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"Do We Have Enough Forests?"

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"Do We Have Enough Forests?"

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PREFACE

As one of the oldest collaborating organizations in the world, IUFRO has for 104 years sought to establish networks among forest scientists who seek the mutual support of shared discussion, information, publications, research protocols and material. IUFRO now has over 15,000 scientists in 715 institutions in 115 countries with 275 research groups addressing virtually all topics relevant to forests and forestry.

In addition, however, IUFRO seeks to collaborate with other relevant organizations and it is delighted to participate in the publication of this important report. IUFRO and IIASA have been close institutionally as well as geographically and the author of the report, Sten Nilsson, has been chairperson of IUFRO's Working Party S4.07-05 - Economic Evaluation of Forest Damage - for several years.

The importance of this report can not be over-emphasized. International and national policy institutions need objective assessments of the amount of forests we need, of which types and in which locations. The paper concentrates on the supply and demand for industrial wood and fuelwood with charcoal; it examines the factors affecting these including the impacts of recycling, fibre substitution, land use change and the rising recognition of the importance of non-wood products and services.

Nilsson closes his paper with the challenge "Who or which organization will take this challenge" (of assessing forest needs). It is hoped that the specialist networks of IUFRO's research groups can work with other collaborators to contribute to this process.

J. Burley
President
IUFRO

April 1996

Acknowledgments

It is highly likely that events with such low probabilities that they really could not happen will indeed occur during the next 25 years, and will seriously affect the global forest sector.

The work carried out by Apsey and Reed (1995) on global wood balances has been the inspiration for this paper and I have borrowed much from their work.

IIASA, February 1996
Sten Nilsson
Leader, Forest Resources Project

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1. INTRODUCTION

Generally accepted concepts of the use and value of forestry have changed greatly in the past 20 years. For many years forests were seen as vital for production and industrialization (Westoby, 1962) and were a strong link to general economic development (Hirschman, 1958). Over the years development agencies have followed this path (World Bank, 1978).

During the 1970s a dramatic change began. Westoby (1978, 1979) started to doubt his ideas that the forest industry was a powerful engine of economic development and that the benefits and profits from the industry filter down to the population at large. However, it was not until the late 1980s that Westoby solidly formulated his new ideas. At that time, public criticism of the forest industry intensified. This criticism was not concerned that the forest resources would be insufficient to satisfy the needs of wood production, environmental protection, and recreation, "instead, it was a question of the forestry profession not being able to integrate these interests into forest management" (Hellström and Reunala, 1995). This public criticism was driven by a change in societal values.

The first policy-oriented sign of a change concerning forestry was the 1978 World Forestry Congress in Jakarta, entitled "Forests for People." The conclusion from the congress was that the benefits from forests are important only if they affect people.

Today, the global forestry agenda is complex and to a large extent dominated by issues and values outside the market. Hyde et al. (1991) have identified the current topics in the forestry discussion (Table 1).

Table 1. Characteristics of the Global Forest Debate Today. Source: Hyde et al. (1991).

Activity	Demand	Supply
Industrial wood	Local/Global - private	Nonsite/site specific
Fuelwood	Local - private	Site specific
Climate Change	Global - public good	Nonsite specific
Biodiversity	Local/Global - public good	Site specific
Global environmental tourism	Global - private	Site specific
Local/National environmental functions	Local/National public good	Site specific
Non-wood products	Local - private	Site specific
Erosion	Local - public good	Nonsite specific

A number of questions must be answered about the future of the world's forests. Poore (1994) has formulated and addressed some of these questions. In the following list I have revised Poore's questions to reflect the topics given in Table 1:

- How much forest land do we need?
- Where should they be located? What types of forests do we need? What are the purposes of forests?
- How much of the forests should be set aside for industrial timber and fibers?
- How much should be reserved for fuelwood?

- What are the environmental functions of forests and how much of the forests should be set aside for these purposes?

Several additional themes can be identified in the current forestry debate. First, forests must serve the global society (the people) with many different needs. Second, the different demands on the different functions of forests must be determined by the global society (by the people). Third, the existing tools for the management of global forest resources have difficulties meeting existing and future demands. Fourth, whether the resource is used for timber, fuelwood, carbon sequestration, non-wood products, or some other purpose, secure tenure is the first condition of a sustainable forest development. Fifth, the fate of forests is tied to the fate of their users; they will rise or fall together (Durning, 1994).

To answer the question, "Do we have enough forests?" I will use the existing demands on the forest functions of the global society as a starting point (Forests for what?). For several issues the information on the existing and future demands is rather sketchy and in many cases it is not available at all. In this discussion I am trying to be as quantitative as possible and I have employed different existing quantitative projections to build some consistent scenarios. The presentation of the paper is illustrated in Figure 1.

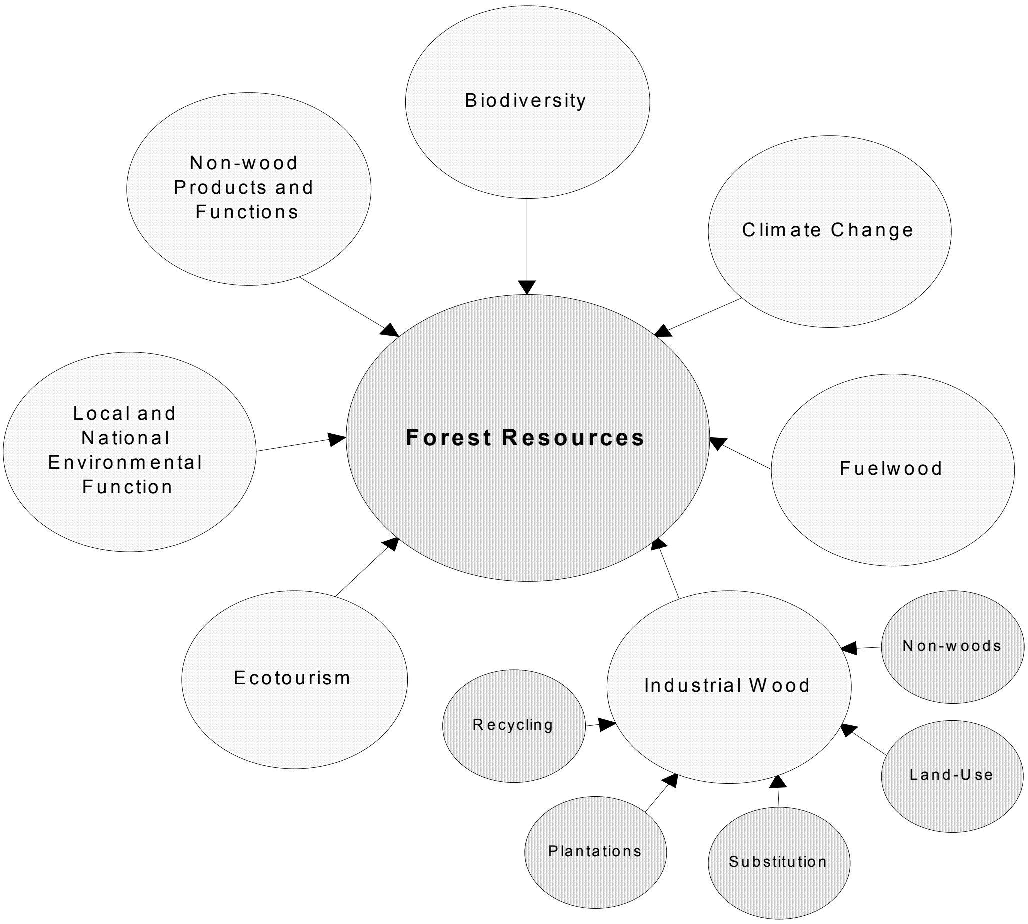


Figure 1. Structure of the Presentation.

2. INDUSTRIAL AND FUELWOOD SUPPLY - MAINSTREAM SCENARIO
2.1 Introduction

The "closed forest" area of the world is estimated at 3.8 billion hectares (Hagler, 1995). But the values of the society limit the availability for fuel and fiber supply. Hagler (1995) has estimated that only 2.1 billion ha or 55% of the "closed" forests is available to meet the world's demand for fuel and fibers. The distribution of the forest areas available for production of fuel and fibers is presented in Table 2.

Table 2. Estimated Production Forest by World Region in 1995 (million ha). Source: Hagler (1995).

	Coniferous	Non-coniferous
North America	268.6	170.2
Latin America	8.9	660.1
Western Europe	65.9	32.3
Russia and Eastern Europe	324.2	131.8
S.E. Asia	98.7	228.5
Rest of World	7.1	74.3
World total	773.4	1297.2

From Table 2 we see that coniferous forests in Russia and non-coniferus forests in Latin America are the main variables in the global fiber supply equation.

Hagler (1995) estimates that the available forests can support a sustainable long-term harvest of 3.7 billion m^3 (under bark) of fuelwood and industrial fibers (38% coniferous and 62% hardwood) (Hagler, 1995).

The profile for global roundwood production in 1993 is presented in Table 3.

Table 3. Global Roundwood Production in 1993 (million m^3). Source: FAO (1995d).

	Fuelwood & Charcoal	Industrial		Total
		Coniferous	Non-coniferous	
World total	1875.9	929.3	528.9	3334.1
Volume %	56.3	27.9	15.8	100.0
Africa	493.6	10.2	49.4	539.3
North & Central America	156.7	458.7	128.0	746.6
South America	247.9	55.9	63.7	358.8
Asia	866.4	94.1	175.5	1119.7
Europe	50.9	191.3	61.9	331.5
Oceania	8.8	23.6	13.3	43.7
USSR/CIS	51.5	95.5	36.8	337.1

From Table 3, we see that in 1993 some 56% of the world's roundwood production was of fuelwood and charcoal. On average, total roundwood production between 1970 and 1992 increased 1.3% annually. For 1995, the total demand has been estimated at 3.7 billion m^3, of which 45% will be consumed as fuelwood and charcoal. This closely corresponds to the sustainable harvest identified by Hagler (1995).

2.2 Industrial Wood Availability

The annual allowable cut (AAC) has been used by governments to control harvesting and is based on an estimated sustainable harvest level. AACs are increasingly being restricted by social and environmental constraints.

Foresters have been measuring forests for several decades, but surprisingly information on existing forest resources and how they could be utilized is still lacking. Much confusion exists over the way foresters and administrators estimate potential and future economic wood supply (Apsey and Reed, 1995).

Recently, a number of studies have been released which try to estimate the future industrial wood supply based on conventional approaches. In the following I use these studies to estimate the future availability of industrial wood. My main sources are ITTO (1993), FAO (1994), Simons (1994), Pöyry (1994), Apsey and Reed (1995), European Parliament (1994), Nagle (1995), TAPPI (1995), Brooks (1995), work carried out within ETTS V (Pajuoja, 1995), work conducted on Russia by IIASA (Nilsson, 1995b; Backman, 1995), Price Waterhouse (1995), Neilson and Smith (1995), Nilsson (1994), Zhong (1995), Mochizuki (1995), Interforest (1993), United Nations Forest Study Papers (1994), and Nilsson et al. (1992a, b).

I have tried to harmonize, as consistently as possible, the information from these sources in Table 4. Nevertheless, there are surprisingly large differences in the experts' estimates of the availability of industrial wood by the year 2010. As seen from Table 4, for 2010 the estimates differ by some 260 million m^3 for coniferous species and 200 million m^3 for non-coniferous species. For 2020 the differences between the highest and lowest estimates remain about the same as those predicted for 2010.

The production figures for 1993 are based on FAO statistics (FAO, 1995e), but are adjusted for the countries missing in these statistics by the sources mentioned above.

There are especially large differences in the estimates in total roundwood in the USA, Latin America, Other Asia, Russia, and Japan and in coniferous species in Canada. Why is this so? There are two main explanations. First, we do not have sufficient inventory information. Second, there are major uncertainties on how the changing values of the society will affect the utilization of the industrial forests, particularly AACs and wood availability, in the future (e.g., Price Waterhouse, 1995; Perez-Garcia, 1993; Lippke and Conway, 1994). In other words, how will social and environmental initiatives constrain future forest resources? In the following, I briefly discuss the reasons for the large variations in the above regions. In the USA, there are doubts about the reliability of the existing American inventories (Colberg, 1992;

Table 4. Estimated Availability of Industrial Roundwood (million m^3 under bark). The 1992 Figures Are Estimated Production Figures.

	1993		2010		2020	
	Coniferous	Non-coniferous	Coniferous	Non-coniferous	Coniferous	Non-coniferous
Canada	165.3	7.9	127-158	38-50	135-162	42-55
USA	285.8	116.7	245-289	117-140	265-317	125-155
Latin America	63.6	67.4	85-100	89-118	105-110	105-120
Africa	10.2	49.4	12-16	54-59	14-16	57-65
Oceania	23.6	13.3	33-41	17-18	53-58	19-21
China	63.3	35.5	50-60	30-35	53-60	32-40
Japan	18.8	6.8	20-55	8-9	22-55	9-10
Other Asia	12.0	133.2	14-16	65-124	16-19	65-129
Russia	86.2	31.7	130-194	30-70	175-235	30-80
Eastern Europe[1)]	48.0	32.7	59-64	47-52	61-66	49-53
Western Europe	78.1	35.8	86-108	39-56	91-113	41-58
Nordic region	85.0	9.6	89-108	11-14	89-116	12-15
World Total	939.9	540.0	950-1209	545-745	1079-1327	586-801

1) Includes the European countries of the former USSR.

Cubbage, 1994). There is also uncertainty on what constraints environmental initiatives will cause in the future (Lippke and Conway, 1994). The latest impact of non-timber demands has reduced the sales of the US Forest Service by 40 million m^3 since 1989 (Warren, 1995).

The large difference expected in the availability of coniferous species in Canada is mainly due to uncertainties about future environmental regulation (Price Waterhouse, 1995; Ontario Forest Policy Panel, 1993).

The uncertainties identified for the Latin America and Other Asia regions are connected to the unreliable inventory information on the forest resources, concerns over the speed at which the supply will decrease from the natural forests (regulations, environmental constraints, increased harvesting costs), and the issues of implementation and performance of industrial forest plantations. There are doubts on Russia's forest inventory information and how much of the forests will be accessible and available. For example, the Federal Forest Service of Russia (1995) reports a net increment of 822 million m^3 per year on forested areas (closed forests). Tentative results from work done at IIASA (Shvidenko et al., 1995) indicate that the annual net annual increment on forested areas may be 1150 million m^3. In addition, the future supply in Russia will heavily depend on the uncertain evolution of the democratic and economic transitions.

