which constitutes the real drain, not just the part which is recorded as removed. In the more intensively managed forests the discrepancy may be quite small. In the majority of the world's forests, however, the logging residual component of the drain can be quite substantial, especially in those where there is no market for pulpwood or small or defective logs. The removal statistics for the world as a whole could well understate the drain associated with industrial wood utilisation by 30 to 40%.

4. Taking these considerations into account, the present annual drain, for industrial wood, shows an average of 0.7 m3 per hectare. How this compares with the average growth potential of the forests is hard to say with certainty since such estimates are scarce and fragmentary. Overall however, the average current annual increment, in terms of industrial wood could hardly be less than 2 to 3 m3 per hectare. On that basis the potential supply capacity of sustained yield forest management, left to itself, has plenty in reserve to meet rising demands for industrial wood.

5. However, this optimism must be tempered by the effects of acid rain in the temperate regions and by losses due to a number of factors resulting from the absence of effective forest management in the tropical regions. While strong environmental measures have been initiated in some countries to reduce acid rain these measures have come too late to reverse some of the damage. While loggers in the industrialized countries may be able to count on support from environmentalists to combat acid rain, they are certainly at odds concerning the amount of forest land which should be withdrawn from logging to protect sensitive environmental values. There is significant pressure as well as for withdrawal of portions of the tropical rainforest from logging in order to reduce the rate at which the genetic heritage is being lost and to protect other values.

6. However the main threats to the tropical forest are not from industrial logging but from slash and burn agriculture and unmanaged fuelwood gathering. Indeed while industrial logging can contribute to the destruction of the tropical forest if not undertaken under a forest management plan, its effects have the potential of having exactly the opposite effect by helping to bring a larger portion of the tropical forest under management. Bringing forest land under management is critical. First this can ensure that conversion of forest lands to other uses does not occur by accident, but through controlled and regulated processes which reflect the true economic and social value of these lands as forest versus their value in other uses. Second, harvest and above all fuelwood harvesting, must be carried out according to a plan. The real allies of the environmentalist whether they understand it or not are those industrial timber producers who have a commitment to forest management. This is not to say that all environmental and logging interests are identical, but there is enough common ground to make it very much in the interest of both groups to co-operate, as they indeed have in many fora. With regard to the preservation of the tropical rain forest the International Tropical Timber Organization (ITTO) is one forum where environmentalists and the forest industries have found considerable common ground.

7. While industrial forest practices can be improved without greatly increasing the cost of logs, it should be emphasized that the real threats to the tropical forests do not come from this quarter. One of the greatest is the haphazard conversion of forest lands to temporary agriculture. In only one or two years such lands are not longer suitable for agriculture and are abandoned. These lands, stripped of their productivity through leaching and erosion, all too often do not revert to forest lands, but become wastelands. Erosion can ruin productive fisheries, flood control, irrigation and hydro-electric facilities. The other main factor accounting for deforestation is over-harvesting of wood for fuel. The 1989 FAO Yearbook of Forest Products

puts harvesting of fuelwood (including charcoal) at nearly fifty percent more than that of total saw and veneer logs. But volume alone is not a very accurate indicator of the problem. Most fuelwood harvesting takes place in a totally unmanaged environment. Further the fact that the trees taken are of a small diameter means that a lot more trees are felled to generate the same volume.

The extent of the timber production resource base

8. The total area of the world's forest resources is approximately 3,500 to 4,300 million hectares, depending on the definition favoured and, to some extent, the purpose which the estimate is intended to serve. The lower level is that given in the latest available FAO (1988) assessment and is taken as the basis for the estimates in this review. This area represents roughly 27% of the land surface of the planet, a proportion which is fairly close to that which the classical European foresters used to recommend as the minimum area of forest required for national economic and social well being. To the extent that it is a sensible criterion the world is still fairly well endowed with forests.

