UNEP, Rick Collins, Topham Picturepoint

Forests

Global overview

The unique nature of forest ecosystems has long been acknowledged. Forest ecosystems play multiple roles at global as well as local levels: as providers of environmental services to nature in general — and humans in particular — and as sources of economically valued products (see box). The 1972 Stockholm Conference recognized forests as the largest, most complex and self-perpetuating of all ecosystems, and emphasized the need for sound land and forest use policies, ongoing monitoring of the state of the world's forests and the introduction of forest management planning. It was recommended that countries should:

- strengthen basic and applied research for improved forest planning and management, with emphasis on environmental functions of forests; and
- modernize forest management concepts by including multiple functions and reflecting the cost and benefits of the amenities that forests provide.

The Conference also called for:

- cooperation of United Nations bodies to meet the needs for new knowledge to incorporate environmental values in national land use and forest management; and
- continuing surveillance of the world's forest cover through the establishment (in countries) of an appropriate monitoring system.

Today, the Stockholm Conference recommendations relating to forests remain valid and unfulfilled, in many ways, because of conflicting interests in managing

Forest goods and services

- Industrial wood, woodfuel, non-wood forest products such as fibre, food, medicines
- Soil generation, soil and water conservation, purification of air and water, nutrient recycling, maintenance of biological diversity (habitats, species and genetic resources), mitigation of climate change, carbon sequestration
- Employment and income, recreation, protection of natural and cultural heritage

Sources: UNDP, UNEP, World Bank and WRI 2000, FAO 2001a

forests for environmental conservation and economic development.

Deforestation over the past 30 years has been the continuation of a process with a long history. By the time of the Stockholm Conference, much of the Earth's forest cover had already been cleared. The historic loss of forests is closely related to demographic expansion and the conversion of forest land to other uses. Major direct causes of forest degradation brought on by humans include overharvesting of industrial wood, fuelwood and other forest products, and overgrazing. Underlying causes include poverty, population growth, markets and trade in forest products, and macroeconomic policies. Forests are also susceptible to natural factors such as insect pests, diseases, fire and extreme climatic events.

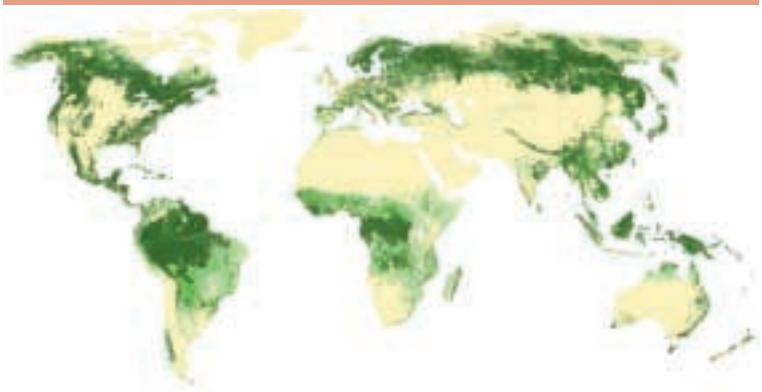
A number of assessments of changes in forest cover have been carried out over the past 30 years (including FAO and UNEP 1982, FAO 1995, FAO 1997, FAO 2001b, UNEP 2001 and WRI 1997). While differing in their definitions of forest cover, methodology and specific results, making detailed comparisons unreliable, these assessments have reinforced each other in their overall depiction of declining forest areas and continued degradation of forest ecosystems.

The *1980 Tropical Forest Resources Assessment* by FAO and UNEP was the first comprehensive assessment of tropical forests. The rate of tropical deforestation was calculated at 11.3 million ha a year (FAO and UNEP 1982), vindicating the fears of the Stockholm Conference about the alarming rate of global forest loss. Since then, while forest area in developed countries has stabilized and is slightly increasing overall, deforestation has continued in developing countries (FAO-ECE 2000, FAO 2001b, FAO 2001a).