Japan has unused forest reserves and has carried out a 10-million-hectare plantation program. In spite of this, the coniferous output has dropped by nearly 8 million m^3 since 1970 and non-coniferous output has decreased by nearly 10 million m^3 (Apsey and Reed, 1995). These decreases seem to be a result of changing values concerning forest utilization in Japanese society. Some forecasters expect this to continue. Others project that the market will force Japan to use its untapped resources.

Based on the information in Table 4, the boreal forests supplied some 40% of the industrial coniferous supply in 1992; this share is estimated to remain the same in 2010 and 2020. In 1993 the developing world was providing 29% of the total global wood supply. This supply is estimated to decrease to 27% in 2010 and 2020. To offset the decrease in the supply from the natural forests, there must be an increase in the supply from plantations. The decreased supply from natural forests is caused by early harvesting, overharvesting, decreased sustainable management of tropical forests (in 1963, 89 million ha were under some form of management, but in 1990 only 60 million ha were being managed according to FAO, 1993), and increased protection measures. Thus, the developed world will remain the main supplier of industrial wood.

2.3 Fuelwood and Charcoal Availability

In 1993 nearly 56% of the wood produced was fuelwood and charcoal (FAO 1995d). Therefore, it is rather disturbing to conclude that there is no updated systematic fuelwood supply and demand analyses carried out for the entire world. Data on production of fuelwood and charcoal are very doubtful even in advanced industrialized countries. The most in-depth supply and demand analysis was conducted in 1981 by the FAO.

The production of fuelwood and charcoal increased between 1970 (1362.4 million m^3) and 1993 (1875.9 million m^3) by 514 million m^3, an increase of some 38%. The most recent forecasts of the fuelwood situation have been generated by FAO (1995d, time horizon 2010) and Apsey and Reed (1995, time horizon 2020). These estimates project future consumption as consumption trends. These consumption trends closely follow production trends and are primarily supply driven. Therefore, these estimates can also be used as production estimates. As further discussed in section 3.3, the real demand for fuelwood is actually much higher than the consumption trends presented.

The FAO (1995d) and Apsey and Reed (1995) production figures and estimates have been adjusted with other sources (see section 2.2) because not all countries are included in these estimates. These adjustments are presented in Table 5. Also, included in this table is an estimate which has been produced using data from Zuidema et al. (1994) and the IMAGE model (Alcamo, 1994). Zuidema et al. (1994) have carried out supply analyses on fuelwood in their work on land-use changes. These analyses are discussed in Nilsson (1995b). They indicate much less fuelwood availability, in comparison with the mainstream thinking in the sector, because of dramatic land-use changes.

It should be highlighted that the consumption trend/production estimates are based on historical data. The statistics on fuelwood production are probably an underestimate of real production. Using detailed studies Jones (1995) points out for India that 10 times more fuelwood was collected than officially reported.

Table 5. Estimated Availability of Fuelwood and Charcoal (million m^3). The 1993 Figures Are Estimated Production Figures.

	1993	2010	2020
Adjusted FAO (1995d) and Apsey and Reed (1995) estimates			
Canada	6.8	7-8	8
USA	93.3	90-103	90
Latin America	304.5	312-329	357
Africa	493.6	635-727	738
Oceania	8.8	12-15	15
China	200.1	221-230	240
Japan	0.4	0.8-1	1
Other Asia	666.0	822-848	978
Russia	49.0	70	80
Eastern Europe[1)]	20.5	25	25
Western Europe	28.8	30	35
Nordic region	9.5	10	10
Others	--	30	30
World total	1881.3	2265-2426	2607
Zuidema et al. 1994	1881.3	1500	1450

1) Includes European countries of the former USSR.

According to available estimates it can be concluded that the availability of fuelwood and charcoal is estimated to be between 2265 and 2425 million m^3 in 2010 and 2607 million m^3 in 2020 according to mainstream thinking. If dramatic land-use changes foreseen by Zuidema et al. (1994) occur, the availability will only be 1500 million m^3 in 2010 and 1450 million m^3 in 2020.

Johansson et al. (1993) assume that in the period between 2025 and 2050 fuelwood and charcoal production for applications such as cooking will be largely phased out and the supply of traditional fuelwood in the period between 2025 and 2050 will be 1050 million m^3 in developing countries and 193 million m^3 in developed countries (in total 1243 million m^3 per year). Thus, this estimate is more in line with estimates by Zuidema et al. (1994) presented in Table 5. Johansson et al. (1993) also suggest that, in addition to traditional fuelwood availability, there could be a supply of some 10 billion m^3 per year from energy plantations in the period between 2025 and 2050. This last estimate should be regarded as what could be achieved by a global, renewable energy policy.

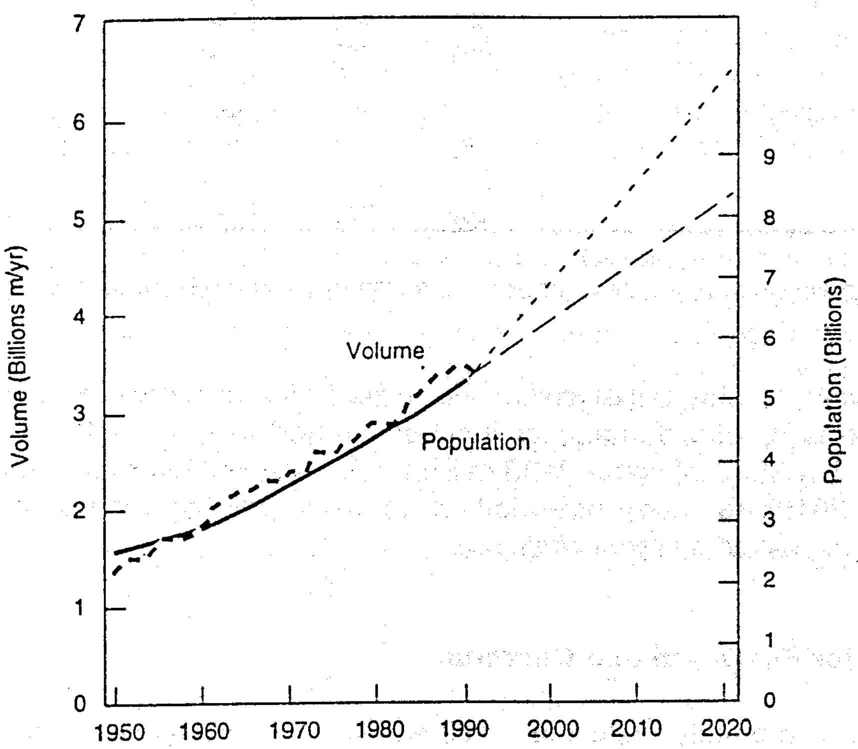
Most fuelwood is produced in developing countries (some 90%). Apsey and Reed (1995) admit that a continued loss of the forest cover in developing countries will substantially decrease future fuelwood availability and stress that "it is difficult to understand the absence of orderly research into this worsening condition."

3. DEMAND – MAINSTREAM SCENARIO

3.1 Introduction

Increases in wood consumption are mainly driven by improvements in economic well-being and increases in population growth. After water, wood is probably our most important raw material (Sutton, 1993). Sutton (1993) has illustrated the relationship between global population and the total wood harvest. I have updated these estimates to the year 2020 by applying the latest available population growth estimates (Lutz, 1994, central estimate; United Nations, 1994i, medium-variant projections). The results are presented in Figure 2.

Figure 2. Total Wood Harvest Volume and World Population Projections, 1950-2020.



The figure shows that world harvest in 1992 was some 3.4 billion m^3. By employing Sutton's approach world harvest would be about 5.5 billion m^3 in the year 2010 and nearly 6.5 billion in the year 2020 (total of industrial wood and fuelwood).

3.2 Industrial Roundwood Demand

Currently most analyses of the future demand on industrial roundwood use econometric models that take into account population growth, economic growth, end-use patterns, technological change, and other factors. Analyses of this kind are carried out regularly by international organizations (FAO, 1995b; United Nations, 1986; ITTO, 1993; Brooks and Baudin, 1994). A number of consultant companies have also presented estimates based on some sort of models in addition to their soft market knowledge (e.g., Pöyry, 1993; Simons, 1994). Governmental organizations and the academic community are also producing analyses of this kind (e.g., Kallio et al., 1987; Nilsson et al., 1992b; Perez-Garcia, 1993; Sedjo, 1994).

In the following I summarize the most recent analyses on industrial roundwood demand at the global level. The results are presented in Table 6.

Table 6. Forecasts of Demand on Industrial Roundwood (million m^3).

	1993			2010			2020		
	Conif.	Non-conif.	Total	Conif.	Non-conif.	Total	Conif.	Non-conif.	Total
FAO 1995d	939	540	1479						
FAO 1995b				1682	992	2674			
FAO 1995d				1423	855	2278			
Pöyry 1994						2050			
Pöyry 1995[1)]						2000			
Apsey & Reed 1995				1210	730	1940	1400	850	2250
Simons 1994				1362	783	2145	1538	1013	2551

[1)] Revised projection due to new paper consumption forecasts presented by Jerkeman (1995).

The current view (in this paper called the mainstream scenario) held by the forest industry projects a total demand of industrial roundwood in 2010 of some 2100 million m^3 and in 2020 of some 2400 million m^3. The FAO (1995b) estimate (2674 million m^3 in 2010) has been regarded as unrealistically high; the second estimate FAO (1995d) is viewed as more realistic.

3.3 Demand for Fuelwood and Charcoal

Biomass fuels – primarily fuelwood – still account for 35% of the energy supply in developing countries (World Bank, 1992). In Africa, 90% of the population uses fuelwood for cooking, the equivalent of roughly 1.5 tons of oil for each family per year (Jepma, 1995). The World Bank (1992) states that the consumption of fuelwood and charcoal in the world is still increasing (Table 7).

Table 7. Increases in Fuelwood and Charcoal Consumption. (Average annual growth rate in percentage. Calculations are based on tons of oil equivalents.) Source: World Bank (1992).

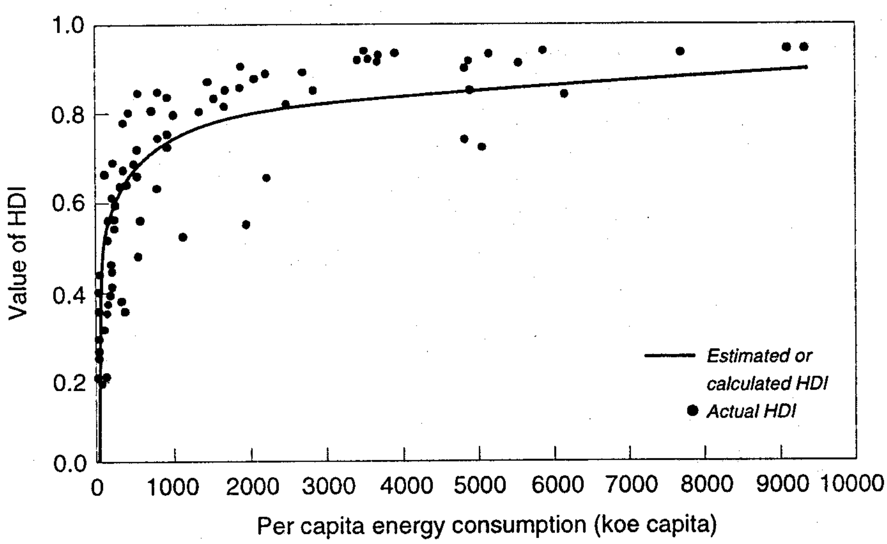
	Period	
	1965-1980	1980-1989
World	1.8	2.2
Low and middle income	2.2	2.3
Sub-Saharan Africa	2.9	3.2
East Asia and Pacific	2.1	1.9
South Asia	2.3	2.3
Latin America and Caribbean	2.4	2.1

The real demand for fuelwood is difficult to estimate (Leach and Mearnes, 1989). Historically, demand has been supply driven. Updated estimates on demand (FAO, 1995d; Apsey and Reed, 1995) are based on consumption trends, which are supply driven. The real fuelwood and charcoal requirements are much higher than the consumption trends presented.

The FAO (1983) attempted to estimate the real fuelwood and charcoal requirements under 1980 conditions. The study showed that, at that time, 2000 million people were dependent on wood, of which 96 million were unable to satisfy their minimum energy needs for cooking and heating. An additional 1052 million people were in a deficit situation and could only meet their needs by depleting forest reserves. The deficit was estimated to be 400 million m^3. In 1983 the FAO forecasted that, by year 2000, 2400 million people would either be unable to sustain minimum energy requirements or would be forced to deplete the forest reserves. The deficit for year 2000 was estimated at 960 million m^3.

The UNDP (1990, 1994) has developed a Human Development Index (HDI); this index combines the indicators of life expectancy, educational attainment, and income into a composite index. This index has a strong relationship with per capita energy consumption in developing countries. The influence of per capita energy consumption on the HDI begins to decline somewhere between 1000 and 3000 kilograms of oil equivalents (koe) per capita (Suarez, 1995). Thus, energy is a crucial factor for socioeconomic development, as Figure 3 clearly illustrates.

Figure 3. Estimated Relationship between HDI and per Capita Energy Consumption in 1991-1992. Source: Suarez (1995).



Currently, 81 countries, with a total population of 4750 million inhabitants (some 87% of the world's population), have not yet reached an energy consumption of 3000 koe per capita, and 62 countries, with a population of 3800 million, have not yet reached a consumption of 1000 koe per capita. The HDI of these countries is very low, between 0.19 and 0.80 (Suarez, 1995).

It is important to point out that in developing countries energy requirements must be distinguished from energy demand; the latter only reflects transactions occurring in the market (Goldemberg and Johansson, 1995).

Thus, it can be concluded that in the fuelwood debate there is a need to distinguish between consumption trends, demands, and basic requirements.

The estimates available on consumption trends (supply-driven) project that between 2310 and 2380 million m^3 of fuelwood and charcoal will be consumed in year 2010 (Apsey and Reed, 1995; FAO, 1995d) and 2590 million m^3 will be used in year 2020. Solomon et al. (forthcoming) show a higher consumption rate – namely, 2520 million m^3 in year 2010 and 2920 million in year 2010.

Estimates on future demand (transactions occurring in the market) are not available.