9. At present around 1700 million m3 of industrial roundwood are harvested annually from this forest resource, the rate having risen steadily at around 1.5% annually over the last 10 years. The two sets of figures - area of the resource and the annual demand - give the earlier quoted drain of less than 0.5 m3 per hectare.

10. It is, however, misleading to relate the rate of drain to the total area on that basis. Three qualifications at least are necessary. The first has already been referred to: removals understate the drain. To correct this figure the present annual drain should be set around 2200 to 2400 million m3. Secondly, around 200 million hectares is under some form of protected reservation and thus not available for timber production at all. Finally, much of the remainder, (around 800 to 1000 million hectares) must be ruled out for use as industrial timber production because the forest is too stunted or low yielding or the terrain is too difficult for harvesting operations.

11. Having deducted these areas from the total, the area of forest from which the industrial wood requirements can be drawn is reduced to around 2300 million hectares. This situation is summarised in Table 1.

12. The average intensity of harvesting for industrial wood therefore is closer to 1.0 m3 per hectare for the forests from which it is actually drawn. But even at this higher level of usage industrial wood requirements do not really put any strain on the present sustainable capacity of the forests available for timber production.

The changing resource base

13. Several factors are combining to change the area of the world's wood resource base. Perhaps the most obvious is that the total area is steadily being reduced by clearance each year of substantial areas, probably amounting between 16 and 20 million hectares, mainly for agriculture but also significantly for infrastructure. The important factor about this rate of loss is that it is more likely to rise than fall until the present economic conditions in most of the developing world are reversed. Most of the forest lost through these causes is tropical, but some clearing of temperate forests for agriculture continues. Not all clearance, however, takes place at the expense of forests which could otherwise contribute to the sustainable wood supply. Some occurs in the category deducted earlier as unsuitable for timber production and some is even in the theoretically totally protected reserves. Hence the annual net loss of timber production might be no more than 80 to 85% of the total being cleared each year, i.e., say 12 to 16 million hectares.

14. The second factor is that the area of forest is, at the same time, increasing as abandoned farmland reverts to forest, either through the slow process of natural succession or by accelerated programmes of plantation establishment. Most of this addition comes from agricultural adjustment, land rehabilitation and industrial forestry programmes in the temperate forests of the developed countries. Some of the tropical forest clearances also fall into this reforestation category, as agricultural developments on unsuitable land fail or cleared land reverts to forest fallow. Unlike the temperate areas, however, it would be hazardous to count on these areas remaining permanently as forest since, under present conditions the attempts are almost certain to be repeated.

15. One result of this reforestation is that forest plantations and some agricultural tree crop plantations are starting to become a significant component of the world's sustainable wood resource. At present they account for rather less than 0.5% of the world's forest area. By that measure they are almost negligible and at the present rate of expansion, 5 to 6 million hectares a year, (Sedjo, 1989) it will be a long time before they amount to much in that respect. However, from the point of view of industrial wood supply, their area is no measure of their eventual impact. Plantations are on average, at least 5 times and often 10 to 20 times more productive than natural forests. Hence, even as a relatively small proportion by area their much higher productivity will bring a noticeable increase in the average annual productivity of total forest resources. This effect on average increment, combined with increasingly intensive management in natural forests, means that a rising average sustainable annual growth rate per hectare over the world's timber production forests is a third factor to be taken into account.

16. An estimate of the net effect of these forces is summarised in Table 2. The outlook presented there is derived from the present extent of the resource base for sustained timber supplies and how its sustainable wood supply capacity would change under the stated assumptions.

17. For how long this sustainable capacity will be sufficient to supply the wood-based industries depends on the evolution of demand for wood products.