FAO's *Global Forest Resources Assessment 2000* (FAO 2001b), using for the first time a common definition of forests as areas of at least 0.5 ha with tree crown cover of more that 10 per cent, concluded that:

- The total area covered by forest is approximately 3 866 million ha, almost one-third of the world's land area, of which 95 per cent is natural forest and 5 per cent is planted forest; 17 per cent is in Africa, 19 per cent in Asia and the Pacific, 27 per cent in Europe, 12 per cent in North America and 25 per cent in Latin America and the Caribbean

Forest cover 2000



Forest covered some 3 866 million ha of the planet in the year 2000 — somewhat less than one-third of total land area

Note: dark green represents closed forest, more than 40 per cent covered with trees more than 5 metres high; mid-green represents open (10–40 per cent coverage) and fragmented forest; light green represents other woodland, shrubland and bushland

Source: FAO 2001b

Change in forested land 1990–2000 by region

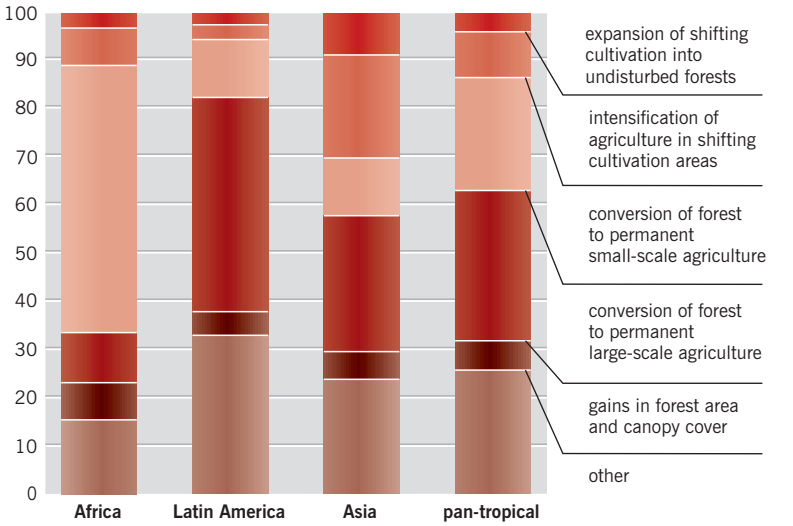
	total land area (million ha)	*total forest 1990 (million ha)*	*total forest 2000 (million ha)*	*% of land forested in 2000*	*change 1990-2000 (million ha)*	*% change per year*
Africa	2 963.3	702.5	649.9	21.9	-52.6	-0.7
Asia and the Pacific	3 463.2	734.0	726.3	21.0	-7.7	-0.1
Europe	2 359.4	1 042.0	1 051.3	44.6	9.3	0.1
Latin America and the Caribbean	2 017.8	1 011.0	964.4	47.8	-46.7	-0.5
North America	1 838.0	466.7	470.1	25.6	3.9	0.1
West Asia	372.4	3.6	3.7	1.0	0.0	0.0
world	**13 014.1**	**3 960.0**	**3 866.1**	**29.7**	**-93.9**	**-0.24**

Source: compiled from FAO 2001b Note: numbers may not add due to rounding

(see table on page 91). About 47 per cent of forests worldwide are tropical, 9 per cent subtropical, 11 per cent temperate and 33 per cent boreal.

- At the global level, the net loss in forest area during the 1990s was an estimated 9.4 million ha (equivalent to 2.4 per cent of total forests). This was the combined effect of a deforestation rate of 14.6 million ha per year and a rate of forest increase of 5.2 million ha per year. Deforestation of tropical forests is almost 1 per cent per year.
- The area under forest plantations grew by an average of 3.1 million ha per year during the 1990s. Half of this increase was the result of afforestation on land previously under non-forest land use, whereas the other half resulted from conversion of natural forest.
- The world's natural forests have continued to be converted to other land uses at a very high rate. During the 1990s, the total loss of natural forests (deforestation plus the conversion of natural forests to forest plantations) was 16.1 million ha per year, of which 15.2 million ha occurred in the tropics.
- In the 1990s, almost 70 per cent of deforested areas were changed to agricultural land, predominantly under permanent rather than shifting systems. In Latin America most conversion was large scale, whereas in Africa small-scale agricultural enterprises predominated. Changes in Asia were more equally distributed between permanent large- and small-scale agriculture and areas under shifting cultivation.