Rapid growth in the general energy consumption has been forecasted by the IEA (1995). In these projections fuelwood is not treated specifically, but the solid fuels (including coal and biomass) are estimated to increase by 100-125% between 1992 and 2010. An increased biomass consumption is also estimated by WEC (1994) and WEC/IIASA (1995). The FAO (1994a, b) estimates that the current average energy consumption of 22.2 GJ per capita in the developing world may increase to 35 GJ per capita and that a substantial part must come from biomass. Greenpeace (1993) proposes a fossil-free energy future. To achieve this, biomass must supply 13% of global energy supply in 2010 and 24% in 2030; the current supply is 7%. The land requirements on arable, pasture, forest, and wood lands for such energy production would be 118-215 million ha in 2010 and 158-384 million ha in 2030.

It has been argued that with improvements in living standards the traditional use of fuelwood and charcoal in the developing world would decrease (Johansson et al., 1993). However, supporting the high biomass energy estimates are the population growth estimates for the developing world (Lutz, 1994; United Nations, 1994i) and the projections of increases in rural consumption of fuelwood (e.g., Madagascar with a collection of 6164 kgs of fuelwood per average household, Munasinghe, 1993; and the WRI, 1994, estimates that in India the fuelwood consumption in total wood consumption increased from 6.4% to 9.3% between 1980 and 1990).

All of the studies cited follow a top-down approach. To estimate the basic fuelwood and charcoal requirements that are necessary to achieve socioeconomic development, I have applied basic data used in the FAO study (1981) and attempted to update this study using population development projections (United Nations, 1994i, Medium-Variant Projects) and estimates on fuel utilization and energy efficiencies (World Bank, 1992). This preliminary update assumes a linear relationship between energy consumption and population size, and is probably not suitable under all conditions. Suarez (1984) has shown that the smaller the family in the developing world, the larger the energy consumption per capita at a specific income level. No distinction is made between urban and rural people in the update. Njie (1995) has shown that rapidly growing urban centers consume more fuelwood per capita than rural areas in the developing world. The WRI (1994) estimates that in year 2025 4 billion people in the developing world will be classified as urban residents. The United Nations (1980) has made estimates and projections on future urban and rural populations, which were later updated by Jepma (1995). These updated estimates indicate that in the year 2020 urban residents will make up 48% of the population in tropical Asia; 56% in tropical Africa; and 82%, in tropical Latin America. The approach taken follows a bottom-up approach and only describes the size of problem concerning the basic fuelwood and charcoal requirements.

The analyses show that 3800 million m^3 of fuelwood and charcoal will be required in year 2010 and that 4250 million m^3 will be needed in year 2020. If I combine the Suarez concept (1995) with the FAO approach, I arrive at even higher requirements. Analyses following the updated FAO approach show a deficit of 1425 million m^3 of fuelwood and charcoal requirements in year 2010 and 1650 million m^3 deficit in year 2020. The forecasts of different "demands" on fuelwood and charcoal are summarized in Table 8.

Table 8. Forecast of "Demand" on Fuelwood and Charcoal (million m^3).

	1993	2010	2020
FAO (1995d) (Consumption trend)	1876	2396[1)]	
Apsey and Reed (1995) (Consumption trend)		2325[1)]	2607[1)]
Solomon et al. (forthcoming) (Consumption estimate)		2520	2920
Basic requirements based on updated FAO (1981) bottom-up approach		3800	4250

1) Adjusted for countries without basic FAO statistics.

The outlook on the future demand for fuelwood and charcoal in the developing world has been summarized by Jepma (1995):

> "It is highly unlikely that a massive transition from biomass fuels to commercial energy sources will occur in the near future."

4. THE BALANCING ACT - THE GLOBAL BALANCES – MAINSTREAM SCENARIO

Global balances can be estimated from projections of future supply and demand. The balance for industrial roundwood is presented in Table 9.

Based on the results in Table 9 there may be a total shortage of as much as 300 million m^3 of industrial wood already in the year 2010. The shortage is for both coniferous and non-coniferous species. In 2020 the possible total shortage of industrial roundwood may increase to 800-900 million m^3; this shortage is also for both coniferous and non-coniferous species.

As stated earlier the demand for fuelwood and charcoal is difficult to determine. Therefore, it is difficult to determine if there is a gap in the fuelwood supply (Leach and Mearnes, 1989; Hall, 1993). The balances achieved for fuelwood and charcoal are presented in Table 10.

A comparison between the FAO (1995d) and Apsey and Reed (1995) consumption trends and production trends is rather uninteresting from a balance point of view because they are strongly interlinked. A comparison between the FAO (1995d) and Apsey and Reed (1995) production trends and the Zuidema et al. (1994) consumption estimate shows a deficit of 95-255 million m^3 in year 2010 and a deficit of some 315 million m^3 in year 2020. A comparison of the Zuidema et al. (1994) consumption estimate with their supply scenario based on forecasted land-use changes shows shortfalls of 1020 million m^3 in year 2010 and 1470 million m^3 in year 2020. The shortfalls identified through the bottom-up approach developed by FAO (1981) on basic fuelwood and charcoal requirements are 960 million m^3 in 2000, 1425 million m^3 in 2010, and 1650 million m^3 in 2020. Thus, the estimates indicate a serious fuelwood and charcoal shortage which will seriously limit future socioeconomic development possibilities in the developing countries (see Suarez, 1995).

Wood shortages have been projected many times, but they have never actually occurred. The difference between past projections and the current situation is that, currently, there is broad consensus on this issue (e.g., TAPPI, 1995).

Even if the calculations identifying shortages are accurate, in reality the shortages will never appear. A number of balancing measures will occur to achieve an equilibrium: decreases in demand due to increased prices, introduction of new and more fiber-efficient technology, substitution of products, placement of higher values on fiber which will stimulate increases in supply (McNutt, 1995). But the projected shortages will increase pressure on the existing forests and increase competition with other demands on the forests.

Table 9. Global Industrial Wood Balance (million m^3).

	2010			2020		
	Conifers	Non-Conifers	Total	Conifers	Non-Conifers	Total
Simons, 1994	+60	-39	+21	-82	-209	-291
Apsey and Reed, 1995	-257	-177	-434	-315	-251	-566
McNutt, 1995			-75 – -125			
Calculations based on this paper	0 – -473	+15 – -310	+15 – -783	-73 – -459	-49 – -427	-122 – -886

Table 10. Global Fuelwood/Charcoal Balance (million m^3).

	1980	2000	2010	2020
FAO (1995d), Apsey and Reed (1995), and Zuidema et al. (1994) estimates			-95 – -255	-315
Zuidema et al. (1994) estimates with land-use changes			-1020	-1470
FAO (1983) bottom-up approach	-400	-960		
Updated FAO (1981) bottom-up approach			-1425	-1650

5. SENSITIVITY ANALYSIS OF THE MAINSTREAM SCENARIO

In the following section, I carry out a simple sensitivity analysis of the mainstream scenario. The analysis is not quantitative but rather qualitative and indicates the direction of major factors.

5.1 Recycling

The mainstream scenario for industrial wood takes into account current trends in recycling. But could a dramatic increase in recycling improve the balances in the mainstream scenario of industrial roundwood?

A major concern about recycled paper arose during the late 1980s and early 1990s. The market demand for waste paper was very low, and waste paper was regarded as an environmental problem. Governments introduced mandatory collection through regulations (packaging ordinances).

The introduction of this legislation caused turmoil in the market and the effect was a glut of waste paper. The resulting low prices attracted new investors. Suddenly demand was growing faster than supply and prices increased dramatically. The price development is illustrated in Figure 4 for a selected grade of paper in several countries in Europe. In early August 1995 prices fell dramatically because of an oversupply. Prices also dropped in the U.S. in late summer 1995, with prices higher for waste paper than for virgin fibers. One explanation for these price fluctuations is that the regulations on the waste paper collection caused imbalances in the supply and demand with serious price disturbances.

The paper industry projects that demand for recovered paper will continue to grow (Table 11).

Table 11. World Consumption of Recovered Fibers in the Paper Industry (million metric tons). Source: Cesar (1995).

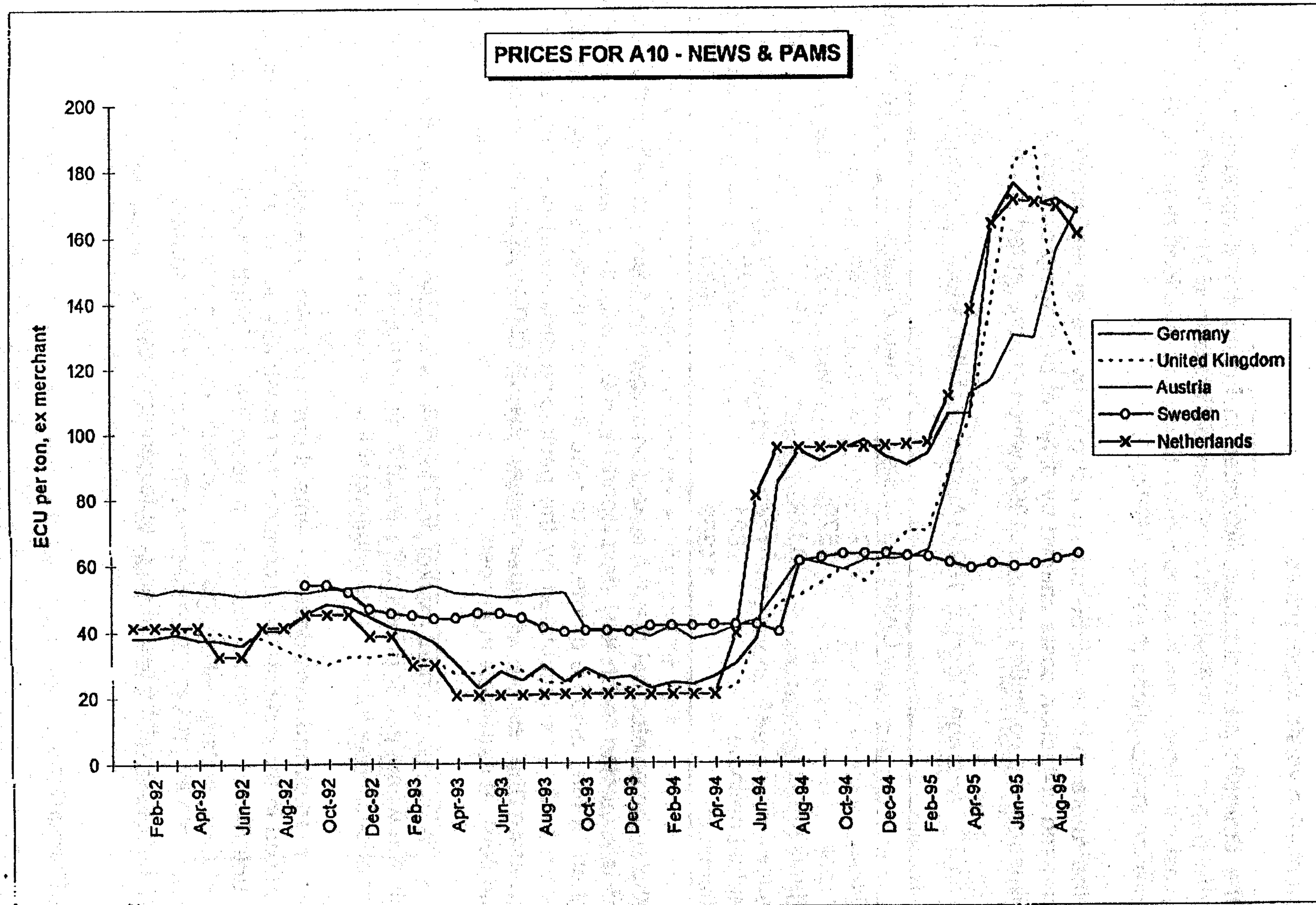
1980	1990	1995	2000	2005	2010	2020
53.5	77.5	100.0	127.5	145.0	195.0	After 2010 consumption levels off

The FAO (1995d) estimates even further increases in recovered paper consumption: from 94.2 million tons in 1993 to 243.7 million tons in 2010.

Thus, consumption is expected to continue to increase steadily until 2010. This trend is taken into account in the mainstream scenario. After 2010 consumption is expected to level off.

Increases in demand for imported waste paper will depend on the availability of waste paper as a raw material. Export supply will decrease. Exports from the USA (the world's largest exporter) will decrease, and domestic mills will tighten control on quantities exported. This trend will also be evident in other exporting countries.

Figure 4. Price Development of Waste Paper of News and Pams. Source: CEPI (1995).



These conditions will result in decreases in quantities available for export and in increases in waste paper prices.

If the dramatic price changes illustrated in Figure 4 are compared with historical waste paper price development, it can be concluded that there have been price explosions (which have settled over time) but the long-term trend has been a decrease in real prices (Nilsson, 1995b).

In the future, prices will be driven not only by the market conditions, but also by increased collection costs caused by different packaging ordinances. I use Austria to illustrate the collection costs in 1994, which are presented in Table 12.

Table 12. Average Costs in 1994 (Austrian schillings/ton). Source: BWS (1994).

	Collection Costs	Reuse Value	Total Costs
Glass	1717	-25	1692
Paper	1570	-590	981
Plastics	13312	9917	23230
Iron	5772	400	6172
Metal Laminate	9621	12757	22378
Aluminum	14362	-1600	12762

It should be pointed out that the collection system in Austria is only partly developed and is expected to be fully developed by 2000, with the costs being substantially higher. It may also be of interest to note that the introduction of the new collection system in Austria (stipulated by the packaging ordinance) has only succeeded in increasing the supply of waste paper by 25,000-30,000 tons (less than 10% collected), at extremely high costs.

Thus, taking into account market development and collection costs, the probability is high that waste paper prices will stay at a high level and relatively close to the virgin fiber prices in the future. This situation will slow industry consumption.

Given market and price developments, it does not seem plausible that the shortages identified in the mainstream scenario for industrial wood would be compensated by an unforeseen dramatic increase in recycling. McNutt (1995) arrives at a similar conclusion stating, "shortages are unlikely to be made up from higher recycling levels." Pöyry (1994) concludes that the impact of increased recycling on the global wood balance will be less than people generally expect.

5.2 Plantations

Many scientists and consultants have advocated that plantations in the Southern Hemisphere will solve the future shortages in wood supply (Sedjo, 1983; Jaakko Pöyry, 1994).

The total area of plantations in 1990 is presented in Table 13 for tropical regions.

Table 13. Tropical Plantations at the End of 1990 (million ha). Source: FAO, 1992; Pandey, 1992; Evans, 1992.