Demand outlooks for industrial roundwood

18. At their present extent, it can be seen that the forests available for industrial timber production would still have a very considerable margin over demand for timber and wood products. Demand in the future may or may not continue to grow at the same rate as it has in the recent past. Projections to the year 2000 which were prepared by FAO in 1986, are currently being revised. In the fourth European Timber Trends Study (ECE/FAO 1986) forecasts were made for Europe for the years 2000 and 2020. An earlier FAO study based on industrial and expert opinions also made forecasts from 1980 to 2000.

19. As the compilation from these outlooks in Table 3 indicates, there is no danger of supply, overall, failing to match demand for industrial wood by the end of this century. Even if demand continued to grow at 1.5 to 2% annually after 2000 it would be well into the third decade of the next century before exceeding an average annual growth rate of 3 m3 per hectare.

20. This is based on the present area of timber production forest. By the middle of the next century, well over one-third of present forest resources will have been eliminated by clearing for agriculture. The gain in average productivity will be unable to match the rate of loss in area unless the plantation resource over the same period expands rapidly enough to fill the gap. The present rate of industrial plantation development would be enough as, in terms of wood production potential, plantations are replacing the forests lost by a factor of 3 to 5. For industrial roundwood raw material supply, the point of global over-cutting is still a long way off provided there is no significant decline in the rate of industrial plantation development or a sharp increase in demand.

The environmentally sound sustainable supply

21. In the light of an environmentally sound sustainable supply, however, the above outlook could be too optimistic. Too few of the world's tropical forests are under management and even fewer are managed on a substained yield basis.

22. The term "environmentally sound" is not very precise. The words used to mean more, but public concern about environmental issues has increased to such an extent that nearly all public information specialists urge their clients to call their policies environmentally sound. Nonetheless, if the rhetoric has lost some of its meaning the underlying concerns are quite real and as important as ever. The issues take on somewhat different meanings in the context of international versus strictly national constituencies. At the national level, the issues tend to concern local effects. These would include preservation of wildlife habitat, recreational and cultural use of forests, watershed protection, the preservation of aesthetic values, maintenance of soil productivity and the productivity of the forest, and the preservation of the physical heritage. At the international level the issues are entirely different. They mainly come down to preserving the global genetic heritage and possible effects on the atmosphere and climate. There is considerable support for the idea that if global values are at stake then there ought to be a global sharing of the burden of costs of achieving these objectives.

23. From the national perspective these issues are easier to deal with since the cause-effect relationships are better understood. But even from the national perspective there are a wide variety of interests and opinions concerning the appropriate mix of environmental versus other interests. The issues are perhaps more difficult to assess from the international perspective. Probably the recent ITTO decision to put the production of tropic timber on a sustained yield basis by the year 2000 represents a good middle ground. It gradually puts the brakes on the erosion of the tropical forest while it protects producers by giving them time to make the necessary adjustments. It must be emphasized, however, that the term "sustained yield" is also not very precise. It means that the potential harvest per time period (eg. harvest per decade) and area does not fall over time but it is not a species specific concept. One of the important effects of the ITTO decision is that it will mean more extensive forest planning and management. Without them, national forest use objectives cannot even be established, much less achieved.

24. Two effects must be taken into account. First, the standards for certain aspects of environmentally sound management can only be met under totally protected reservation. The area at present withheld from timber production on this account will probably be found to be too small. The minimum requirement for tropical forests is, for instance, accepted as 8-10%, by conservation organizations. The demand for such reservations in the forests of developed countries could, under present circumstances, rise to a total of 20-25%. Another 300 to 400 million hectares could therefore easily be withdrawn for these purposes.

25. Second, the restrictions on operations to protect watercourses, wildlife corridors and flora and faunal habitats in order to meet the standards of environmentally sound management will reduce the effective area of the forests available for timber production. The general consensus of studies in that field suggests that the areas which should be protected could amount to another 25-30%. Average annual productivity per hectare will therefore be at least that much lower than calculations based on the nominal area of the timber production resource.

26. The net effect of these second generation factors would be to reduce the effective area of the world's timber production resource from which future supplies can be safely anticipated to around 1400 to 1700 million hectares, considerably less than half the present total forest area.

