

Policy Brief No. 1

Forests in Global Warming

Patrick Humphreys and Matti Palo



The United Nations
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This publication is a policy-focused summary of the UNU/WIDER manuscript on *World Forests and Global Warming: Scenarios and Policies*, edited by Professor Matti Palo, Dr Eustáquio J. Reis and Professor Birger Solberg.

The manuscript has been prepared within the UNU/WIDER project on the Forest in the North and the South, directed by Professor Matti Palo of the Finnish Forest Research Institute (METLA) with Dr Eustáquio J. Reis of the Institute of Applied Economic Research (IPEA), Brazil.

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UNU World Institute for Development Economics Research (UNU/WIDER)
Katajanokanlaituri 6 B
00160 Helsinki, Finland

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Tropical rainforest in Malaysia
Photo by Matti Palo

RESEARCH FINDINGS

The multidisciplinary research project on the Forest in the North and the South, organized by UNU/WIDER, shows that, in spite of modest forest expansions in the North, the ongoing deforestation of the world's forests is greatly contributing to the greenhouse effect.

- Deforestation is often a consequence of market distortions that hide the real economic value of forests and result in the inefficient use of an important resource.
- Policies for slowing down deforestation are not, therefore, in conflict with promoting sustainable economic development.

The main underlying causes of deforestation are:

- rising national income per capita (up to a certain threshold level of income) and the growth of the local population;
- uncertain property rights, which reduce the incentive to intensify agriculture and sustainably manage forests;
- state or other public ownership of forests, where a low price is set on standing trees that does not respond to scarcity and ignores the value of non-wood forest products and services; and
- other government policies, for example, taxes, subsidies and fiscal policies.

The pace of deforestation is faster:

- if ecological conditions are well suited for agriculture;
- when information about changes in forest resources becomes more accurate, up to a certain level of information; and
- in areas that are more accessible.

The instruments for combating deforestation are:

- remove biased subsidies or taxes, and slow down road construction. These would have the most rapid effects;

- improve systems for monitoring forest resources. This is a medium-term instrument; and
- control population and promote economic growth and diversification. These are long-term measures.

Other policies can focus directly on the link between forest growth and the quantity of the greenhouse gas, carbon dioxide, in the atmosphere:

- on a national level, policies for managing and exploiting forests so that they store more carbon, have low costs.
- on the international level, market mechanisms are vital for the efficient allocation of the costs of combating climate change. A country that finds it expensive to reduce emissions should be able to buy extra rights from a country whose net emissions can be more cheaply controlled, possibly through expanding its forest area.

INTRODUCTION

There is an old, old joke that everyone talks about the weather but no one ever does anything about it. This is not true any more.

The past few thousand years have seen a profound change in the face of the world. There may have been greater cataclysms in the history of our planet but this one differs from earlier, natural convulsions. It has been caused by man.

The change has been so vast that it has to be seen from a distance. Great areas of forest in the north of the world have been stripped away. The process continues today at an accelerating rate in the southern hemisphere. Now, the consequences are starting to emerge.

The evidence is strong, and growing stronger, that the climate is changing and the world is becoming warmer. The implications of this are not fully known but are unlikely to be generally beneficial to mankind, whose present settlements and societies have evolved in response to the old weather patterns.

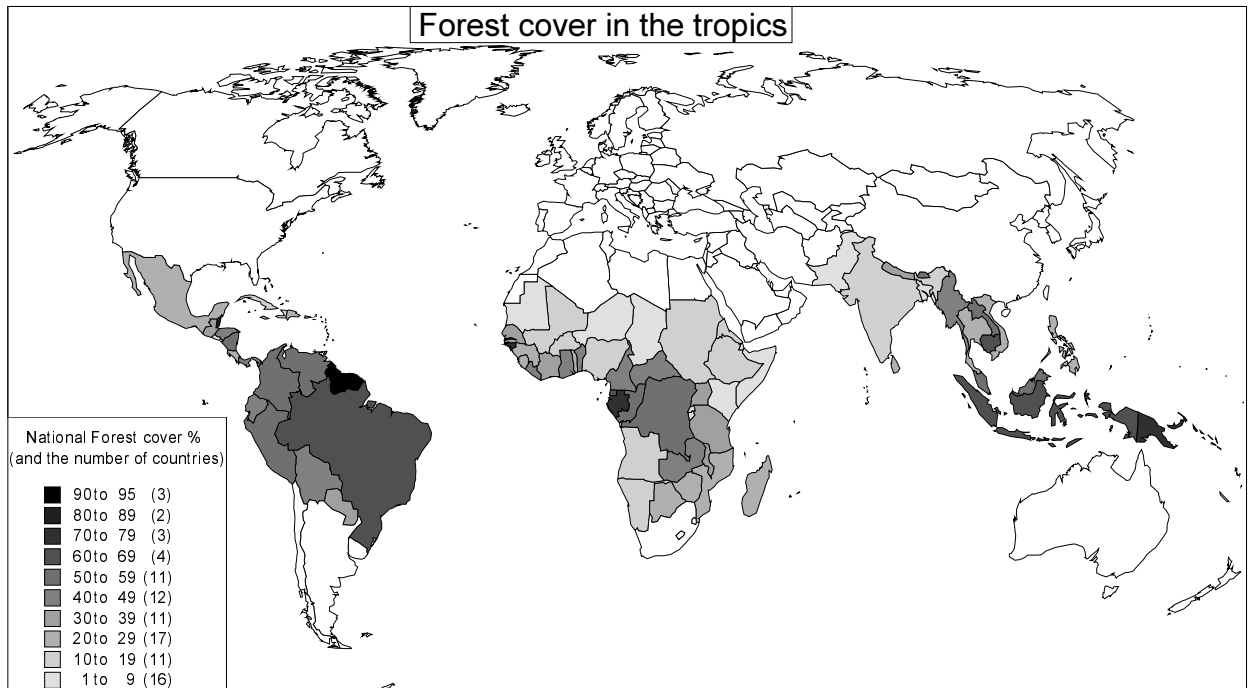
The main culprit in the greenhouse effect is carbon. Forests are a large reservoir of carbon. When trees and plants grow they remove it from the air. When this biomass decays or is burnt, carbon goes back into the air. There is no doubt about this process, but man is still far from controlling the ways he has been accelerating it.