	Africa			Asia			Latin America		
	Indust.	Non-indust.	Total	Indust.	Non-indust.	Total	Indust.	Non-indust.	Total
FAO (1992) and Pandey (1992)	1.4	1.6	3.0	9.1	23.1	32.2	5.1	3.5	8.6
Evans (1992)			3.7			20.3[1)]			9.3

[1)] Not all Asian countries are included in this estimate.

The total plantation area in the tropics was 43.8 million ha at the end of 1990 (FAO, 1992; Pandey, 1992), but the industrial plantations accounted for only 15.6 million ha (36% of the total plantations). The figures in Table 13 are the areas reported by individual countries. Pandey (1992) compared these areas with plantation inventories and survival rates and was able to estimate that the net areas of plantations at the end of 1990 would be 27.6-34.1 million ha rather than the 43.8 million ha reported. The success rate of the plantations was 61% in Asia, 84% in Latin America, and 60-77% in Africa. The growth rate of plantations in the tropics was 2.6 million ha per year (total) during the 1980-1990 period. The growth rate for industrial plantations was 0.86 million ha.

The size of plantations in nontropical countries at the end of 1990 is presented in Table 14. By combining the information in Tables 13 and 14 it can be concluded that there was approximately 45 million ha of high-yield industrial forest plantations at the end of 1990.

Table 14. Forest Plantations in Nontropical Countries at the End of 1990 (in million ha). Source: Pandey, 1992.

Developing Countries		Developed Countries	
China	36.0[1]	New Zealand	1.24
Republic of Korea	2.00	Australia	0.97
Chile	1.45		
Rep. of South Africa	1.33		
Argentina	0.80		
Morocco	0.53		
Uruguay	0.21		

[1)] McKenzie (1995) estimates total plantations to be 34 million ha in China, of which only 2 million ha are high-yield industrial forest plantations.

Forestry consultants still consider the future of the forest industry to be in the plantation forests (Palmer, 1995; McKenzie, 1995), but quite recently their tone has softened somewhat concerning future possibilities (Neilson, 1995).

Palmer (1995) estimates that the forest industrial plantation area will increase in Latin America (Table 15).

Table 15. Industrial Forest Plantation Areas in Latin America (million ha). Source: Palmer (1995).

	1995	2010
Argentina	0.6	0.9
Brazil	4.2	5.0
Chile	1.7	3.2
Venezuela	0.5	0.6
Total	7.0	9.7

In addition, Palmer (1995) estimates that growth in industrial forest plantation will increase the wood supply by over 100 million m^3 (Table 16); this amount is substantial.

Table 16. Changes in Industrial Roundwood Production in Latin America during 1995-2010 (million m^3). Source: Palmer (1995).

		Plantation Forests		
	Native Forest	Hardwood	Softwood	Total Timber
Argentina	2	6	6	14
Brazil	(26)	45	18	37
Chile	2	7	28	37
Venezuela	2	1	7	10
All Others	1	3	2	6
Total	(19)	62	61	104

( ) negative change

McKenzie (1995) estimates the industrial roundwood supply from plantations in Southeast Asia to be 14 million m^3 in 2005 and 15-16 million in 2010 (today's production is 12 million m^3).

Neilson and Smith (1995) estimate that the supply from New Zealand will increase from today's 17 million m^3 to 40 million m^3 in 2020.

Trexler and Haugen (1995) have analyzed the suitability of land available for plantations from a socioeconomic point of view. They have found that between 1995 and 2045 the area of plantations could be increased by 4.6 million ha in Africa, 24.5 million ha in Latin America, and 37.8 million ha in Asia, resulting in a total increase of 66.8 million ha.

Recently, plantations in the Southern Hemisphere have received a great deal of publicity.

Pandey (1992) has carried out analyses of comparative data of growth and yield of the main species in the forest plantations. His conclusion is that, "With few exceptions, forest plantations are generally yielding lower than expected. The potential of forest plantations has not been realized."

Neilson (1995) has carried out a critical review of established plantations in the Southern Hemisphere and to some extent the same has been done by McKenzie (1995) for Southeast Asia. From these two reports, together with Pandey's (1992) findings, the following can be concluded:

- The monitoring of the forest plantations is very poor in developing countries, and the statistics are inaccurate (this is true even for plantations in developed countries).
- It is seldom possible to achieve high productivity (such as 70 m^3/ha in Aracruz in Brazil) in large-scale plantations; often yields are lower than expected, in some cases less than 1 m^3/ha per year. Besides management and technical factors, socioeconomic and political factors seem to be greatly responsible for the low yields.
- The knowledge on growth and yield of industrial plantations is very poor.
- Large-scale plantations have often been started based on small-scale experiments, and as a result, many have failed.
- Many of the tree species in the industrial plantations are not yet domesticated. Domestication means the ability to grow on a range of sites and climates, to respond to silviculture treatment, and to respond to genetic improvements.
- Productivity effects of biotechnology are overestimated by 25-50%.
- Inconsistent forest management has resulted in, among other things, a "sulking" (decreased growth) eucalyptus.
- Production costs have been substantially underestimated.
- Future environmental pressures will be placed on plantation forestry.

So far, plantation forestry has avoided major confrontations with the environmental movement. But during times when belief systems seek to discredit industry's roles in forestry (Mather, 1990; IIED, 1995), and given that environmental issues in forestry have become a springboard to broader social and political concerns (Sargent and Bass, 1992), it seems only a matter of time until the industrial forest plantations will be questioned. In some ways, this process has already begun (National Geographic, 1995).

It is plausible to assume that the importance of industrial forest plantations will continue to grow, but the increased reliance on plantation forests will not change the results of the mainstream scenario presented earlier.

5.3 Substitution of Non-Wood Fibers for Wood Fibers

Non-wood fibers play an important role in the paper industry in regions with limited forest resources. Increased environmental pressures, restrictions on forest uses, and a tightened supply of and demand for fibers also force forest-rich countries to take a closer look at non-woods (McCloskey, 1995).

Atchison (1994) and McCloskey (1995) have looked into the availability of non-woods suitable for the pulp and paper industry. They estimate the current worldwide availability to be about 2.5 billion metric tons. Major sources come from wheat, rice, and barley, corn and sorghum stalks, and sugarcane bagasse. Only a small percentage of this is used for pulp production today (less than 10%).

The potential in non-woods is large. The technology is available and is continually being improved.

There are two concerns connected with non-woods. First, the non-woods are predominantly seasonal, which places special demands on logistics and storage to maintain a year-round operation. Second, the non-woods have a variety of fiber and cell types and extraneous materials, which require specific fiber preparations (McCloskey, 1995).

The development of the worldwide non-wood pulping capacities is presented in Table 17.

Table 17. Worldwide Non-Wood Pulping Capacities (million metric tons). Source: Atchison (1994).

1985	1990	1993	1998 estimate
13.35	15.56	20.74	23.46

The global non-wood pulping capacity is estimated to increase from 8.1% of the total pulping capacity in 1985 to 11.2% in 1998. Croon (1995) estimates a rapid growth in the global non-wood pulping capacity between 1995 and 2005, namely, an increase of some 30%. This estimate is double the rate of increase estimated by Atchison (1994). The main part of the total non-wood pulping capacity is located in China (74%) and India (6%). Only 4% is located in the developed world. Croon (1995) concludes that "there are signs on the horizon that non-wood fibres will replace recycled fibre as the next hot item for the pulp and paper industry to tackle."

Thus, even if the non-wood fibers have a bright future, it may take a long time for a major breakthrough. Therefore, the non-woods will probably not change the trend identified in the mainstream scenario for industrial roundwood.

5.4 Land-Use Change and Deforestation

Table 18 gives the FAO (1995b) estimate of deforestation, reported as change of the forest cover in the developing world, between 1980 and 1990.

Table 18. Deforestation of Forest Cover between 1980 and 1990. Source: FAO, (1995b).

	1980 million ha	1990 million ha	Losses in million ha per year	% per year
Tropical Africa	568.6	527.6	4.10	0.7
Tropical Asia	349.6	310.6	3.90	1.2
Tropical Latin America	992.2	918.1	7.41	0.8
Non-Tropical Africa	14.3	13.0	0.13	0.9
Non-Tropical Asia	130.2	125.7	0.44	0.4
Non-Tropical Latin America	44.3	41.6	0.27	0.6
Total Developing	2099.2	1936.5	16.27	0.8

The average total net loss is over 16 million ha per year in the developing world, a total of 162.7 million ha over the period studied. The FAO (1995b) estimates that the change of the forest cover has caused a loss of some 2.7 billion metric tons of biomass between 1980 and 1990.

The table does not indicate which type of forests the decline has taken place in or the degree of degeneration of the forests. In a sample of 143 countries, the FAO (1995a) estimates that the natural forests have declined by 184 million ha between 1980 and 1990 and the decline in other wooded land is 95 million ha. In further analyses the FAO (1995b) has determined that, between 1980 and 1990, 92.05 million ha of the closed tropical forests underwent a change: 8.97 million ha became open forests; 9.27 million ha, long fallow shifting cultivation; 9.17 million ha, fragmented forests; 2.53 million ha, shrubs; 21.57 million ha, short fallow; 34.79 million ha, other land cover; 3.95 million ha, plantations; and 1.78 million hectares are now covered by water. The net deforestation figures are far from revealing the whole truth. When considering the type of changes and degeneration, the picture looks even more disturbing.

There is no simple explanation for deforestation. Most authors generally agree on which agents are directly involved in destroying the forests; they often disagree in their assessment of the primary causes (Utting, 1993). Some claim that the population factor is the main driving force for deforestation (Shaw, 1989), but no simple correlation can be drawn between population pressure and deforestation. Brown and Pearce (1994) have presented a summary of studies which test a number of hypotheses using different econometric and statistical techniques. Most of the 16 studies analyzed identify population and population density as an important influence. Brown and Pearce also summarized the current level or lack of knowledge concerning the process of deforestation in the tropics.

Palo (Palo and Salmi, 1987, 1988; Palo and Mery, 1990; Palo, 1994) has perhaps developed the most advanced quantitative model on the roles of system causality and population in deforestation and regressive development. Palo lists the population factor, along with other factors, as playing an important role in the deforestation process.

Concerning the future development of deforestation in tropical countries, Brown and Pearce (1994) state, "It is clear that only when we understand more fully the complex causes of unsustainable exploitation and degradation of tropical forests can we formulate coherent policy to prevent destruction."

Meyer (1994) concludes, "There is a solid reason to assume a continued acceleration in deforestation rates in much if not most of the biome in the foreseeable future." He regards this assumption as a very likely possibility, with a deforestation rate of 19 million ha per year by 2000. Williams (1994) states that the process of change in the forest will extend into the future; for those living in or near tropical forests, the forests will continue to provide land, fuel, and shelter for an increasing population as long as the forests last.

Trexler and Haugen (1995) have carried out detailed analyses of the current deforestation rates and the external parameters likely to influence future deforestation patterns in selected tropical countries. These parameters include population growth, urbanization, agricultural trends, land-tenure policies, development of infrastructure, expansion of cash crops, government and land-use plans, extension programs, public perceptions of forest resources, energy needs, and laws and regulations. The authors conclude that some countries in the tropics will see decreases in deforestation, others will experience increases in deforestation, and still others will remain relatively stable. But overall, the losses will decline in the tropics partly because the forests in some countries will have already been eliminated. Results from the "Business-as-Usual Scenario" (no new countermeasures are taken against deforestation) by Trexler and Haugen (1995) are presented in Table 19. Under this scenario, the accumulated loss is estimated to be an additional 650 million ha between 1995 and 2045. According to this estimate tropical forests will experience a total loss of some 865 million ha between 1980 and 2045.

Table 19. Annual Deforestation Rates and Cumulative Deforestation (million ha). Source: Trexler and Haugen (1995).

	1995	2005	2015	2025	2035	2045	Cumulative Total
Africa	4.6	3.9	3.3	2.9	2.5	2.5	196
Asia	3.3	3.0	2.7	2.2	1.9	1.8	148
Latin America	7.8	6.3	5.1	4.2	3.6	3.6	305
Total							648

Jepma (1995) has developed an advanced global policy simulation model (IDIOM) to analyze possible future processes of tropical forests. His base scenario on deforestation (no countermeasures) in the tropics is presented in Table 20. The calculations are based on the FAO's (1995b) estimates on forest areas.

Table 20. Accumulated Losses in Tropical Forests from 1990 to 2025 (million ha). Source: Jepma (1995).

		Accumulated Losses	
	1990	2020	2025
Tropical Africa	527.6	73	137
Tropical Asia	310.6	53	62
Tropical Latin America	918.1	119	138
Total	1756.3	245	337

If the Jepma figures are adjusted to be valid for all of Africa, Asia, and Latin America (including nontropical forests) in year 2025, they show a total loss of 367 million ha. These estimates are some 18% lower than the Trexler and Haugen (1995) estimate for 2025.

The losses of tropical forests estimated by Jepma (1995) will also negatively influence the harvesting potential in the tropics (Table 21).

Table 21. Commercial Reserves in the Tropics (billion m^3). Source: Jepma (1995).

	1990	2020	2025
Tropical Africa	1.65	0.60	0.55
Tropical Asia	2.50	0.75	0.70
Tropical Latin America	3.75	1.20	0.90

Deforestation in the tropics and other developing countries is part of an overall land-use change process – land-use change that not only affects the tropics. According to Meyer and Turner (1994), the primary driving forces for these overall land-use changes are:

- The political decision-making process and capacity of the state.
- Vulnerability to economic pressure, the market allocation mechanism, technological development, and wealth distribution.
- Population pressures.
- The quality of environmental resources.

Zuidema et al. (1994) have developed a global simulation model for future land-use changes. Solomon et al. (forthcoming) have used this model to estimate future land-use changes in the global forested areas (closed forests) (Table 22).

Table 22. Forested Areas under a Dynamic Land-Use Change (million ha). Source: Solomon et al. (forthcoming).

	1990	2020
Tropical Forests	2760	2100
Temperate Forests	540	490
Boreal Forests	1380	1520
Total	4680	4110

If the assumptions for these analyses on land-use changes are correct (the estimate for the tropics is in line with the estimates by Trexler and Haugen, 1995), there will be a major decline in tropical forests and an increase in boreal forests (but this increase will not affect the timber supply significantly over the next 50 years).

It seems likely that land-use changes, deforestation, and degeneration of the forest resources in the tropics will continue, and we can foresee an additional loss of tropical forests of some 550-650 million ha over the next 50 years if strong countermeasures are not implemented. From the perspective of land-use change, the shortages indicated in the mainstream scenario are probably underestimated, especially for fuelwood.