27. The global adequacy of supply suggested by the earlier calculations is evidently nowhere as well assured as it would be without these further extensions of the environmental constraints. All the same, the situation is still not desperate. From the summary in Table 4 it can be seen that even by the year 2040 there is still a safety margin of around 25%. Hence it is an outlook which calls for action but not panic. There is still enough time to mount programmes of plantation development to fill the gap.

28. But future supplies do depend heavily on the plantation resources. The environmentally sound sustainable supply from the natural forests available for industrial wood production could have fallen below the demand by 2020. So the surety really depends on there being a well-established plantation resource capable of taking over the load with no slackening of the rate of new planting below the 5 to 6 million hectares per year on which the outlook is predicted. At this point a third possible impact of the requirement for environmentally sound resource management has to be taken into account. This is the growing tendency for limits, allegedly to safeguard the environment, to be placed on the extent, location, and nature of plantation programmes. If these restrictions come to be widely applied then it may turn out that neither the area nor the productivity of the plantation resource can counteract the decline in sustainable supply arising from the reduced area of natural forests available to the timber industries.

29. While on balance the outlook for industrial wood through the next century indicates availability of adequate supplies, it gives few details. Short-run supply-demand imbalances are as likely to arise from time-to-time in the future as they have in the past and there will be regional shortages and surpluses. There will also be short-run market imbalances for some species.

Speciality timbers

30. The declining supply of some of the better known speciality and fine timbers has been mentioned earlier. Secondary wood processing industries which are critically dependent on continuity of supplies of these timbers could therefore be in jeopardy, by the year 2000. In fact, the effects are already evident with rising prices and declining quality of the available supplies. The phenomenon is, however, nothing new so the measures to deal with it are well known and in place. One measure is the substitution of timbers by similar properties, a process by which, in the tropical forests especially, a number of well-regarded species graduated from the so-called secondary species class.

31. Another measure is the establishment of new and replacement sources of supply in plantations. Teak is possibly the outstanding example with extensive and widespread areas already established and more than sufficient to meet world demand, in volumetric terms. There is less assurance about the supply in terms of quality unless longer rotation is applied, as has been shown in Indonesia.

32. True mahogany is another example of successful ensurance of a replacement supply although silvicultural difficulties have, so far, been more limiting for both the range and extent of its expansion. Again the quality of future supplies may be less certain than the volume but an early start in some areas may cushion the supply.

33. In contrast, the plantation solution to future supply with some other species in this category has not, as yet, been tried. For some, such as Ramin, time has perhaps run out and with its slow growth in the natural forests, the past and still current over-cutting, leaves substitution say with Rubberwood or Gmelina as the only viable alternative.

34. A third measure, also already standard practice, is to be more sparing in the use of the supplies still available. Market forces tend to drive secondary processing in this direction rather more than they have yet done with forest practices in the tropics. However it can hardly be long before

the economic messages are reflected in stumpages and sustained supply controls, just as they have been with speciality timbers in temperate forestry. The economic exigencies would then spur technological measures (e.g. veneer slicing, drying, figure matching) to make the best technical as well as economic use of the high value resource.

The regional outlooks

35. This global view of overall adequacy of future supplies does not apply uniformly at the regional level. Some parts of the world have had deficits for many years. In some instances the shortages arise from natural causes but for the most part they have been created by past mismanagement and in many places are being aggravated by continued mismanagement. On the whole, however, this is not a major problem. With industrial wood, local and regional deficits can be met by imports of raw materials, semi-processed wood or the finished article. In fact the ease with which imports can displace local products in their home markets is a constant complaint of timber growers and primary processors.

36. The simple expedients of international trade theory and practice are less applicable with non-industrial wood. Rarely can the value of the products or the incomes of those most in need bear the costs of long distance transport. This, in turn, can affect the industrial wood supply since needs for wood fuel and similar subsistence uses which must be satisfied as a matter of survival will over-ride any legal or economic commitments to wood for industry.