At least we are starting to notice. In the past few years researchers have begun looking at forest-based industries and forest policies on a global level. The subject is still in its infancy. There is still a variety of differing definitions of a forest. Widely used statistics can be unreliable and are often incompatible.

This summary is an overview of the results of a three-year project by UNU/WIDER to research the causes of deforestation, what is likely to happen over the years ahead in deforestation and forest expansion, and how this will affect the climate via carbon emissions and sequestration.

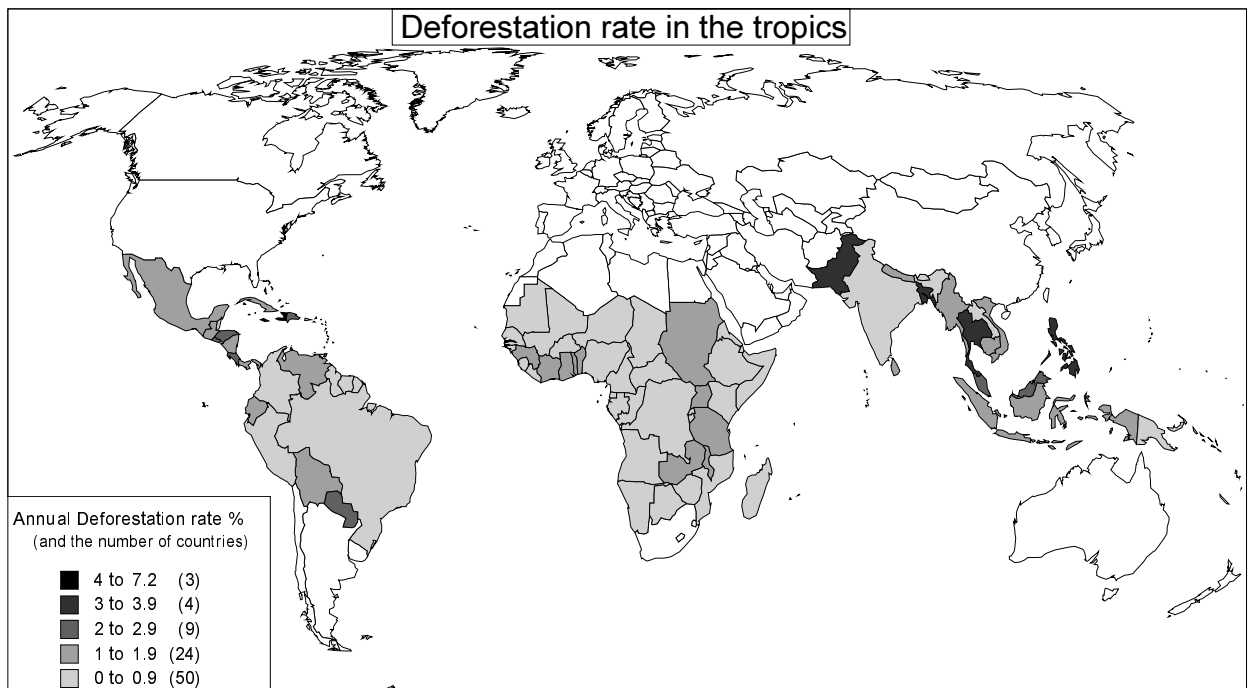
Finally the report looks at North/South interdependency and different policies to find the most cost-effective ways of removing carbon from the air.

FIGURE 1



Natural forest cover (natural forest area /total land area) % in 90 tropical countries in 1990 (data source: FAO FORIS 1995) [10 value ranges]. **Refer to book chapter 5.**

FIGURE 2



Annual national deforestation rate (deforested area /forest area) % in 90 tropical countries between 1981-90 (data source: FAO FORIS 1995) [5 value ranges]. **Refer to book chapter 5.**

1 WHY DEFORESTATION CANNOT BE STOPPED

For several thousand years man has been clearing forest for agriculture. In the northern hemisphere, industrialization also increased the pressure on forests. This is now happening in the South.

The forests of the world cover 3400 million hectares, which is 27 per cent of total land area. In the South about 14 million hectares of natural forest are being removed annually (Figures 1 and 2). The amount by which forest area is increasing in the North, nearly 2 million hectares a year, is small by comparison (FAO 1997). These are fairly rough figures but certainly show the direction we are going.

Book
chapter 1

In some parts of the world, forest clearing has been going on for hundreds or even thousands of years. Until recently, it seemed to be an efficient economic activity, putting underused resources to better use, like farming.

The public in developed countries is now starting to take a global view. It wants tropical forests to be preserved as an important environment, to prevent climatic change and preserve biological diversity. In developing countries, on the other hand, the local population sees forests as essential resources to be exploited. It is important to understand the local, national and international conditions behind this.

Book
chapter 5

To see what is happening, we first need definitions of different kinds of forest. Then, a number of forest inventories need to be conducted over a period of time. When the FAO was preparing its Forest Resources Assessment 1990, it found that in the great majority of tropical countries, only one national inventory had ever been undertaken. The quality of data is now improving and a global picture is starting to emerge.

Book
chapter 4

The causes of deforestation fall into four groups: economic, demographic, ecological and political/social factors. Economic factors include things like income, the demand for wood and agricultural products, etc. Demographic factors concern population pressure. Ecological factors are related to the fertility of the soil, its susceptibility to erosion, the topography and the climate. Just about anything else falls under the category of political or social factors.

This simple structure hides a more complex mechanism, because there is interaction between these different factors. For example, when incomes are low and agricultural productivity is poor, population growth increases the pressure on forests because the extra demand for food requires extra cultivated area or shorter fallow periods. A rising population can also create more demand for forest products, leading to the overexploitation of forests. But at higher income levels the population effect seems to disappear.

Income is another factor affecting deforestation but again in two different directions. In a poor society, extra income is likely to create extra demand for agricultural and forest products. Also extra capital can enable the poor to step up their rate of deforestation. But in wealthier societies (at least where wealth is not too unevenly spread) rising income is accompanied by a rising forest area.

It remains true that, at any level of income, extra wealth could be channelled into large investment projects and agricultural subsidies often associated with deforestation. This points to another crucial element in deforestation: the distortion of market forces caused by artificially low pricing of forest resources.