5.5 Non-Wood Demands

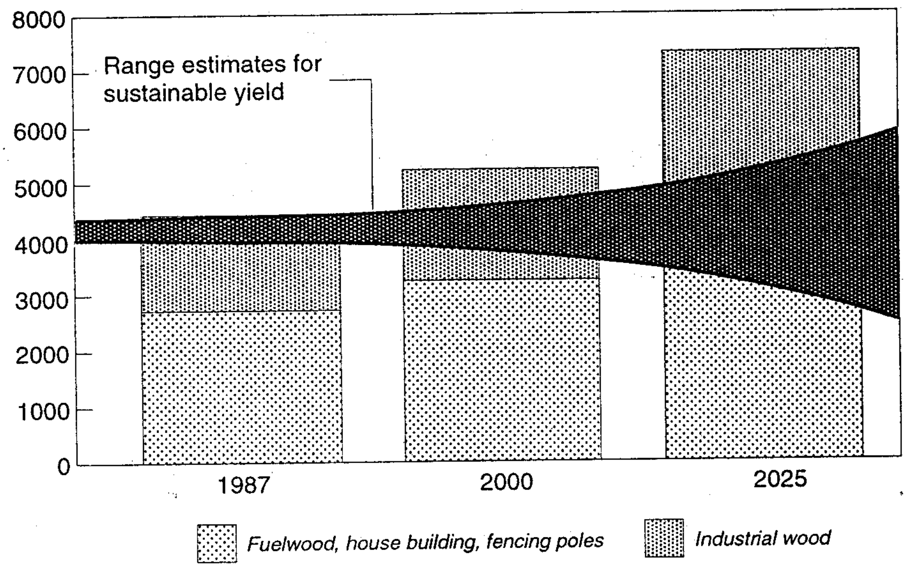
The "new" demands (biodiversity, sustainability, land use, etc.) or non-wood functions have significantly affected the wood supply. Price Waterhouse (1995) estimates that actions taken in 1994-1995 by the British Columbian government to secure non-wood demands will reduce the AAC in British Columbia by 12 million m^3 (from 71.3 to 59.0 million m^3). Warren (1995) estimates that US Forest Service sales have been reduced by 40 million m^3 since 1989 because of new non-wood demands. Brooks (1995) predicts that in the future the proposed harvest in the Pacific northwest of the USA will be as low as 20% of the average harvests for 1980-1989 due to new non-wood demands. Pisarenko and Strakhov (1995) point out that the AAC in Russia has been reduced by 117 million m^3 between 1990 and 1995. A major part of the reduction of AAC is within coniferous species (96 million m^3). Some 60-65% of these reductions are due to non-wood demands.

Sallnäs et al. (1995) have studied the consequences of implementing the certification rules currently being discussed in Sweden. The study is being conducted in an area of rather uncomplicated forest landscapes from the point of view of biodiversity. One conclusion is that cashflow will be 15-20% lower under the conditions of the certification rules than under strict economic regime conditions. Wood production will also decrease by 15% over the 100-year period in the certification case. This study shows that, in regions with complex biodiversity concerns, the economic and supply effects will be substantial, and there will also be difficulties in fulfilling all of the certification rules.

If the WWF rules discussed in Sweden are applied to Finnish conditions, net annual revenue will decrease by 20% in comparison with conventional forestry measures. The annual harvest will decline by some 17% (Finnish Forest Research Institute, 1995). Similar results were also achieved for Canada (Gooding and Van Damme, 1995). Thus, the existing case studies indicate a decrease in the annual harvest and a decrease of 15-25% in economic results if the criteria for preserving biodiversity is to be employed.

All of these case studies were carried out for boreal forests. Therefore, under more complex conditions the impact of the criteria can be expected to be even larger. On the issue of the sustainable forest management, the World Bank (1995) stresses: "While scientific and popular concern about the sustainability of forests is growing throughout the world, current indicators of sustainability are at best crude estimates." Based on this fact, the Bank presents a sustainable yield with large variations (Figure 5).

Figure 5. Projected Global Roundwood Consumption and Sustainable Yields, 1987, 2000, 2025 (million m^3). Source: World Bank (1995).



Many of the new demands are driven by international agreements: the Framework Convention on Climate Change (FCCC), the Convention on Biological Diversity (CBD), and the Statement of Principles on Sustainable Forest Management. Other initiatives that address the forest resources and forest management have emerged from local and national NGOs.

Most current agreements and ongoing initiatives are more politically motivated than scientifically motivated (Nilsson, 1995c). These initiatives probably signify just the beginning of a new era of forest policy (Nilsson 1995c). In addition to the international politicization of non-wood issues, a few other events have taken place. The scientific literature reflects less dependence on pure scientific approaches than it has in the past and increasingly supports the need for caution – the Precautionary Principle (O'Riordan and Cameron, 1994). A summary of this issue can be found in

Howlett and Sargent (1993). Also, the environmental issues in forestry have become a springboard to broader social and political concerns (Sargent and Bass, 1992). Dewar (1995) has made a thorough and critical review of the strategies of the overall management of the international environmental NGOs and claims that the overall target is to establish a new Global Governance Agenda. This agenda calls "for more powers to new global institutions, a revamping of the United Nations and a devolution of various national powers down to the neighborhood" (Dewar, 1995).

Given that we are beginning a new era of policy-setting in forestry and the high degree of international politicization of non-wood demands, we may encounter surprises that will further limit the uses of forest wood. These surprises are difficult to forecast, but a plausible assumption is that the surprises will worsen the shortages presented in the mainstream scenario.

6. NON-MAINSTREAM SCENARIOS FOR INDUSTRIAL ROUNDWOOD

Some studies of the forest sector have identified developments of the industrial roundwood demand and supply that are different from those in the mainstream scenario.

One non-mainstream scenario maintains that the demand for forest products will reach saturation and that the industrial forest plantations will outperform the traditional suppliers (in spite of what is said in section 5.2). The assumption is that the consumption of forest industrial products in the developed world has stagnated and will even decrease because other materials will substitute for wood. This development is illustrated by the consumption figures of coniferous lumber in Europe (Figure 5).

For paper and board, the conventional assumption is that there is a linear relation between consumption and GNP. Figure 6 shows that in developed countries consumption is stagnating. The new "growth" countries will not follow the conventional consumption pattern but will jump directly into the stagnating pattern because of this substitution process.

The industry has recently expressed concern about this possible development. Brandinger (1995) indicates that the construction sector in Europe has had a growth rate of 2-3% per year but that the lumber market has only grown by 0.8%. Industrialists also express concerns about the replacement of paper products, for example, by new information technology (Veckans Affärer, 1995).

These assumptions have led to an approach that encompasses multiple curves of consumption of wood products in relation to per capita GDP. By following this approach countries are grouped into four categories according to a consumption pattern with stagnating development (given in Figure 8).

Figure 6. Consumption of Coniferous Lumber in Europe from 1970-1994 (million m^3). Source: Libäck (1995).

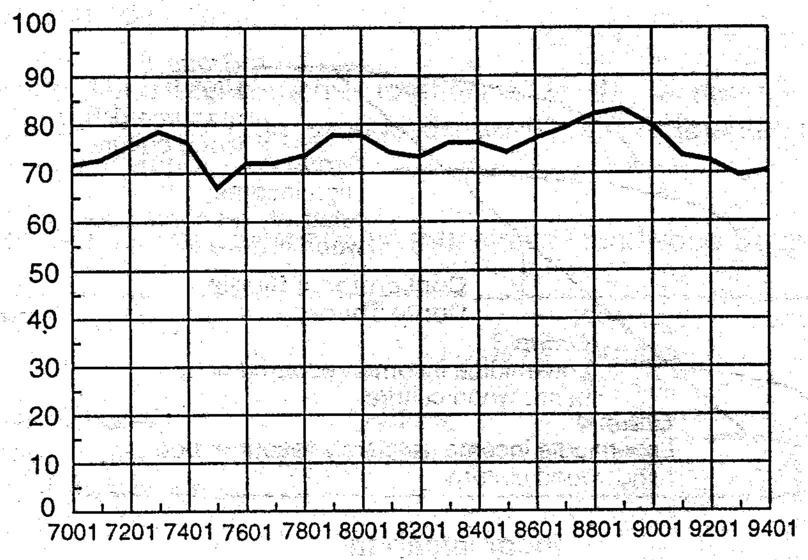


Figure 7. GDP and Paper Consumption per Capita. Source: Pöyry (1994).

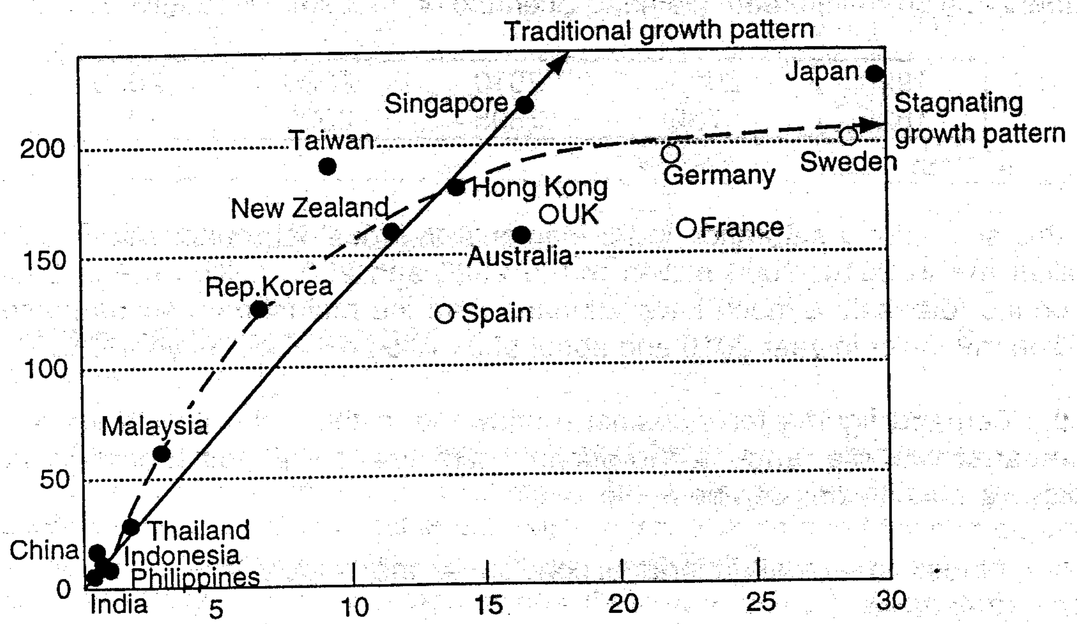
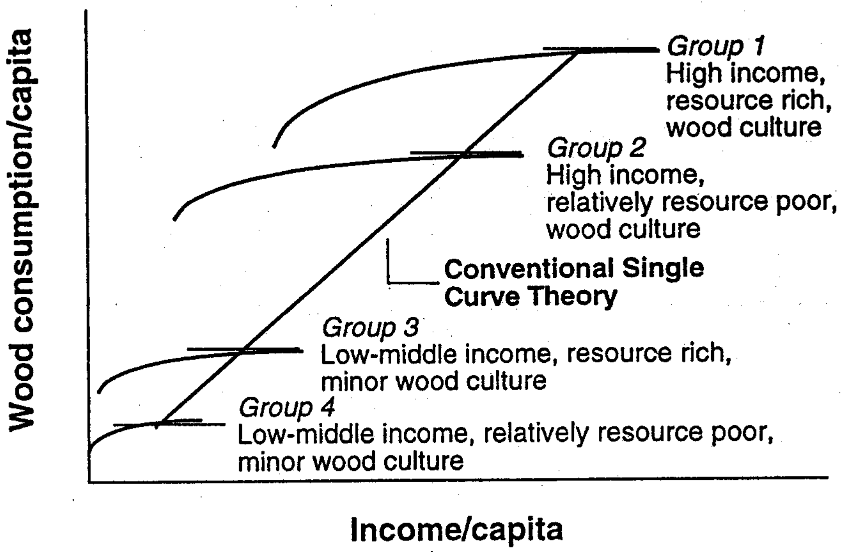


Figure 8. Illustration of the Principle of Multiple Curves Versus Conventional Single Curve Theory.



Some North American industries have applied this theory in their forecasts of future demands. It should be pointed out that these results have not been widely discussed. The results are presented in Table 23.

Table 23. Non-mainstream Demand Scenario on Industrial Roundwood (million m^3).

1990	2000	2010	2020	2050
1626	1730	1895	2000	2200

In this scenario, a saturation in the demand on industrial roundwood is set at 1895 million m^3 in 2010, 2000 million m^3 in 2020 and 2200 million m^3 in 2050. This scenario forecasts a much lower demand than the mainstream scenario: some 200 million m^3 lower in year 2010 and about 500 million m^3 lower in year 2020.

If the demand figures for industrial roundwood in this non-mainstream scenario is compared with the range of the supply estimates in the mainstream scenario, the following conclusions can be made:

- Under the most favorable conditions, the supply and demand would be balanced.

- Under the less favorable conditions, we would still have a shortage of 400 million m^3 in year 2010 and a deficit of 335 million m^3 in year 2020.

However, the non-mainstream scenario also has a different view of the future wood supply. This scenario assumes a major shift in the supply pattern and does not identify any shortages in the supply. The scenario divides suppliers into three groups: enduring, expanding proven, and present but diminishing. The supply scenario is presented in Table 24.

In this scenario the developments forecasted in the enduring and diminishing regions would be due to high production costs, environmental regulations, and increased non-wood demands.

Table 24. Non-Mainstream Scenario on Industrial Roundwood Supply (million m^3).

Supply Region		Average Supply 1986-90	Year 2050
Enduring: Mainly Boreal (Nordic, Canada, Russia, Eastern Europe, Japan, Iberia, China, India)	- Conifers	646	665
	- Hardwoods	158	193
		804	858 (965)[1)]
Expanding proven: Tropical/Sub-Tropical Plantations (Argentina, Brazil, Chile, Oceania, South Africa, Central America, South America, and Southeast Asia Plantations)	- Conifers	75	345
	- Hardwoods	123	714
		198	1,059 (590)[1)]
Diminishing: (W.Europe, USA, S.E. Asia Natural Forests)	- Conifers	409	240
	- Hardwoods	228	100
		637	340 (685)[1)]
Total	- Conifers	1,130	1,250
	- Hardwoods	509	1,007
		1,639	2,257 (2240)[1)]

[1)] Second estimate conducted by another industrial group.