37. The broad regional variations from the global situation are reflected in the attached tables. Perhaps the most important and disturbing fact is the declining significance of the tropical regions. The distribution and the rate of decline would no doubt vary between the tropical regions. Africa, for instance, could cease to register in the commodity timber trade virtually through lack of resources alone. Asia and Latin America, while still having some natural forests and significant plantation resources may have to compete with the highly productive and strategically located industrial plantations of the developed countries. The more promising future in timber production for the tropical forests lies, it would seem, with the speciality and fine tropical hardwoods. The shortage of supply of these is imminent and certain.

The time factor

38. The fact that it is going to take time for supply measures to contribute to the future supply/demand balance has two important implications. The first is that anything which can be done to increase productivity in the forest, natural as well as plantation, and to shorten rotation has to be done together with the plantation replacement measures. All aspects of more intensive management such as tree breeding, fertilization, accelerated thinning regimes,

and soil cultivation will have a place. The risk, referred to
plantation development may not be allowed to proceed solely in
of industrial timber production, lends a degree of urgency to t
adoption of these necessarily long term silvicultural measures.

39. The second is that measures on the industry side will have
as insurance against any shortfall in the plantation supply.

40. Not all of the measures, however, which seem, at first sigh
available on the industry side are practicable. With some, suc
intensity of utilisation of the wood from felled trees, the obs
economic. The lower quality logs and smallwood which are left
are, as a rule, more expensive to handle or process than the t
taken. Eventually, declining supplies and technological advanc
should create the conditions to bring them within economic rang
happens there are some measures that industry can undertake to
transition.

41. Part of the economic problem with the smallwood residues is
the logging systems used for the main scale operations. Design
handling of big pieces they simply cannot handle the residual r
reasonable cost. Timber sales procedures and property rights c
other operators who have appropriate gear from coming in either
or subsequently. Sometimes, admittedly, the appropriate equipm
has not yet been adapted to logging but that only confirms that
as much institutional and organisational as it is economic. To
this is something which is in the industries' own hands and doe
principle, have to wait for more favourable economic conditions

42. For certain other measures, the obstacles are mainly techn
industry-based measures can be more immediately effective. Hig
content, chemical constituents in the bark or the wood or irrit
from machining, limit the extent to which some species can be u
while the potential uses for others are limited by difficulties
machining or behaviour in place. In such cases more resources
research and development might overcome the problems and thus a
usable resource base.

43. How well such measures would qualify as meeting the standar
environmentally sound sustainability is, to a degree, question
roundwood often provides habitats for fauna and floral elements
eco-system as well as playing an important role in nutrient rec
removal to augment the supply of industrial wood supply would,
necessarily be as neutral as environmental soundness would requ

44. The increased use of commercially less-accepted species (CLAS), with the technical limits mentioned above, is also questioned. The problem of these lesser-used or lesser-known or secondary species is usually raised in reference to the tropical forests. It is, of course, not confined to them. Most types of temperate forest have species which could, if they were used, add to the sustainable supply. But in the tropical forests, the majority of the species are in this category and often a very substantial proportion, up to 60% in some forest types, of the standing wood volume. With this addition the tropical forests could have at least twice the potential allowed for in the calculations underlying the supply potential shortage of the mid 21st century.

45. However, measures to increase the utilisation of the secondary species of the tropical forests could not qualify as environmentally-sound management. The essential feature of environmentally sound timber harvesting and management operations is that they should have a low and temporary impact on the forest eco-system. The fewer trees removed per hectare, the easier it is for the operation to be conducted as a low impact one. But the increased utilisation of the secondary species implies removing more trees per hectare unless they are to be used instead of the present preferred species. The first approach breaches the low impact requirement of soundness; the second would make no addition to the wood supply.