In many of the tropical countries where deforestation is now so rapid, the forest is either open-access, common or government-controlled land. As a result, the economic value of a living tree is either zero or decided according to arbitrary principles. There is no competitive pricing of the standing forest so increasing scarcity has little or no effect on how it is managed.

Book
chapter 5

Another common feature in the tropics is rotational agriculture, where forest is cleared and the land farmed until crop yields start to deteriorate, after which more forest is cleared. If rights to land ownership are weak, the farmer has no incentive to invest in more intensive land use and sustainable methods. Better to carry on clearing the apparently worthless forest.

Rotational agriculture can still be sustainable if the period of farming is short enough to prevent permanent damage and the fallow period long enough to allow the forest to return and revitalize the soil. Under population pressure, land is often farmed to the point of exhaustion, including unsuitable areas such as steep slopes. The result is permanent deforestation and erosion.

Book
chapters 4
and 5

Of course, deforestation depends not only on income, population and land ownership but also on how well the area suits agriculture. More forestland is destroyed per head of population where the conditions are

best suited to agriculture. Wet lowlands experience less deforestation per capita because they are less suitable, less accessible and more disease-ridden.

Then there is the information effect. As the amount of data about forests increases, the rate of deforestation seems to pick up, perhaps because information reduces the risks for economic agents that exploit forestland. This is obviously not true indefinitely. As reliable data becomes available for a reasonable historical period, the pressure to save forests increases.

Book chapter 5

1.1 The Amazon

Two-thirds of the Amazon consists of closed and open forests. The rain forest covers about 5.5 million square kilometres, of which 60 per cent is inside Brazil. For more than two centuries frontier settlements in Brazilian Amazon were based on spontaneous migration. Deforestation was restricted to areas along main rivers and the south of the Amazon delta.

In the 1960s deforestation rates started increasing considerably, and about 35 million hectares have been removed in the last 20 years. This was the result of regional policies, based on military concern about internal security. Credit and subsidies to agriculture combined with expansion of the road network pushed the agricultural frontier towards the northwest while regional incentives encouraged settlements inside the Amazon.

Most of the new 'farming' units were unproductive because they ignored soil fertility, so the migrants soon returned to urban areas or moved on to clear new areas. Cattle ranching became the main agent of deforestation. Other activities like timber extraction, charcoal production, mining and hydroelectric dams had minor roles.

In the mid-1970s government policies shifted back to the idea of 'growth poles' where development was focused on large-scale private projects of agricultural, livestock and mineral development.

Studies of the 1970-85 period show that regional policies created an extra 20 per cent of deforestation, most of this due to better accessibility via road building. Growth poles had no significant effects.

Logging has so far been a minor factor in the deforestation of the Brazilian Amazon. Compared with Southeast Asia this is mainly explained by the lower density of valuable trees in the Amazon and higher transportation costs there.

Logging has mainly been a by-product of the process of turning land over to agriculture.

Book
chapter 6

Brazilian Amazon is still in the first stages of frontier expansion, characterized by plenty of cheap timber, high transport costs and uncertain property rights. More recently, though, the consolidation of the frontier has led to a rapid expansion of logging.

1.2 Indonesia

Indonesia covers about 192 million hectares, of which nearly 60 per cent is under forest cover. The underlying source of Indonesian deforestation is the large population pressure and a low income level.



Tropical rainforest cleared for shifting cultivation in Indonesia

Photo by Ari Siiriäinen

The average income of Indonesians has increased considerably in the past twenty years, and there have been gains in agricultural productivity. However, the Indonesian Forestry Sector Model indicates that the increase in forest cover which these gains would otherwise have caused, has been eliminated by the rise in population density. Such is the effect of increasing population that it is

predicted that Indonesia's outer islands will lose forest cover until it falls to about 25-30 per cent.

The forests provide employment and generate exports, contributing 16 per cent of all foreign exchange earnings in the past decade. Timber production is still mostly from natural forests but this is declining. The government is now promoting value-added wood-based industries, such as pulp and paper production, and corporations are now establishing plantations to provide roundwood and pulpwood in particular.

Within a national context, deforestation is seen as destructive only when highly valued flow of timber and forest services are replaced with a land use that yields less. This is not the case if virgin or logged forest is converted to sustainable shifting cultivation, plantations or agroforestry. Urban land, too, can have higher national value than forestland.

However, wasteful deforestation is widespread, the result of poor incentives for land management and the failure to take into account intangible forest services. About 10 million hectares, equivalent to 10 per cent of natural forests, is covered by deforested land and deforestation is continuing by one million hectares annually.

Indonesia's efforts to turn its forest resources into quick exports and employment have resulted in non-sustainable logging and other land use. Logging concessions usually cover periods of 20 years. This is significantly shorter than the 40-100 years that natural timber stands need to regenerate naturally. This is one of the factors hindering its transition to sustainable forest management.

Book chapter 7

1.3 China

Records on the evolution of China's forests stretch far back into the past. Although definitions and concepts have changed over time, there is still a clear historical picture of the changing landscape.

In ancient China about half of the land was covered by forest. Deforestation began around 6000 years ago. Rivers that have been yellow with the silt of soil erosion for thousands of years were once clear, according to early literature. Climatic change can have caused some deforestation but its main effect was probably to make vegetation recovery more difficult.

Logging and subsistence agriculture have led to land degradation, soil erosion and desertification. About 200 years ago only a quarter of the land had forest cover and, at the time of the first national inventory in 1976, about an eighth. Deforestation in the Communist era was the deliberate result of turning significant amounts of forest to agricultural use. The amount of cultivated land did not rise significantly, evidently because much was lost through soil erosion and natural damage.

After the second national forest inventory had shown a dramatic decline in forest area, policies were revised and forest management and plantation schemes introduced. By 1992 total forest area and growing stock were both increasing (although deforestation of natural forests is continuing on a minor scale).

The recovery of China's forests was due to the scarcity response, the fact that deforestation reaches a practical limit before the physical one. In part, this is the information effect – better data on forests leading to conservation. Market forces were also at work here; although land is still owned by the state, user rights have been vested in families, villages and corporations.