7. NON-WOOD DEMAND AND SUPPLY

7.1 Introduction

Global balances of industrial wood and fuelwood have been discussed in the previous sections. Substantial uncertainties have been identified in the quantifications of these products, but in comparison with the demand for and supply of non-woods, the problems identified with these quantifications and estimates must be regarded as simple. For most non-woods there are many uncertainties and surprises, and the data are scarce.

7.2 Climate Change and Forestry

The issue of climate change and forestry has several dimensions, but there are three major ones:

- The impact of climate change on the forest resources.
- Forestry's contribution to climate change.
- The mitigation possibilities of forestry.

With regard to the future impact of climate change on the forest resources, the IPCC (Solomon et al., forthcoming) concludes that up to the year 2050 the most important agent in vegetation change would be changes in land use: "We know of no processes [technological or natural] which have been quantified that would ameliorate this enormous impact [land-use change]." Sharma et al. (1992) estimate that population pressures could reduce the tropical forest area by 30% by 2025, which is in line with the estimate by Zuidema et al. (1994). The IPCC (Solomon et al., forthcoming) estimates that climate change alone would be responsible for a 1-9% increase in land suitable for forests, with the largest gains in temperate and boreal regions, up to the year 2050.

Perez-Garcia et al. (forthcoming) have carried out analyses on the effect of climate change on forest growth, production, consumption, prices, and trade up to the year 2040. They have used four General Circulation Model Simulations. The climate scenarios have been linked to the Terrestrial Ecosystem Model (TEM) (Raich et al., 1991; McGuire et al., 1993; Melillo et al., 1993). TEM is a process-based model which uses data on climate, soils, and vegetation to estimate the net primary production (NPP) taking into account carbon and nitrogen cycling and other environmental factors. The effects on productivity are not analyzed in the models discussed by the IPCC (Solomon et al., forthcoming). In the four climate scenarios, global NPP was estimated to increase by 20-25% on average, with the greatest increases in boreal and temperate forests. The productivity effects were transformed to the CINTRAFOR Global Trade Model (Cardellichio et al., 1989). The results from this model show that coniferous timber production in Canada will increase between 13-22% in Canada. In European producer countries, such as Finland and Sweden, the timber production will decrease by 4-10% in spite of a large increase in NPP (18-32%). There is a similar impact on non-coniferous timber production, but the players are different (higher output in the USA and China and lower output in Russia and Europe). The overall net economic impact of climate change is positive with a net present value increase between US$ 10.7 and US$ 15.9 billion (at 1980 prices), for the global forest sector (Perez-Garcia et al., forthcoming). On the other hand, Burton et al. (1995) predict minimal economic impacts from climate change on the US; they predict the change in economic welfare will be less than 1% (positive under some conditions and negative under others). De Steiguer and McNulty (1995) show that the projected climate change will have a negative economic impact of less than 1% on the Southern US timber markets.

Perez-Garcia (1995) concludes that there are strong links between carbon fluxes and demand on industrial forest products. The foreseen increased demand on coniferous forest products will slow down the expansion of the carbon forest sinks over time.

Dixon et al. (1994) estimate that in 1990 the low-latitude (Asia, Africa, America) forests were a net source of carbon, emitting 1.6 ± 0.4 Gt of carbon into the atmosphere; this impact was mainly due to deforestation. The mid-latitude forests (USA, Europe including the Nordic region, China, and Australia) were net sinks removing 0.26 ± 0.09 GtC in 1990. The high-latitude forests (Canada and Russia) were also estimated to be net sinks in that year, removing 0.48 ± 0.1 GtC. In 1990 the global forests were a net source of 0.9 ± 0.4 GtC. The probability is high that this net source of carbon from forests will remain even if the emissions from deforestation decrease over time (Trexler and Haugen, 1995).

Nevertheless, a number of actions are possible that would increase the sequestration of carbon. Numerous studies have been carried out on the impact of forestry on the global carbon balance (for an overview, see FAO, 1995c).

Nilsson and Schopfhauser (1995) have analyzed the global availability of suitable lands for plantation. They found that about 345 million ha could be used for plantations and agroforestry. By implementing an efficient plantation program over a 25-55-year period, a maximum fixation rate of 1.5 GtC per year will be reached after 40 or 50 years, which corresponds roughly to 25% of carbon emissions from fossil fuels (IPCC, 1994; FAO, 1995d). Dixon et al. (1991) and Winjum et al. (1992) estimate that the carbon storage as an impact of forest management could be between 5 (high altitudes) and 50 (middle altitudes) metric tons of carbon per ha. Shvidenko et al. (1995b, c) estimate that Russia could, through improved management and increased forest protection, increase the carbon sequestration by 300-600 million metric tons per year. Thus, improvements in forest management of existing resources may significantly improve global carbon balance.

However, Englin and Callaway (1995) stress that the west coast of the USA may experience considerable negative environmental impacts from changes in forest management aimed at controlling carbon.

The substitution of biomass for fossil fuels has the potential of helping to close the CO_2 cycles and to dramatically change the global-warming implications (FAO, 1995c). Many estimates on the potentials have been presented (Hall, 1994; and earlier references on this subject in the text). However, it should be pointed out that studies of the full fuel cycle conclude that substituting biofuels from forests for fossil fuels may contribute to ameliorating the increase in CO_2, but that producing biofuels is not necessarily the best choice under all circumstances (Marland and Schlamadinger, 1995).

Thus, the prospects for improving the carbon balance through plantations, improved silviculture, and replacement of fossil fuels by wood are rather bright, but will they materialize? The difficulties identified for industrial forest plantations in section 5.2 are dramatically larger for carbon fixation plantations. FAO (1995c) stresses that tree plantations solely for CO_2 sequestration cannot function unless they are planned and managed in conjunction with timber, fuelwood, watershed protection, non-wood products, and non-commodity recreation values. These factors reduce the realization of plantations dramatically. The Nordwijk Declaration on Climate

Change in 1989 established a target of net growth in forests of 12 million ha per year by 2000. In 1991 it was concluded by the IPCC that this target was unrealistic.

A key question is, Who is going to pay for and manage the carbon sequestration plantations? No one is volunteering.

One option would be joint implementations (countries or industries offset their emissions by establishing plantations in a foreign host country); this method was established by the Framework Convention on Climate Change. Before the Committee of the Parties met in Berlin in 1995, seven forestry joint implementation projects (with rather small areas) were established (Jepma and Nilsson, et al., 1995). But this activity seems to have lost momentum after the Berlin meeting.

So far, no one has explicitly expressed concern (concrete targets) over the need for future sequestration by forests in the global carbon balance.

No forest policy for carbon management has been implemented (at least not to my knowledge). The unanswered question remains: Who is going to pay for the adjustments?

In spite of the good prospects of substituting wood for fossil fuels, the transition is going rather slowly and in some cases countermeasures have been taken against the transition. The transition is driven by the market price of wood for energy. In no case that I am aware of has the transition been driven by concerns for the carbon balance and the future climate.

Duinker (1995) concludes that there seems to be little room for carbon management in the already complex management situation of the Canadian forests. I tend to agree that this is also true at the global level. I predict that in the foreseeable future, improvements in sustainable forest management and increases in forest areas will continue to be driven by the market and not by concerns for the carbon balance.

7.3 Biodiversity

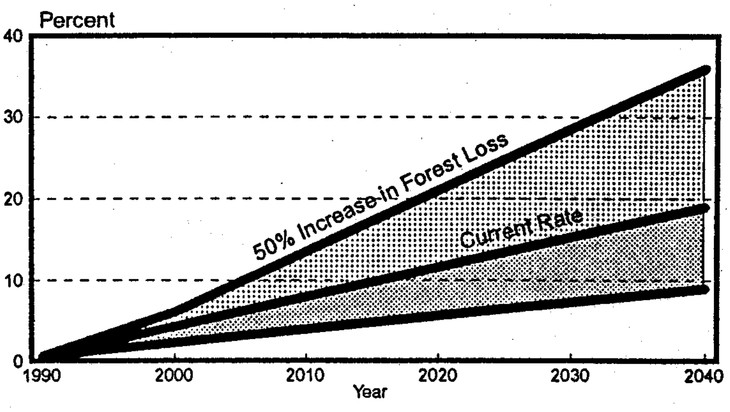
Pearce (1995) points out that most biodiversity losses are a result of land conversion or land use. He presents a rate of conversion between 1980 and 1991 (Table 25). However, the table shows fewer forests losses than the estimates presented in section 5.4.

Table 25. Land Conversions 1979/81-1991 (million ha). Source: Pearce (1995).

	Cropland	Pasture	Forest	Other	Total
Africa	+9	+8	-26	+11	+1
N. and C. America	-2	+4	+2	-4	0
S. America	+13	+21	-42	+11	+3
Asia	+6	+66	-26	-43	+3
Europe	-2	-3	+1	+4	0

The world's stock of forestry-related biodiversity is clearly threatened. This is illustrated in Figure 9.

Figure 9. Percent of Tropical Forest Species Likely to Be Lost over the Coming Decades. Source: Erlich and Wilson (1991), and Wilson (1994).



The term biodiversity is used to describe the number, variety, and variability of living organisms (WCMC, 1992). To apply this definition to any form of quantitative analyses, a number of steps are required (Ontario Forest Policy Panel, 1993; World Bank, 1995);

A. Identify indicators at different temporal and spatial scales for biodiversity.

B. Based on the indicators, estimate the present status of biodiversity.

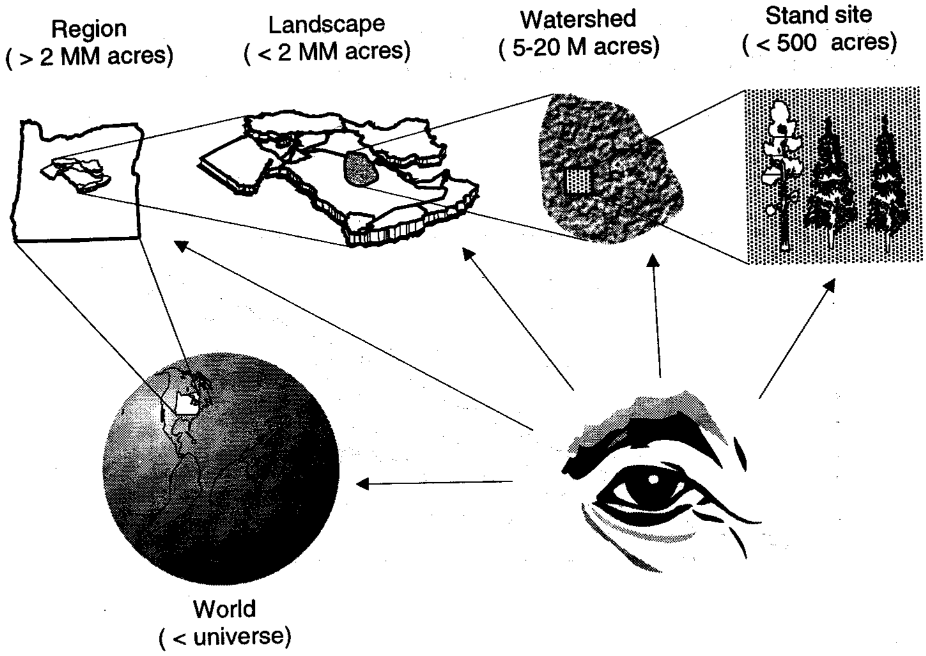
C. Identify future biodiversity demands.

D. Identify how well the current management systems are fulfilling future biodiversity demands.

E. Identify measures required to fulfill biodiversity demands (conservation and management).

These steps are very difficult to complete because they must be carried out in an integrated mode across multiple geographic scales (Figure 10).

Figure 10. Biodiversity Requires Integrated Analyses across Multiple Geographic Scales. Source: Salwasser et al. (1994).



The advantages of the method illustrated in Figure 10 are confirmed by quantitative analytical work carried out on Siberia by IIASA (Duinker, forthcoming). From this work it can be concluded that the biodiversity issue has certain characteristics at the stand level and other, different, characteristics at the landscape level; at the regional level these characteristics are yet again different. Walker (1994) confirms the importance of interactive scale analyses and stresses "there are three scales of ecosystems relevant to global change issues; patch, landscape and region."

It can be concluded that in the current situation we do not have a consensus on which indicators to use to measure biodiversity. In addition, the data that will help us to identify where biodiversity is threatened and what local pressures it faces are missing (World Bank, 1995). HMSO (1994) and May (1995) support this conclusion. May (1995) states that our lack of understanding of the causes of biological diversity or its role in maintaining ecosystems is disturbing.

The demands we place on future biodiversity also depends on what value we attach to the conservation of diversity. We are far from forming any consensus on the value of biodiversity (Pearce, 1995).

Based on these facts it can be concluded that there are limited possibilities for designing a quantitative analyses on biodiversity supplies and demands within forestry.

To identify some quantitative indications of which direction the demands might go, I have carried out a few incomplete calculations.

I start with conservation and protected areas. Udvardy (1975) has developed a system for defining the earth's biomes (Figure 11). The World Conservation

Monitoring Center (WCMC, 1992) has identified protected areas within these biomes. The WRI (1994) has calculated the percentage of the biome areas subject to high and medium human disturbances.

If we define sustainability in a way that means "all things to all people" (Tomorrow, 1995) and determine that all biodiversities have equal value, independent of location, then all biomes should be protected equally. Therefore, we should consider the current protected areas in relation to the areas subject to high and medium human disturbances and try to identify where protection must be increased. In a way the World Bank (1995) has taken this approach. This approach assumes that to achieve this objective a globally protected area must be set up which matches the top 50% (better half) of currently protected biomes. The calculations in Table 26 show that protected areas in the tropical evergreen forests should increase by some 120 million ha and those in the temperate forests should increase by 110 million ha.

However, it should be pointed out that we do not know if the better half of the currently protected areas are sufficient from a future biodiversity point of view.

Figure 11. A Classification of the Biogeographical Biomes of the World. Source: Udvardy, 1975.