Measures in processing and use

46. Industrial measures based on improvements and substitutions in processing and use of the wood available from an environmentally sound sustainable supply seem to be more promising supplements to the forestry measures. They do not the risk so much of the emergence of unsuspected adverse environmental consequences which is always a feature of the complex forest eco-systems. This does not mean that they are fully predictable in that respect but they are more amenable to corrective measures when the unexpected does occur.

47. Wood saving measures are of three general classes. One includes those which increase the yield of finished product from a given quantity of wood raw material. High yield pulping technology is typical of this approach.

48. A second class of measure is that based on the use of waste material from the operations in the forest and in manufacturing. The various types of re-constituted wood panels, the development into wider and expanded use of laminated beams and members and the continuing addition of new products in these fields, such as scrimber and valwood, have already shown that the net gains which can be made are quite considerable.

49. The measures which depend on the utilization of forest residues are not, however, necessarily consistent with increasing the environmentally sound sustainable supply or its efficient use. To the extent that the processes depend on increased use of forest residues they could run into the problems mentioned earlier. Removing the smallwood residues which represent the upper stemwood and branches would reduce the nutrient return to the eco-system. If this additional loss of nutrients were of sufficient magnitude to reduce productivity in subsequent rotations, as it could be with fast growing plantations, (Keeves, 1966) then any increase in the present wood supply could be at the expense of future wood supplies.

50. The main weight of these measures would therefore, have to rest on greater recovery of the residues at the manufacturing and user end. The net effect, it must be assumed will be considerably less in terms of volume and appreciably higher in terms of cost than the experience to date with the use of wood residues might indicate.

51. One important area of increased efficiency in wood use lies in reducing waste. While waste materials can be recycled as fuel or fibre, such recycling is never likely to reach 100 percent of all waste material generated. Nor is fuel or particle board as valuable as if used as a solid wood product. Thinner kerfs and smoother cut more precise cutting are two areas where gains can be made. Other important wood savings can be made through more efficient cutting designs. There are experienced and talented craftsmen who look at a project and intuitively cut lengths and panel pieces so as to waste very little of the wood stock, and for a process that is repetitive, over the long-term even less capable persons can adjust cutting so that wastes are reduced to a minimum. But this is not the rule and much sawnwood and panel stock are lost through wasteful cutting practices. There are a few basic rules that help conserve materials and these should be made a part of wood processing education and training programmes. Management must also try to instil wood-waste consciousness in employees, particular in applications like construction where ad hoc cutting decisions are made routinely by craft workers. Micro-computer-based optimal cutting algorithms can be used to lay out cuts in a way that minimizes the amount of stock lost to scrap. These systems are so cheap and easy to use that they can be used even in situations where the cuts will only be made once, but where the same stock sizes are to be cut repetitively to the same component sizes the use of computer optimized cutting patterns is a must.

52. Another area of potential wood saving lies in improving the durability of wood. If, for example, through proper design and proper wood preservation techniques, the lifetime of a wooden bridge is doubled, that represents a 50 percent saving in wood materials.

53. More weight will, therefore, have to be placed on the third set of measures, which can be broadly described as re-cycling. The main target of recycling has been in paper. Waste paper could be used to a greater extent than at present to replace virgin pulp, but there are technical limits as to how far the substitution can be taken without marked decline in quality and increase in cost. As a partial solution to the supply problem, waste paper recycling is a measure which should be actively promoted by forest industries as a whole and research into extending its potential should be an industry-wide co-operative venture.

54. Recycling of previously-used solid wood products can also offer potential savings. Wooden packaging products such as cases and pallets are widely re-used many times but their ultimate salvage after they can no longer be re-used for say fibre-use is a largely unexploited field. With roughly 5% of the world's timber consumption being in this form there is some potential for a substantial addition to the net raw material supply. However, a much greater potential may lie in the salvage of timber from demolition of old buildings. With over 50% of the world's roundwood consumption going into construction which then involves a substantial amount of replacement, the theoretical potential to salvage much more of the old solid timber is quite high. Even if its nature and condition precluded re-use in the original form it could supplement the supply of raw material for fibre-based industries. A research and development programme to that end would be a good investment for the industry.