Book
chapter 8

Since the 1980s, forestation investment has been project-oriented and has led to large-scale plantation of forest to protect agriculture, combat soil erosion and yield timber. With 34 million hectares, China tops the league of countries with plantation forests. It is estimated that, by 2005, 15 per cent of land could be covered by forest, compared with an estimated 8 per cent in 1948.

But the continuing expansion of China's population could jeopardize this. Although the birth rate has been lowered, annual absolute population increase is still high. If rapid economic growth can be maintained, some problems can be avoided but there will inevitably be continuing pressure on the environment.

1.4 Africa versus New England

Man's alteration of the African environment began with neolithic farming, which started 5000-6000 years ago in northern Africa and the Sahel belt and somewhat later in sub-Saharan Africa. This was well before any contacts with European or other outside societies.

Forests were replaced by grassland and bush long ago in Ethiopia, Uganda, Kenya, Nigeria and Zambia, areas where human habitation was at its most intensive. The forests first began retreating about 2000 years ago, and a second

stage of deforestation took place about 1000 years ago, a time of growing iron production which required great amounts of wood charcoal and created better tools for felling trees.

The predominant force driving deforestation at the present time is assumed to be population, especially as traditional methods of agriculture and land use are unchanged in most parts of Africa south of the Sahara. Africa has the world's highest population growth rate, and is the only region where it is not falling.

Book
chapter 9

Rising population does not always result in deforestation. In the New England region of the USA, the reverse occurred. When the Pilgrims landed there in the early 17th century about 90 per cent of the land was under forest, but by the mid-19th century it was down to about 60 per cent. Over the next 50 years forest cover stabilized, then began increasing, and by 1930 was above 70 per cent. Yet the population was rising steadily throughout this time.

This seems to have been the result of higher incomes and industrial development. The manufacturing sector expanded at the expense of agriculture, and better transport infrastructure allowed trade with other areas, both affecting local land use. However, the increasing forest area depended on the ability of New England to import food from elsewhere and so could not be repeated in all regions without improvements in agriculture.

Book
chapter 10

The history of New England does not conflict with the African experience, of deforestation at a time when the population is rising, incomes are low, farming methods are unchanged, property rights are unclear and there is open access to forests. Without resolution of these critical factors Africa is unlikely to follow New England's pattern of forest development.

1.5 Tanzania

A case study of a village in the Nguru mountain rainforest of Tanzania reached the same broad conclusions as many macro-studies spanning regions or national economies. Peasant farmers are highly averse to risk and have settled into farming practices that are far less productive than the optimal. Fallow periods, for example, are too short.

An increased supply of capital would lead to more efficient agriculture, for example through the use of more fertilizer, so long as the supply of land is restricted. If land were not restricted, though, it would lead to more deforestation.

In the same way, higher crop prices also increase deforestation. In the Nguru forest, if access to agricultural inputs such as fertilizers were improved, the farmers would not be likely to clear more forest because of the relative costs of land clearing.

Population growth was found to be a very important factor behind deforestation. At the present growth rate of 3.7 per cent per year, existing farming systems will be able to sustain the population for no more than 10-15 years. Driven by declining crop productivity and growing food demand, the forest area will be reduced.

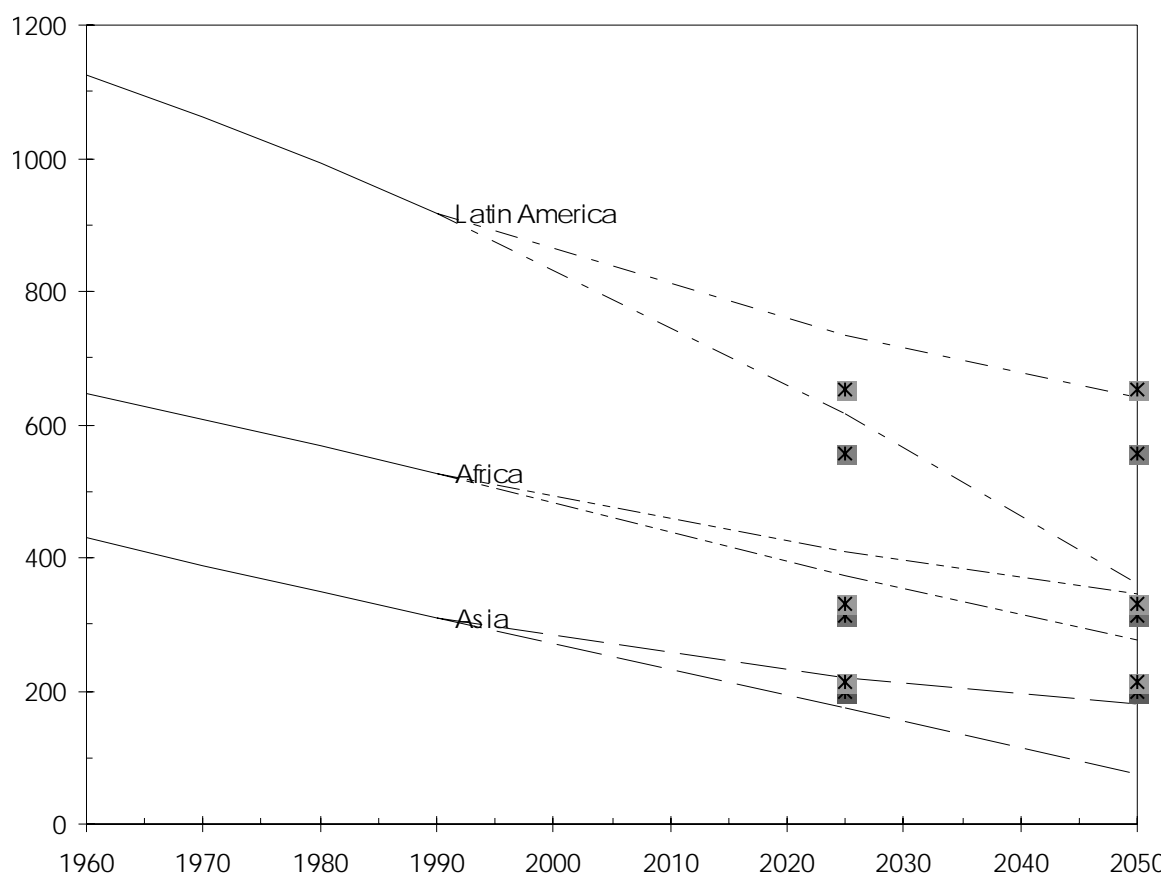
Book chapter 18

 If population cannot be controlled, the pressure on forests could be reduced by reallocating resources and risk management in the short term and introducing more appropriate farming technology in the long term.