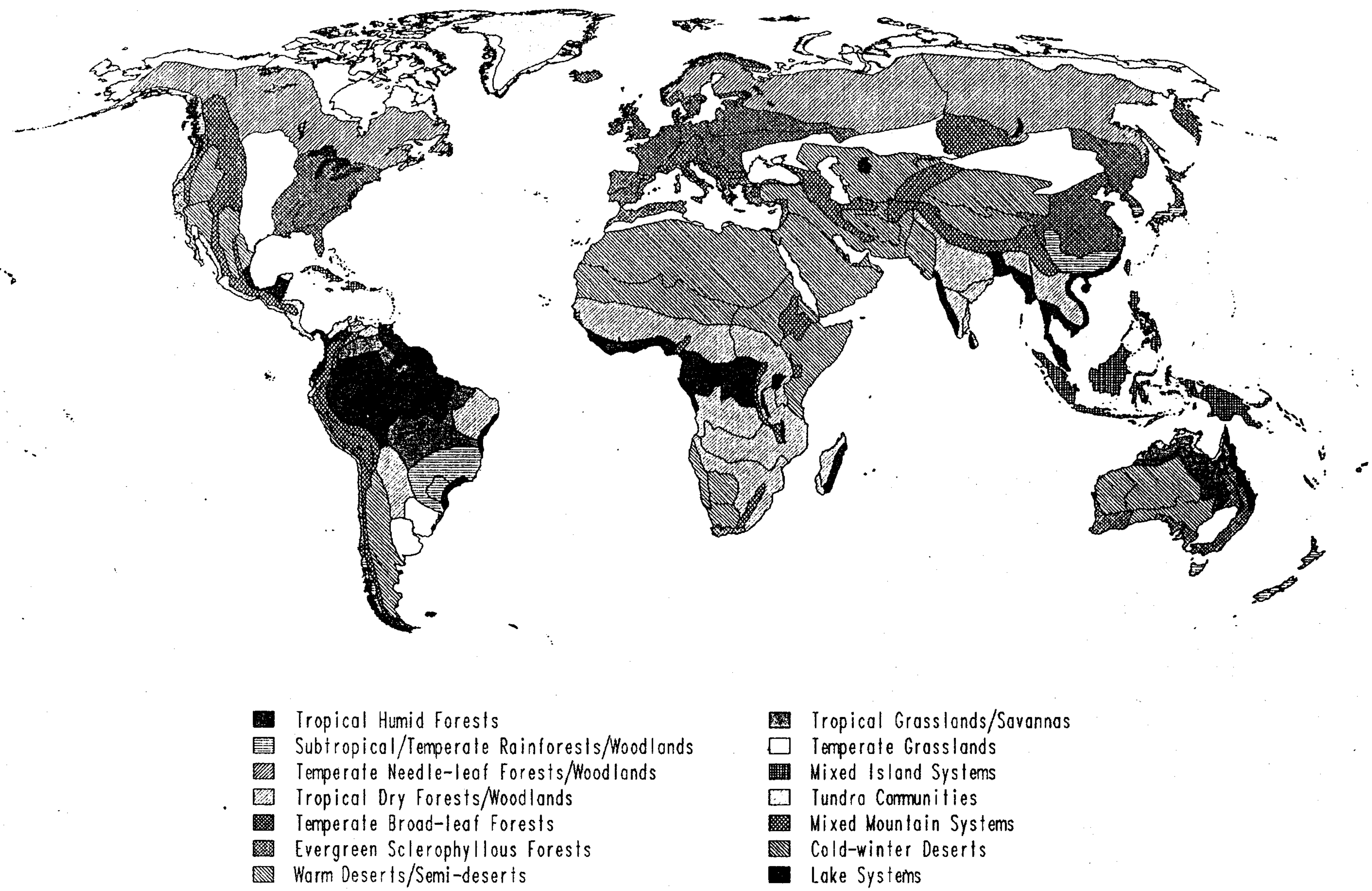


Table 26. Increase in Areas Protected under the Condition that All Biomes of the World Have an Equal Value and Should Match the Better Half of Currently Protected Biomes.

Biome Type	Total Biome Area in 1000 km^2	Current protected area in 1000 km^2	Areas subject to high & medium level human disturbance	Percent of protected areas of disturbance areas	Increased demand for protection to match the better half in 1000 km^2
1. Subtropical/ temperate rainforests	3928	366	2632	13.9	–
2. Mixed mountain systems	10633	820	7517	10.9	–
3. Mixed island systems	3244	246	1732	14.2	–
4. Tundra communities	22017	1643	661	249	–
5.Tropical humid forests	10513	522	3869	13.5	–
6.Tropical dry forests/ woodlands	17313	818	12292	6.7	940
7. Evergreen sclerophyllous forests	3757	177	3495	5.0	273
8. Tropical grasslands/savannah s	4265	198	1109	17.9	–
9. Warm deserts/ semideserts	24280	958	9979	9.6	469
10. Cold-winter deserts	9250	365	4866	7.5	331
11. Temperate Broadleaf forests	11249	357	10157	3.5	1095
12. Temperate needle-leaf forests/ woodlands	17026	487	3116	15.6	–
13. Temperate grassland	8977	70	6499	1.1	859
14. Classification unknown		707			
TOTAL		7735			3967

If we assume that there is a simple relation between the need for protected areas and the number of threatened species (the larger the number of threatened species, the larger the number of areas requiring protection), then one way to look into the demand of protected areas is to study the number of threatened species and the proportion of protected areas (IUCN - categories I-V) in total land area. By using information on protected areas, total land areas, and threatened species from the WCMC (1992) and the WRI (1994), a simple index has been developed for individual countries. The threatened species studied are mammals, birds, and higher-order plants that can be regarded as indicator species of biodiversity (World Bank, 1995). If we assume that the individual countries in a region should match the top 50% of the countries concerning the relation between threatened species and the proportion of protected areas of the total land area, we arrive at an estimate of the minimum demand on protected areas. The results of the calculations are shown in Table 27.

Many criticisms can be made of these calculations. One is that the top 50% does not satisfy the requirements of future biodiversity. None of the areas requiring protection are forest land, but we can assume that a major part is forest.

However, the two number-crunching exercises show that substantial increases in protected areas are necessary to fulfill biodiversity demands.

Table 27. Additional Demand on Protected Areas under the Assumption that All Countries in a Region Should Match the "Better Half" with Respect to the Relation between Threatened Species and Proportion of Protected Areas of Total Land Area. (million ha).

	Indicator Species		
Region	Mammals	Birds	Higher-order Plants
Tropical Africa	165	125	90
Nontropical Africa	9	9	9
Tropical Asia	105	90	105
Nontropical Asia	45	45	40
Tropical Latin America	165	160	125
Nontropical Latin America	45	45	45
Europe	19	21	16

Dinerstein et al. (1995) have carried out impressive work. They have tried to assess conservation needs by examining the existing species lists (i.e., IUCN, 1988), incorporating the aspects of maintenance of ecosystem and habitat diversity, and integrating of the principles of conservation biology and landscape ecology for the terrestrial ecoregions of Latin America and the Caribbean. They have integrated the conservation status with the relative biological importance of ecoregions in order to assign priorities for biodiversity conservation. By using this priority index the demand on conservation of forests in Latin America (including the Caribbean) can be identified (Table 28).

Table 28. Forests Areas Highly Prioritized for Biodiversity Conservation in Latin America, Including the Caribbean (million ha). Source: Dinerstein et al. (1995).

Tropical Moist Forests	309.2
Tropical Dry Forests	42.5
Temperate Forests	19.2
Tropical and Subtropical Coniferous Forests	35.2
Total Forests	406.1
Grasslands, Savannas, and Shrub lands	419.3

Some 40% of the total forests and other wooded lands of the region have been classified as prioritized areas for biodiversity consideration. The current protection of all natural areas for this region is 230 million ha (WRI, 1994).

ecosystem management is to emulate natural ecological patterns and natural disturbances (Duinker, 1995).

The distinction between a natural and unnatural ecosystem is obscure (Noss, 1995). Duinker (1995) raises a red flag at the attempt to emulate natural patterns and disturbances in the forest management. He stresses that nature has millions of patterns and processes: "Which ones are the important few to emulate and which ones do we have the knowledge and tools to emulate?" If we are able to identify the important processes to emulate in the forest management, we are faced with the next problem – namely, to determine natural behavior over time.

Lambert (1967) points out that forests are made up, not of static objects, but of living things that are always developing. Linder (1995) shows that forest reserves and national forest parks established some 70 years ago in Sweden are now losing the natural values for which they were established. Thus, nature is developing in an undesirable direction and efforts must be made to rectify this situation.. In other words, what is the baseline concerning biodiversity to be employed? Which historical time frame should we use to establish a natural management regime?

There are currently many unknowns with regard to forest management and biodiversity. There is no clear consensus of what form this changed management will take at the global level. For the moment, the measures and consequences at this level are not possible to quantify. But it can be concluded from the studies by Sallnäs et al. (1995) and the Finnish Forest Research Institute (1995) that measures currently under discussion will have a serious socioeconomic impact.

7.4 Non-Wood Products and Functions

For the non-wood products and functions there are limited statistics, both on the existing demand and on the future demand. There is also a large variation in demand between individual countries in a region. Another complication is the importance of different functions relative to each other. This problem can be solved only when we have comparable measures available for the different functions. Therefore, at this stage, we can only conclude that forests have a multiple role or function.

To my knowledge only one large-scale attempt has been made to estimate the demand on different functions – UN-ECE/FAO (United Nations, 1993; FAO, 1995b) for Europe, the USA, the former USSR, Japan, Australia, and New Zealand. The results for Europe and the USA are presented in Figures 13 and 14.

For Europe there is a medium to high demand for hunting in more than 80% of the forest area. The figures for recreation, water, and grazing are 50%, 25%, and 20%, respectively. In the USA the demands are the following: hunting, 55%; recreation, more than, 50%; water, 95%; and grazing, 30%. The FAO asked the countries in which areas they expected increased emphasis in the future. Four areas were identified: protection, water, nature conservation, and recreation (FAO, 1995b).

Another interesting aspect of the non-wood products and functions is the temporal aspect of the demands. In 1985 the United Nations carried out a study (UN, 1993) on the demands in Europe in 1980. With this study it is possible to compare the changes between 1980 and 1990. However, it should be noted that there are many uncertainties in the comparison due to differences in data collection. The results of the comparison are presented in Table 29.

Table 29. Changes in Demand on Forest Functions on Public and Private Forests in Europe between 1980 and 1990 (percentage of forest area). Calculated from UN (1985) and UN (1993).

	Changes in Demand	
Function	High Demand	High and Medium Demand
Wood Production	-13	± 0
Recreation	+8	+23
Hunting	+5	+11
Protection	+11	+8
Nature Conservation	+2	+29

The changes in demand are taking place at a rather fast pace. The areas that have a high demand for wood production have decreased by 13% but areas with a high demand for other functions have increased by 2-11% depending on the function. In areas with high and medium demand for these latter functions, the corresponding figures are 8-29%.

We can probably expect a similar development in countries with a fast-growing economy and a rapidly growing middle class. Such a development will affect large forest areas.

Hoskins (1990) and Ogden (1990) have stressed the important role of forests for the security of food. They have identified that trees and forests contribute to the food security in many regions in the following ways:

- Providing a direct source of foods, often in significantly greater quantity and variety than is generally recognized.

- Providing essential nutrients and medicines that increase the nutritional impact of other foods.

- Filling food gaps by supplying food during seasonal shortages and acting as emergency foods.

However, to my knowledge, there is no regional quantifications on either potential supply of or demand for food from trees and forests. It can only be concluded that in certain regions the food value of the forests greatly overshadows the timber value (e.g., an estimate by Peters et al., 1989, shows that the food value is six times higher than the timber value).

Concerning forest products other than wood the statistics are rather limited. The FAO (1995d) states that, for developing countries, "There is a general absence of inventory of non-wood forest products and their planning often lacks scientific basis. The extent of variation in the nature, quality, characteristics and uses of the products compounds the problem." The FAO (1995d) has recently made a serious effort to raise the non-wood product issue on the developing countries' agenda. But in spite of this work, there is still a lack of global demand and supply estimates on the non-wood forest products. At this time it can only be concluded that the demands on forest products other than wood are considerable. Russia and Siberia can be mentioned as examples (Cherkasov, 1988; Nilsson et al., 1994; Pisarenko and Strakhov, 1995). India can be used to illustrate the value of the non-wood forest products and their importance to regional employment (Table 30).

These developments will certainly increase the conflicts in the global forestry debate and further complicate policy-making.

Table 30. Current and Potential Production and Employment of Non-wood Forest Products in India. (Production in 1000 tons and employment in 1000 man-years.) Source: Dwivedi (1993).

	Production		Employment	
	Current	Potential	Current	Potential
Fibers and flosses	355.5	574.5	1214.4	1894.0
Bamboo and canes	1946.0	433.0	49.0	111.0
Essential oils	1.7	102.6	27.2	140.8
Nonedible oil seeds	419.2	6670.8	109.0	1440.9
Tans and dyes	187.4	290.0	21.2	33.2
Gums and resin	91.2	175.5	87.0	145.7
Lac and tasar silk	232.3	334.9	83.7	127.5
Drugs and species	2.6	4.6	55.6	72.7
Edible products	n.a.	n.a.	n.a.	n.a.
Total	3259.0	12482.9	1603.1	3995.8

7.5 Local and National Environmental Functions (including Erosion)

There is a need for plantations to replenish degraded land that has been subjected to environmental deterioration – that is, those lands that are unable to satisfy the local and national demands on environmental functions. Evans (1992) stresses, "stabilizing soil, preventing erosion, controlling water run off in catchment areas, providing shelter from wind and heat and against sand and dust storms are all roles for which trees are widely planted and much needed."

At a global level the need for these kinds of plantations has been analyzed to a limited extent. Grainger (1989) has carried out a study of the tropics. Postel and Heise (1988) have also studied this region. To my knowledge other studies of the subtropical, temperate, and boreal zones have not been carried out. Wiersum and Ketner (1989) have recalculated the tree cover required by the year 2000 in tropical areas identified by Grainger (1989) to correspond to equivalent areas of closed plantations. The results are presented in Table 31.

Table 31. Need for Plantations of Tree Cover on Degraded Lands in the Tropics. (million ha of equivalent closed plantations). Source: Wiersum and Ketner (1989).

Degraded upland watersheds	44-80
Desertified arid lands	50
Wasted fallow lands	23-40
Total	117-170

The data in Table 31 are somewhat dated and probably underestimate actual needs. Taking into account the demands in other regions, the tropics are not included, it can be concluded that the demands for plantations on degraded lands at a global level are probably substantially underestimated.

During the past 45 years an area the size of China and India (1.2 billion ha) has suffered moderate to extreme soil degradation. The extent of soil degradation is presented in Table 32. The degradation is mainly caused by agricultural activities, deforestation, and grazing.