Conclusions

55. While 21st-century wood supplies can be assured if steps are taken to increase plantations and reduce the rate of deforestation, the situation is far from hopeless. In the industrialized countries, steps must be taken in the near future to control environmental threats to the forest such as acid rain. In developing countries the loss of forest to haphazard slash-and-burn agriculture and uncontrolled exploitation for fuelwood will continue but there is hope for some reduction in the rate at which the forest is disappearing. As industrial logging in the tropical-timber-producing countries is put on a sustained yield basis it can be expected that a larger and larger portion of the tropical forest will come under management, which could have a positive effect in controlling deforestation. On the other hand there is a need to safeguard the world's genetic heritage by protection of some portion of the tropical forest in its natural state. There is also a need to ensure that all the potential services of the existing forest are exploited. These include not just logging but also watershed protection, protection of soil productivity, recreational and cultural uses, the provision of wildlife habitat etc. Thus there will be restrictions on logging practices and for some areas the total withdrawal of lands from logging.

56. The above restrictions on logging will have an impact on the potential wood supply and so underline the need to carry through with the expansion of industrial plantations and with reforestation projects. Gains can also be made from the development of measures to increase the efficiency with which wood is used and to improve wood recycling efforts.

57. Most of the impetus for these measures can come from market forces and so do not require explicit governmental measures except to provide the proper macro-economic framework. There are, however, areas where government has an important role to play. The legal and administrative framework must be developed to allow forest plans to be devised and implemented. This means that uncontrolled slash-and-burn agriculture must be halted and cutting trees for fuel brought under control.

58. Governments can also contribute through assisting in the provision of training facilities and the promotion of industrial research, development and information centres. These facilities can probably be best financed through a combination of government-funded financed in part through direct user fees.

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TABLE 1

Estimated Area of World Forest Resource
Available for Industrial Wood Production in 1990
ha x 10^6

REGION	TOTAL	TOTALLY PROTECTED	UNSUITTABLE	NET AVAILABLE FOR INDUSTRIAL TIMBER PRODUCTION
Tropical forest				
Africa	684	51	319	314
Asia	272	19	83	170
Latin America	740	16	179	545
Oceania	38	2	27	9
Sub-total	1734	88	608	1038
Temperate forest				
Africa	1			1
Asia	183	8	19	156
Europe	137	3	9	125
Latin America	51	3	9	39
North America	485	38	44	403
Oceania	47	10	1	36
U.S.S.R.	740	20	273	447
Sub-total	1644	82	355	1207
TOTAL	3378	170	963	2245

Source: F.A.O. 1988
Adjusted for estimated changes since 1980.

TABLE 2

Estimated Environmentally Sound Sustainable Supply Per Annum of Industrial Timber to Year 2040

volumes $m^3 \times 10^6$ R.W.E., areas ha $\times 10^6$ - rounded to nearest 10 $\times 10^6$