2 WHAT WILL HAPPEN TO THE FORESTS?

From 1980 to 1995 natural forests in the South decreased by about 223 million hectares while plantation forests increased by 41 million hectares. Most plantation forests are in temperate latitudes, primarily China, but about a quarter are in the tropics.

FIGURE 3
FOREST AREA (MILLION HECTARES)



Forest area scenarios for tropical Latin America, Africa and Asia (a dotted line indicates low and high trend scenario, an asterisk low and high model-based scenario). **Refer to book chapter 11.**

Data source: FAO FORIS 1995.

Plantations do not contain the same amount of biological diversity and carbon as natural forests, but they do work well in producing fuel and wood for pulping. China and India have by far the largest plantation forests, mainly established to stop soil erosion and the spread of deserts, and to produce fuel. Brazil, Indonesia and Chile have the largest industrial plantations (FAO 1997).

The North dominates the international trade of forest products. Canada, Finland and Sweden are the biggest net exporters. Only a few countries in the South have managed to develop competitive large-scale forest industries. In Malaysia and Indonesia sawmilling and plywood industries have so far been based primarily on natural forests. Brazil and Chile have created pulp, paper and sawmilling industries using plantation forests with exotic tree species.

Book
chapter 1

What happens to forests depends partly on what will happen to global population. There are different scenarios for this. Some expect it to stabilize between 2050 and 2100 at just above 10 billion, others predict it will still be rising strongly. Even if it stays at 10 billion the population of developing countries will have risen from 81 to 89 per cent of the total population.



Tropical deforestation followed by erosion in India

Photo through the courtesy of FAO (H. Null)

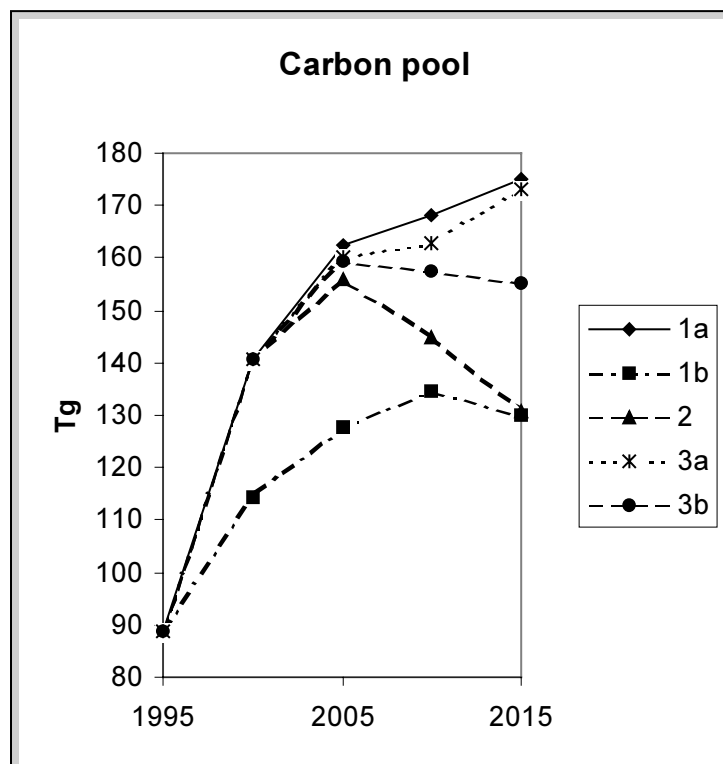
As noted earlier, the effect of population on forest area depends on other variables. At low income levels it induces more deforestation but at higher income levels this effect can be overcome. In the North forest cover is stable and, in Europe in particular, the forests have been expanding for much of this century.

In the South, sustainable economic development has a key role for the future of forests.

There is a large and inevitable gap between attitudes in the developed and developing world. Europe's traditional response to scarcity has been to buy wood from further afield. Now that there are relatively few new accessible areas of exploitable forest, forest management and forest plantations make better business sense.

Active management began in Europe from the 18th century onwards and in the United States at the start of the 20th century. It was encouraged not only by scarcity but also by the realization that the forest performs other non-wood functions, such as preventing flooding, erosion and avalanches.

FIGURE 4



Five alternative scenarios of carbon pool development (in Tg) of the plantation forests in Chile from 1995 to 2015. **Refer to book chapter 15.**

Over the years, the public's attitude to forest has changed considerably in the developed countries. Forest is increasingly seen as an environment rather than just a source of wood. This change originally concerned natural forests in

countries such as Australia and New Zealand but in Europe a similar change in attitude is now taking place towards plantation forest.

Public attitudes in developed countries, however enlightened, will be relevant to the issue of world forests and global warming only if they come to be shared by developing countries. Changes will be more painful there.

The globalization of forest resources presents both opportunities and threats. Most wood and forest products are still consumed in the country where they are produced but a growing proportion of products is traded. US, Scandinavian, Japanese and New Zealand companies have been the most active in overseas operations and investment.

Book
chapter 2

The developed world is still completely dominant in production and trade, even though the South has 57 per cent of the global forest area. Many southern areas enjoy comparative advantages in terms of rapid tree growth, but they may also import the environmental drawbacks.

3 HOW FORESTS WILL AFFECT THE WORLD'S CLIMATE

The probability is high that deforestation, if it continues, will accelerate the changes in the climate of the world that are known as the greenhouse effect. The greenhouse effect is due largely to the release of carbon into the air.

Most of the world's carbon, about 80 per cent, is stored in the oceans. Of the carbon on the ground about a third is in the form of vegetation and an estimated two-thirds is below the ground, in soil, etc.

Most carbon emissions come from burning fuels but a large amount is from the forests. Global forests contain some 200 billion tons of carbon above ground. More than twice that amount of carbon exists underground in the form of humus, peat and soil.