Table 32. Human-Induced Soil Degradation between 1945 and 1990. Source: Oldeman et al. (1990) and WRI (1992).

Region	Total Degraded Area (million hectares)	Degraded Area as a Percentage of Vegetated Land
World		
Total degraded area	1,964.4	17.0
Moderate, severe, and extreme	1,215.4	10.5
Light	749.0	6.5
Europe		
Total degraded area	218.9	23.1
Moderate, severe, and extreme	158.3	16.7
Light	60.6	6.4
Africa		
Total degraded area	494.2	22.1
Moderate, severe, and extreme	320.6	14.4
Light	173.6	7.8
Asia		
Total degraded area	747.0	19.8
Moderate, severe, and extreme	452.5	12.0
Light	294.5	7.8
Oceania		
Total degraded area	102.9	13.1
Moderate, severe, and extreme	6.2	0.8
Light	96.6	12.3
North America		
Total degraded area	95.5	5.3
Moderate, severe, and extreme	78.7	4.4
Light	16.8	0.9
Central America and Mexico		
Total degraded area	62.8	24.8
Moderate, severe, and extreme	60.9	24.1
Light	1.9	0.7
South America		
Total degraded area	243.4	14.0
Moderate, severe, and extreme	138.5	8.0
Light	104.8	6.0

The types of degradation are illustrated in Figure 15.

Wind speed reduction

- Wind erosion is reduced.

Soil cover and ground vegetation

- Forest litter decreases raindrop erosion (Ghosh, 1978).
- The presence of forest litter and forest undergrowth decreases surface soil erosion (Wiersum, 1983; Richardson, 1982).

Binding actions by roots

- Roots beneath a forest is the main contribution to slope strength and prevention of landslides (Rice, 1978).
- Root mat has a binding effect on the soil and prevents soil erosion (Hamilton and King, 1983; Ambar, 1986).

Watershed impacts

- Water drainage from a forest will largely be free of sediments.
- Water drainage from largely forested catchment is usually cleaner than that from open land (however, the quality can be disturbed by forest operations).

Water quantity

- Compared with open land, forest cover affects the flow of water in a positive way (Hamilton and King, 1983).
- Afforestation of a catchment may reduce total water yield but may also prolong the dry season base flow by improving infiltration rates.

Decreased desertification

- Trees help to mitigate desertification (Baumer, 1990).

Shelter improvement

- Trees provide shelter from driving rain, hot sun, and strong winds (Sangar et al., 1977; Baumer, 1990).

Rehabilitation of sites

- Sites for reclamation include contaminated soils, industrial waste landfills, sand dunes, etc.

If these restoration programs are to work there is an urgent need for huge areas of tree cover plantations and increased closed forests. But we still do not know how great the need is.

7.6 Ecotourism or Nature Tourism

In 1990 international tourism was estimated to have generated US$ 250 billion, and domestic tourism was estimated to have generated 10 times that (WCMC, 1992). Cater and Lowman (1994) predict that international tourism (measured as international tourist arrivals) will double between 1990 and 2010 from 456 to 937 million arrivals. Ecotourism will constitute only a small part of the total, but it will grow at an even faster rate than total tourism. Steele (1993) claims that ecotourism is growing at a rate of 10-15% per year. Dixon and Sherman (1990) estimate that this kind of tourism will outpace the growth rate of mass tourism in the future, an estimate which is also supported by Boo (1990).

There is no clear definition of ecotourism. According to Lindberg (1991) ecotourism features natural attractions and sites that have a certain degree of solitude and is distinctly different from large-scale and highly developed mass tourism. Cater and Lowman (1994) define ecotourism as the alternative to mass tourism. From WCMC (1992) analyses it can be concluded that most tourism is motivated by "a mixture of culture, historical, biological, geological and personal attractions." Thus, international ecotourism currently has a relatively small share of the tourism market but will grow. Lindberg (1991) estimates that of the US$ 55 billion spent on tourism in developing countries in 1988, between 4% and 22% went toward ecotourism or nature tourism.

Due to the fashionable features involved, any tourism has a lifecycle and exploitative processes that are characterized by rapid growth, saturation, and decline. A possible development path for ecotourism is given in Table 33.

Table 33**.** Possible Development Phases of Ecotourism. Source: Prosser (1994).

Type	**Explorers** (Discover a destination)	**Off-beat adventurers** (Penetrate a region)	**Elite** (Status conscious groups arrive on expensive tours)	**Early Mass** (Middle-income groups)	**Mass Packages**
Number of tourists	Very few	Small	Limited	Steady flow	Massive

Fennell and Smale (1992) conclude that the likelihood of ecotourism or alternative tourism to develop to such an extent that it takes on the characteristics of mass tourism is remote.

Many reports identify ecotourism as a threat to the environment (e.g., Levitin, 1994; Butler, 1994; Lindroth, 1995). There are three primary concerns about ecotouris: (1) the continuing growth of tourists, (2) the increasing ability to penetrate even more remote locations, and (3) the assumption of the right to do so (Prosser, 1994). Steele (1993) stresses that many of the environmental problems of ecotourism stem from open access. Segersteen (1995) illustrates examples of tourist companies in Sweden promoting ecotourism with the old view that every man has a right to enter private land; this attitude is causing problems for forest owners.

Ecotourism seldom results in substantial employment opportunties or benefits and generally requires a considerable amount of time to generate a profit (Fennell and Smale, 1992 and Kangas et al., 1995). The volume of ecotourism must be considerable before it can achieve sustainable economic development. Therefore, a key question is, At what point do ecotourists become part of the environmental problem (Zebich-Knos, 1994)?
Budowski (1976) argues that tourism and conservation can benefit from each other. Tourism can bind support to conservation programs that supply educational, scientific, and recreational resources; these resources, in turn, will attract more and

different kinds of tourists. Experience shows that sustainable ecotourism must be based upon the principles of ecosystem structures and functions. The lessons learned so far (Prosser, 1994) tell us that ecotourism will only be sustainable if tourist numbers and distribution are controlled and if local populations take the responsibility for both the conservation of their envornment and the management of ecotourism. Whelan (1991) points out that ecotourism alone will not save disappearing ecosystems. She stresses that "unless ecotourism is planned to minimize environmental damage, maximize economic outcomes and involve the local communities, then it may actually harm the environment and local peoples."

In conclusion, ecotourism, both international and domestic, is projected to grow substantially, but a quantitative estimation of its impact on future utilization of global forest resources is currently an impossible task. However, it can be concluded that growing ecotourism will increase future demands on global forest resources.

8. DO WE HAVE ENOUGH FORESTS?

All signs indicate that we do not have enough forests on the globe to fulfill all the current and future demands on global forests. There may not be a physical shortage of forests, but the different kinds of demands will be difficult to meet. A review of the literature indicates that the following points must be highlighted:

Shortage of Industrial Roundwood
Studies show that there will probably be a rather substantial shortage of industrial roundwood already by 2010.

Dramatic Shortage of Fuelwood and Charcoal
Currently, all signs indicate that there will be a crucial shortage of fuelwood and charcoal. This shortage will limit socioeconomic development in the developing world. However, there are great uncertainties in current estimates on demand for and supply of fuelwood and charcoal. There is an urgent need to start global analyses of the fuelwood situation based on a bottom-up approach.

Uncertainties in the Roundwood Supply Estimates
Only rough estimates exist on what the global exploitable forest can and will produce in the form of roundwood in the future. The estimates for major supply regions vary as much as 100% according to reliable analysts. The rate of increment in the main regions is still uncertain. There are substantial problems with the reliability of the growth data, not only in the developing world (Adlard, 1995) but also in the developed world. For example, growth and yield information in Canada is rather anecdotal, and in order to sort out the yield information, Canada has been forced to resort to the Delphi technique (Phillips et al., 1995).

Two Regions Hold the Keys to the Industrial Roundwood Balance
Plantations in the Southern Hemisphere are crucial to balancing the global supply of non-coniferous fibers. Many questions remain on the outlook for plantations in Southern Hemisphere. Russia holds the key to balancing the global supply of coniferous forests. But two questions remain unanswered: Can and will Russia

develop its enormous inventory of coniferous forests (Perez-Garcia et al., forthcoming)?

Increased Usage of Recovered Paper and Non-wood Fibers
The usage of recovered paper and non-wood fibers will continue to increase. But this increased usage will probably not improve the global shortages of fibers identified in the foreseeable future.

Continued Increases of Deforestation and Degeneration in the Tropics
All signs show a dramatic increased loss of forest resources and degeneration in the tropics. It can only be concluded that countermeasures taken against deforestation have been insufficient.

There are also many uncertainties connected with future degradation and degeneration of the forests (Brown and Lugo, 1990; Brown et al., 1993; and Poore, 1994).

Dramatic Land-Use Changes will Continue
Dramatic land-use changes will continue to seriously affect forest resources. These changes will influence deforestation rates, fiber supplies, fuelwood supplies, and supplies of non-wood products and functions.

Non-Wood Demands will Continue to Grow
"New" demands, such as lifecycle approaches, biodiversity, environmental protection, water, hunting, ecotourism, and recreation, will continue to grow. A serious problem with these demands is that few attempts have been made to analyze their impacts on other forest functions and socioeconomic developments. Studies on these aspects are urgently needed.

The Degradation of Land will Continue
There are some 1.2 billion ha of moderately to extremely degraded land on the globe. The continuation of this degeneration process is due to several different factors. Restoration of degraded lands requires that efforts focus on huge areas of tree-cover plantations and closed forests. Efforts made so far are insufficient.

Forestry's Role in the Climate Change Process is Uncertain
The prospects for improving the carbon balance through plantations, improved silviculture, and replacement of fossil fuels by wood are rather bright. Much research is going into this field, but limited actions based on future climate concerns have been implemented. A new mechanism is required if forests are to play a crucial role in balancing future climate changes.

Increased Forest Production will Improve the Global Environment
Based on the reviews in this paper, it can be concluded that the largest global environmental problem connected to forestry is probably the limitations of forest production. Similar conclusions have been made by some environmentalists (Edman, 1995). It is also probable that, for global forests to play a crucial role in the lifecycle, society will require increased forest production.

Lack of Data, Knowledge, and Consistent Overview

There is a serious lack of data, knowledge and consistent overviews of the items on the global forestry agenda. Analyses and understanding on how the different items on the agenda interact at large-scale levels are also lacking.

The World Bank (1995) states "immediate action is needed to make forest monitoring reliable and more than a once-a-decade event." The FAO (1995b) points out that there is an urgent need to conduct "studies on a global basis concerning areas under the risk of biodiversity losses."

Given that the UN has just celebrated its 50-year anniversary and that efforts are underway to set internal forestry policy, it is rather astonishing that so much data and knowledge are still missing. International organizations such as the FAO and the World Bank and aid organizations such as USAID, CIDA, SIDA, and Finnida have pumped billions of dollars into forestry activities over the decades, and yet we cannot answer some of the most basic questions concerning global forest resources and their functions.

There is obviously a need for a new approach in international forestry.

<u>Is the Current International Policy-setting in Forestry Relevant?</u>
Forestry policy, to a large extent, is now set at the international level. In many cases it is carried out through international political negotiations (Nilsson 1995c), and it often follows the Precautionary Principle (O'Riordan and Cameron, 1994). International NGOs are playing a major role; they are attempting to achieve a New Global Governance Agenda that increases the power of new international bodies and decreases national power (Sargent and Bass, 1992; Dewar, 1995). As a result of these new trends, actions taken are often based on incomplete information, and the consequences they may have on national and global forest resources, forest functions, and socioeconomic developments are seldom analyzed in advance (e.g., see Section 5.1 on Recycling, and Sallnäs et al., 1995).

Environmental issues in forestry have also become a springboard to broader social and political concerns often rarely considered in any other sector (Sargent and Bass, 1992). This may be a positive development if we take into account certain events. In 1978 the World Forestry Congress stated that "forests are for the people." The World Bank (Serageldin and Steer, 1995) concluded that one of the purposes of the Earth Summit in Rio was to give people the right to different environmental functions of the earth. Some have defined sustainable forestry to mean "all things to all people" (Tomorrow, 1995). Cousteau (1995) says the goal of civilization is to ensure to all a certain "quality of life," adjoined by a fundamental "joy of living."

But there is an inconsistency in the international environmental organizations' attempts at policy-setting. Even if they speak about broader social and political concerns in connection with environmental forestry issues, their actions are mainly based on pure environmental values. There are also inconsistencies in the policy-setting by governments concerning natural resources. There are concessions to the environmental values, but the policies are driven mainly by traditional macroeconomic criteria (mainly GDP), which only measure the produced assets and do not consider human resources and natural capital. Recently, the global society has started to question the traditional GDP criterion. "If GDP is up, why is America down?" (Cobb et al., 1995). "The issue is whether we have indicators that are relevant to people's needs" (Prowse, 1995). Similar concerns have been expressed in The Economist (1995) and by Becker (1995). Recently, the World Bank made a major breakthrough by merging the different values in society (Serageldin, 1995). The Bank has incorporated human resources and natural capital criteria in its evaluation of wealth and has arrived at tentative results (Table 34).

Table 34. Preliminary Estimates of Wealth and its Composition by Country. Source: Serageldin (1995).

		Sources of Wealth in Percentage		
	Estimated wealth (US$) per capita	Human Resources	Produced Assets	Natural Capital
1. Australia	835,000	21	7	71
2. Canada	704,000	22	9	69
3. Luxembourg	658,000	83	12	4
4. Switzerland	647,000	78	19	3
5. Japan	565,000	81	18	2
6. Sweden	496,000	56	16	29

From the 192 countries studied, the World Bank has concluded that produced assets (manufactured capital) represent only 16-20% of the wealth. Manufactured capital has, to a large extent, directed policy-setting on natural resources.

In order for different international organizations to make a solid contribution to forestry policy-setting and to the future of society there is a need for critical thinking on which roles the international organizations should play in this process and how they should contribute to the policy-setting.

Thus, the environment is only part of the problem. The other parts are jobs, the quality of life, and so on – and they are all connected at the same points: the governances of the resources (Commonor, 1991).

The Challenge

To institute solid policies for forests and for society, there is a great need for an objective assessment of how much forests do we need, what types of forests do we need, and where should they be located. These questions must be addressed in an interactive and consistent way. Poore (1994) has already requested such an assessment. The assessment should take into account human resources, produced assets, and natural capital.

Who or which organization will take on this challenge?

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