AREA AVAILABLE FOR TIMBER PRODUCTION	YEAR 1990	2000	2010	2020	2030	2040
Tropical Forest						
Natural - Nominal area	1040	900	740	580	450	330
- Area adjusted for reserves	1030	850	630	440	340	250
Plantation	10	30	40	60	70	90
Temperate Forest						
Natural - Nominal area	1230	1180	1090	980	880	780
- Area adjusted for reserves	1050	940	820	740	660	590
Plantation	80	120	170	220	270	290
SUSTAINABLE SUPPLY						
Tropical Forest						
Natural at:						
1.0 m3/ha	1030	850	630	440	340	250
1.5 m3/ha	1540	1270	940	660	510	370
2.0 m3/ha	2060	1700	1260	880	680	500
Plantation at:						
8.0 m3/ha	80	240	320	480	560	720
12.0 m3/ha	120	360	480	720	840	1080
15.0 m3/ha	150	450	600	900	1050	1350
Temperate Forest						
Natural at:						
3.0 m3/ha	3150	2820	2460	2220	1980	1770
4.0 m3/ha	4200	3760	3280	2960	2640	2360
4.5 m3/ha	4720	4230	3690	3300	2970	2650
Plantation at:						
8.0 m3/ha	640	960	1360	1760	2160	2320
12.0 m3/ha	960	1440	2040	2640	3240	3480
15.0 m3/ha	1200	1800	2550	3330	4050	4350
Total Tropical	1110-2210	1090-2150	950-1860	920-1780	900-1730	970-1850
Total Temperate	3790-5920	3780-6030	3820-6240	3980-6630	4140-7040	4090-7000
TOTAL ALL	4900-8130	4870-8180	4770-8100	4900-8410	5040-8770	5060-8850
Plantation Supply as % of Total	15-17	25-27	32-39	46-50	54-58	60-64

Note: Adjusted for changes and restrictions as discussed in text.

TABLE 3

Projected Global and Regional Production of Industrial Roundwood to the Year 2040
$m^3 \times 10^6$ R.W.E.

SOURCE OR BASIS	Mean 1986-7	YEAR 1990	2000	2010	2020	2030	2040
Recorded	1604						
F.A.O. 1982		1741	2086				
1986		1414	1811				
1988		1655	2077				
Chase 1986		1397	1706				
Extrapolated at a constant rate of 1.0% p.a.		1650	1826	2017	2228	2461	2719
1.5%		1679	1949	2262	2624	3046	3534
2.0%		1703	2076	2531	3084	3760	4584
Projections by F.A.O. (1988)							
Africa	53	53	64				
Asia	254	333	444				
Europe	298	328	404				
Latin America	104	125	190				
North America	574	529	653				
Oceania	30	20	25				
U.S.S.R.	291	280	318				
Extrapolated at a constant rate of 1.5%							
Africa		55	64	74	86	100	116
Asia		266	308	358	415	482	559
Europe		312	362	420	488	566	657
Latin America		109	127	147	170	198	229
North America		600	697	809	938	1089	1264
Oceania		31	36	42	49	57	66
U.S.S.R.		304	353	410	476	552	641
World		1677	1947	2260	2622	3044	3532
Extrapolated at the annual rate at the average 1976/7 and 1986/7							
Africa		56	67	80	96	114	136
Asia		266	308	358	415	482	559
Europe		310	353	401	457	519	591
Latin America		109	127	147	170	198	229
North America		613	762	947	1178	1466	1820
Oceania		32	38	45	54	65	77
U.S.S.R.		289	284	278	272	267	262
World		1675	1939	2256	2642	3109	3674

TABLE 4

Projected Annual Drain of Industrial Wood from the Global Forest Resource Available for Timber Production Compared with Environmentally Sustainable Supply to the Year 2040

$m^3 \times 10^6$ R.W.E. rounded to nearest 100×10^6

	YEAR					
	1990	2000	2010	2020	2030	2040
Drain	2100- 2300	2300-2700	2600-3300	2900-4000	3300-4900	3500-6000
Env. Sust. Supply from:						
Natural For.	5800- 9600	3700-6000	3100-4900	2700-4200	2300-3700	2000-3200
Plantation	700- 1300	1200-2200	1700-3200	2300-4200	2700-5100	3100-5700
Total Supply	6500-10900	4900-8200	4800-8100	4900-8400	5000-8800	5100-8900
Drain as % of Total Supply	21-32	33-47	41-54	48-59	56-66	67-69
Natural For. Supply	24-36	45-62	67-84	95-107	132-143	175-187