Book chapter 1

3.1 The South

Between 50 and 60 per cent of the carbon stored in forests is in tropical latitudes. These are the main areas where deforestation is taking place.

One reason is that the population is growing fast. The United Nations medium fertility projection estimates the world population at 8.2 billion people in 2025 and 9.8 billion in 2050. The population of Africa in 2050 will be about three times the present level and the populations of Asia and Latin America nearly two times their present levels. This will put considerable pressure on tropical forests.

Another influence on the forests will come from changes in income. If the national trends between 1981 and 1990 continue, GNP per capita will fall 1.1 per cent in Africa between 1990 and 2050. There will be a slower fall in Latin America, 0.2 per cent, and an increase of 3.1 per cent in Asia. In the tropics as a whole, GNP per capita will increase 0.9 per cent.

Applying these assumptions it has been estimated that the total forest area of the tropics could fall by roughly 560-680 million hectares between 1990 and 2025. This is a reduction of at least a third. Beyond 2025 deforestation will slow down and forest areas will stabilize, thanks to lower population growth, improved information on forest resources and increasing incomes (Figure 3).

The amount of carbon released into the air by the change in land use depends on how much is stored in vegetation and the soil, how deforestation takes place, and

how much the soil is disturbed. If tropical forest is converted to shifting cultivation, about 60 per cent of the carbon contained in its plant life will be lost. In time, though, some of this land will come to be used for permanent agriculture and almost 100 per cent of the carbon in its plant life will be released. Soil carbon loss will vary between 20 and 50 per cent.

Book
chapter 11

The result will be the emission of 80-100 billion tons of carbon into the atmosphere between 1990 and 2025, or 2.2-2.6 billion tons per year. The target of holding down global emissions of carbon will be extremely difficult to achieve.

But it also follows that measures to reduce the rate of deforestation in the tropics would have a significant effect on carbon emissions. Tropical America has the greatest potential for storing carbon followed by tropical Africa and tropical Asia.

3.2 The North

Deforestation in western Europe and the United States has already gone into reverse, thereby removing carbon from the air and storing it in wood, other vegetation and the soil. Although the developing world cannot easily follow the same path, it is worth looking at what happened.

Almost all of the old-growth forests of central Europe had been cleared by the Middle Ages so today's European forests are semi-natural or plantation forests. Most US forests were logged over in the 19th century but the area ceased to decline after 1940. In the second half of this century, European and North American forests have been growing faster than before, while the amount of felling has been small.

The demand for wood has changed because other materials have replaced it, and because forest industries have become more efficient. Recycling has also played a part.

Net growth of European and North American forests has been faster because of improvements in silviculture, the managed growth of forest trees. Its aims have been to regenerate felled areas and to maintain a large growing stock at all phases in the age of the forest.

Additionally, in Europe, the dominant effect of air pollution has been to increase the growth rate of individual trees. This has been mainly because of increased nitrogen precipitation and the higher concentration of carbon in the air.

At the same time, the trend in agriculture has been towards smaller, more productive areas, especially in grazing. The land released from agriculture has become available for afforestation.

A study of 17 west European countries in 1993 estimated that the carbon stored in their vegetation was rising by 40-60 million tons a year. The fastest growth was in Ireland, the slowest in Greece. The forest area in the United States is twice as high so even though the rate of carbon accumulation seems to be somewhat slower than in Europe, the carbon pool is estimated to be increasing by 65 million tons a year.

Carbon has not only been building up above the ground in biomass but also in forest soils, where it is stored in the form of peat and humus. Dead leaves, needles, bark and other biomass that falls to the ground decays more slowly in the north than in southern latitudes. It has also been suggested that tree harvesting promotes the accumulation of carbon in the soil because only the trunk is removed.

The increase in carbon in northern forest soils is based on indirect evidence. This indicates that about 70 per cent of the carbon in northern coniferous zone, forests lies in the soil and only 30 per cent in above-ground biomass.

At the same time, it is worth emphasizing that the increased amount of carbon laid down in the North has been far from enough to counter deforestation in the South. In addition, replacing fuelwood with fossil fuels, as has happened in developed countries, will not improve the carbon balance unless power generation can be made more efficient.

Large amounts of carbon will continue to be absorbed by western European and US forests for at least 5-10 more years but the growing stock cannot expand indefinitely. Within 50-100 years, they will have stopped reducing the amount of carbon in the air. If this estimate is correct, they will then have compensated for 10-15 per cent of the carbon emissions of the area.

Book
chapter 12

To achieve any more reductions in carbon emission levels, additional plantation forests will be needed in the southern hemisphere. Large plantation forests already exist but they have not been managed to take account of how much carbon they can hold.

A study based on data from Norway shows a difference in optimal forest management strategies, regarding fertilization, thinning and the timing of final felling, depending on whether the principal objective is cash flow or controlling carbon emissions.

3.3 Amazon

Brazil has the largest growing stock of trees in the world, most located in Amazonia. The faster pace of deforestation in the Brazilian Amazon has been a major source of carbon emissions to the atmosphere. In 1978, an estimated 1 per cent of world carbon emissions was attributed to Amazon deforestation. By 1988 the proportion had risen to about 3 per cent.

Given that agriculture represents only a small part of Amazon GDP, which in turn is less than a tenth of Brazilian GDP, slowing down Amazon deforestation could be one of the cheapest ways of reducing the greenhouse effect.

Estimating the future rate of deforestation is difficult. It has not been climbing continuously and was lower in 1994 than in 1988, though still large. A model to predict deforestation and the effects on carbon emissions has to take into account the effects of infrastructure, population and land-use and then relate the changes in land use to movements in the stock of carbon in Amazon vegetation and the soil.

The model adopted assumes that the principal source of deforestation is the conversion of forest to agricultural use and that logging is merely a by-product of this. The patterns of deforestation are assumed to be set by where the road network expands and where the population grows.

The impact of deforestation on carbon emissions depends on the type of forest cleared and its carbon content and the type and intensity of agriculture that takes place on the cleared land. Slash-and-burn clearing, for example, emits only about a third of the carbon content of vegetation immediately because combustion is inefficient.

The model used yielded surprising results when applied to the Carajás Investment Programme, the exploitation of a very rich mineral area in the southeast of the Amazon. This has widely been expected to have overwhelming environmental and economic consequences, but the model indicates that its deforestation effect is not very serious and that the impact on carbon emissions is relatively small.

One of the reasons is that development in Carajás will attract people out of the rural sector and decrease the demand for land, especially in the more densely forested areas. Meanwhile, the increase in income will be considerable.

The simulation shows the importance of an approach that takes all major related factors into account when assessing the impact of development on forests and carbon emissions.

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3.4 Indonesia

Tropical forests have the greatest growth potential and Indonesia is the world's most important country for the tropical timber trade. It could therefore play an important role in controlling carbon emissions.

Any large-scale programme for forest conservation or plantation needs to examine the costs of different strategies and their benefits, including the main environmental considerations.

Apart from the effect of absorbing carbon from the air, these benefits relate to the stability of the tree layer, the structure and species mix of the mature forest, its other flora and fauna, and properties related to the soil such as protection from erosion and surface water flow. Also to be considered are the effects on local climate and the actual and probable use of chemicals required.

In an Indonesian context, the choice of strategy will also depend on whether the area in question is currently grassland, has already been selectively felled, or is non-logged rain forest.

Combining measures of cost efficiency, environmental soundness and the potential for absorbing carbon, a mixed plantation on grassland of *paraserianthes falcataria* and *acasia mangium* in short rotations (ten years) ranked very high. Also a long-term rotation of *shorea spp* absorbed a high amount of carbon and produced a good economic result. Both alternatives are no-regret options, meaning that they are profitable without considering the effect on carbon.

Ten-year plantations of just one tree species, *paraserianthes falcataria*, produced better effects on carbon and a higher economic yield but had a lower environmental score than the mixed alternative.

The study makes a number of simplifications that may not hold true if the strategies are implemented on a large scale. For example, it assumes low labour

costs and high sawnwood prices. But it is cautious in its estimates of the amount of carbon that will be absorbed, and does not take into account that some of the wood produced may be used to replace fossil fuels.

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Thus, although containing inevitable inaccuracy, the study indicates the promising potential of Indonesia for controlling carbon levels if international institutional arrangements can create the right incentives.

3.5 Chile

The forest sector of Chile has expanded rapidly in the past 25 years and now accounts for 3 per cent of GDP and 10 per cent of exports. It is based on fast-growing monocultural plantations, either of radiata pine or eucalyptus. At the same time, however, natural forests have been widely neglected and their deforestation has continued.

The attraction of plantations is primarily economic. Investments have been very profitable and the risks acceptable. In plantations, *pinus radiata* and *eucalyptus sp.* normally grow faster than natural forest stands and artificial ecosystems are cheap and easy to manage. The products they are used to make command good prices and revenue is realized more quickly than from a natural forest.

Plantations have been stimulated with subsidies and tax exemptions. They already cover 2 million hectares and are certain to be expanded greatly in the years ahead. The amount of carbon held in these plantations is estimated at about 92 million tons, with about 13.3 million being laid down per year.

Harvesting and thinning can be regarded as only a temporary reduction of the carbon stored, as this will be recovered as the forests resume growth or are regenerated. Chilean law requires that logged areas must be successfully reforested. The impact on the total amount of stored carbon could be increased by expanding the range of products made from radiata pine and eucalyptus, particularly durable products.

The impact on atmospheric carbon will increase as plantation areas expand and as existing plantations become more mature. Even under aggressive forest management – felling all plantations older than 21 years and half of those aged 16-20 – the carbon pool in 2015 will be about 50 per cent higher than today. Under optimal or conservative management scenarios it will be approximately twice as high (Figure 4).

It is unrealistic to expect forests to be managed solely for the purpose of controlling carbon levels, but this aspect can be readily integrated into a set of criteria for sustainable forest management.

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chapter 15



Thirteen-year old pine plantation forest (*pinus radiata*) in Chile
Photo by Gerardo Mery

4 WHAT COULD BE DONE ABOUT CLIMATE CHANGE?

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chapter 16

The fast rate of forest loss in the tropics is significantly raising the amount of greenhouse gas. Conversely, the rapid rate of forest growth possible in the tropics could curb carbon emissions.

There are various estimates for the amount of forest that would need to be planted in order to stabilize the amount of carbon in the air. In any case, the area is vast and so is the cost, even if the opportunity cost of the land is ignored.



Country-side in Kangasala, Finland

Photo by E. Oksanen, METLA

The area required would be less if some of the wood produced could be used to reduce the world's consumption of fossil fuels and if the decrease of natural forests in the tropics can be halted. But much of the forest plantation taking place today is focused on efficient wood production and a viable return on capital invested. Environmental effects are external factors.

A cost-benefit analysis of plantations in the Philippines found that, when a tentative evaluation of some of their environmental impact is included, their economic profitability improved by 20-90 per cent. The implication is that there is solid economic justification for adapting the market mechanism to reflect the full array of effects. One method would be via lower interest rates.

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chapter 19

Other mechanisms should focus on creating a local economic benefit from tropical forestry. Penalty-based systems are not seen as an effective control over farming families operating below the poverty line. Similarly, poor farmers often cannot afford the initial inputs required for more efficient and sustainable cultivation methods. To the extent that global warming is considered a costly problem, and tropical forests a solution, income transfers would be more effective.

Transfer schemes could allow industrialized nations to meet emission targets without compromising the competitiveness of their industry. However, income transfers would be effective only if they trickled down to change the farming systems currently causing deforestation.

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chapter 16

4.1 The national level

Most of the causes of deforestation lie in the hands of national governments. The divergence in views between developing and developed nations first emerged in the lengthy negotiations preceding the forestry principles of the Rio UNCED Conference in 1992.

The non-binding statement agreed at Rio set a list of objectives for 'sustainable' forest management in terms of a number of ecological, social, economical, cultural and spiritual needs. The list of needs was comprehensive. The simultaneous unrestricted pursuit of all of them is obviously not compatible with sustainable forestry.

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chapter 2

The results of the UNU/WIDER research project, on which this summary is based, point to two important factors influencing deforestation that could easily be converted into national policies.

Since tropical forests come under pressure because of rising population and rising income at certain low levels, the pressure could be reduced by controlling

population, diversifying economies, raising food yields from existing agricultural areas and creating new sources of fuelwood.

If rights of farm ownership or occupancy were stronger, farmers would have more incentive to invest in equipment and methods that would improve the productivity of their land. Clear title to property would provide collateral for loans. An adequate supply of loans on fair terms is another prerequisite.

Stronger property rights would also help to improve the management of natural forests. Deregulating the prices of standing trees would bring normal rules of profitability to the management of natural forests. Now that most tropical forests are publicly owned and open-access, prices tend to be fixed at a low level, so deforestation is financially more beneficial. If forests are to be properly conserved, their value must be reflected in the price of trees via a competitive market system.

Ecological factors are the next most important causes of deforestation, of which the key one seems to be accessibility of the forest. The most immediate and effective policies would therefore be to slow down or stop road construction and other forms of infrastructure. There will certainly be strong business and political opposition to this.

More forest resource monitoring is desirable. To some extent this is contradicted by the finding that more reliable data about forests promotes deforestation, but it is probably only a short-term effect. If national governments have forest information of better quality and quantity, they are better placed to manage their resources.

Natural and semi-natural forests can be managed to conserve the amount of carbon they store, while forest plantation management policies could be adapted to increase the amount of carbon stored in vegetation and soil. A more efficient long-term strategy would involve extending the use of forests for wood products and fuel.

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chapter 5

It is unrealistic to expect forests to be managed solely for their effect on carbon emissions: management will continue to be guided by traditional economic benefits. However, a number of management strategies are no-regret options, increasing the amount of carbon stored without net costs.

4.2 The international level

The carbon balance can be influenced by emission control and forestry management and plantation. Effective long-term action will require coordination on the international level because the benefits of preventing climate change are mainly global while the costs are national and local.

There is widespread agreement that the level of greenhouse gases in the atmosphere should be stabilized. Reducing carbon emissions, removing carbon from the air, or both could do this. The problem is to find ways of combining what is fair and what will work. Meanwhile emissions are increasing.

Simply freezing emissions at their present levels would be unfair in freezing the distribution between rich and poor countries, and inefficient by ignoring the fact that the cost of cutting emissions varies considerably among countries. At the other end of the scale, proposals that would penalize only the developed countries would probably affect the whole world economy in a negative way.

The alternative to these extremes is to establish instruments to limit carbon emissions via market mechanisms. A country that finds it expensive to cut emissions would be able to buy extra rights from a country where emissions can be more easily and cheaply controlled, perhaps by growing forests. The result should be efficient and fair at the same time. Several different instruments have been proposed.

One is a tax on carbon emissions, collected from the developed countries that are the large net emitters today and paid to the developing countries. In effect, the environmental services that the South is now providing free to the North would become a paid export. National governments could still delegate some responsibility for meeting commitments, for example, by requiring power companies to offset their carbon emissions by investing in forestation.

The fundamental drawback to a tax-based system is that policy makers would have to guess the level of tax necessary to achieve a certain emission level. They would probably set it at a low level, in order to reduce outcry and to avoid depressing their national economies.

The alternative of tradable permits has the advantage of setting directly the maximum amount of emissions for the system as a whole. Payable permits give a permanent incentive for users to invest in technology that will lower emissions and, thereby, reduce the need to pay for additional permits. At the international

level a permit market would let one country pay another for carbon stockpiling. It would obviously create net transfers to developing countries.

There are still fundamental problems concerning who will administer any system and enforce correct payments, how taxes should be determined or permits distributed, and how the very poorest countries should be dealt with. The likeliest solution will be a system combining elements of the different proposals, moving towards greater dependence of tradable permits once it is clear where the costs and benefits of reducing carbon emissions lie.

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chapter 3

If the already-industrial countries want the tropical world to stockpile carbon, they will have to provide incentives to the countries of the South not to convert their forests to other uses. Any form of compensation needs to be based on proper valuation of the economic potential of the forest area to be preserved.

5 OUTLINE OF THE BOOK MANUSCRIPT

World Forests and Global Warming: Scenarios and Policies

Edited by Matti Palo, Eustáquio J. Reis and Birger Solberg

A research project of the World Institute for Development Economics Research of the United Nations University (UNU/WIDER)

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6 LIST OF CONTRIBUTORS

A total of 23 contributors has participated in the UNU/WIDER project on the Forest in the South and North, comprising 11 different nationalities, 15 doctors, 6 professors and 9 different disciplines:

FERNANDO A. BLANCO, IPEA/DIPES, Rio de Janeiro, Brazil

RAIJA-RIITTA ENROTH, Finnish Forest Research Institute, Helsinki

HANS FREDERIK HOEN, Agricultural University NLH, Ås, Norway

PAULA HORNE, Finnish Forest Research Institute, Helsinki

MARKKU KANNINEN, Tropical Agriculture Research and Higher Education Center, Turrialba, Costa Rica

PEKKA KAUPPI, Finnish Forest Research Institute and University of Helsinki

ERKKI LEHTO, University of Helsinki

ALEXANDER MATHER, University of Aberdeen, Scotland, UK

GERARDO MERY, Finnish Forest Research Institute, Helsinki

GERALD C. MONELA, Sokoine University of Agriculture, Morogoro, Tanzania

BENI D. NASENDI, Ministry of Forestry, Indonesia

ANSSI NISKANEN, University of Joensuu, Finland

MATTI PALO, Finnish Forest Research Institute, Helsinki

ALEXANDER S. P. PFAFF, Columbia University, New York, USA

BOEN PURNAMA, Forest and Nature Conservation Research and Development Center, Bogor, Indonesia

EUSTÁQUIO J. REIS, IPEA/DIPES, Rio de Janeiro, Brazil

OLLI SAASTAMOINEN, University of Joensuu, Finland

ROBERTO SCOTTI, Università degli Studi di Firenze, Italy

ARI SIIRIÄINEN, University of Helsinki, Finland

BIRGER SOLBERG, Norwegian Forest Research Institute NISK, Ås, Norway

JUSSI UUSIVUORI, World Forests, Society and Environment Project, Helsinki, Finland

YAOQI ZHANG, University of Helsinki, Finland

CARLOS EDUARDO FRICKMAN YOUNG, IPEA/DIPES, Rio de Janeiro, Brazil