Causes of forest area change (percentage of total) by region



In the 1990s, almost 70 per cent of deforested areas were changed to agricultural land. In Latin America, most conversion was large scale, whereas in Africa small-scale agricultural enterprises predominated

Notes: 'pan-tropical' refers to data samples from satellite images of tropical areas; regions do not correspond exactly to GEO regions

Source: FAO 2001b

A recent study using globally comprehensive and consistent satellite data estimated that the extent of the world's remaining closed natural forests (where crown cover is more than 40 per cent) in 1995 was 2 870 million ha, about 21.4 per cent of the land area of the world (UNEP 2001). About 81 per cent of these forests are concentrated in just 15 countries. Ranked in the highest to lowest order these are: the Russian Federation, Canada, Brazil, the United States, Democratic Republic of the Congo, China, Indonesia, Mexico, Peru, Colombia, Bolivia, Venezuela, India, Australia and Papua New Guinea. The first three countries contain about 49 per cent of the remaining closed forests. More than a quarter of closed forests grow on mountains (see box on page 68).

Forest products

Wood supply and production remains the focus of most forest inventories. More than one-third of above-ground woody biomass is located in South America, with 27 per cent in Brazil alone. Estimates by FAO (2000) show that global production of total roundwood reached 3 335 million m^3 in 1999. Just over half of this was fuelwood, about 90 per cent of which was produced and consumed in developing countries. On the other hand, industrial roundwood production, 1 550 million m^3 in 1999, was dominated by developed countries, which together accounted for 79 per cent of total global production. The overall trend for industrial roundwood production was relatively flat during the 1990s. This was a significant change from the rapid growth that occurred prior to 1990.

Commercial logging methods are often destructive and contribute directly or indirectly to deforestation. In West Africa, it was estimated that in obtaining 1 m^3 of logs, about 2 m^3 of standing trees are destroyed (Serageldine 1990). Logging is especially damaging on steep slopes or in sensitive ecosystems such as transitional forests and mangroves (see box opposite). Where certain species are selected, non-target species can also be damaged. Clearing of forests impacts most severely on local populations, who lose vital sources of food, fuel, construction materials, medicines and areas for livestock grazing. It also exposes soils and shade species to wind, sunlight, evaporation and erosion, accelerating siltation in

dams, rivers and the coastal zone, as well as causing severe floods.

There is a global trend towards greater reliance on plantations as a source of industrial wood. The development of a significant global plantation estate is quite recent; half of all plantations in the world are less than 15 years old. Asia has led plantation establishment globally; as of 2000, about 62 per cent of all forest plantations were located in that region. Other significant developments include: rising private sector investment in plantations in developing countries; increasing foreign investments in plantations; and an expansion of 'outgrower' schemes whereby communities or small landowners produce trees for sale to private companies (FAO 2001b). Forest plantations typically contain only one, or a few, species, which makes them less biologically diverse and more susceptible to diseases and other disturbances than natural forests.

Forest industries continue to adapt to changes in raw materials, namely the increased supply of plantation wood and of a wider range of species. Recently there has been an emergence of innovative ways to make better use of available supplies and of residues and waste. Such new developments include laminated veneer lumber, glue-laminated timbers and products based on wood fibres. In addition, modern technologies that reduce environmental impacts, through pollution control and other means, are now available to wood-processing industries (FAO 2001a).

In addition, many countries have imposed bans on timber harvesting, either to conserve their forest resources or as a response to devastating natural calamities (such as landslides and flooding) that are attributed, rightly or wrongly, to excessive commercial logging. The effects of logging bans differ widely with the type of policy, the products affected, market conditions, etc. In some situations, logging bans can shift harvesting pressure from one region to another, affect forest-dependent communities, increase or decrease employment opportunities, and disrupt markets (FAO 2001a). There is also increasing interest in forest certification which offers the potential to provide a market incentive for better forest management (see box on page 94).

Trade trends in forest products show an increased proportion of the total production of wood products being exported, increased domestic wood processing prior to export, increased trade among developing countries (particularly in Asia) and trade liberalization at a global level. At the same time some countries are introducing export restrictions to address national environmental and market problems. Forest trade and environment issues have been under consideration by both the World Trade Organization Committee on Trade and Environment and the Intergovernmental Forum on Forests. Impacts of trade on some commercial tree species are currently under review by a working group of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (FAO 2001a).

Where the forest meets the sea

Flock of birds in a mangrove forest at Orissa, India

Source: UNEP, Van Gruissen, Topham Picturepoint

Mangrove forests thrive in intertidal zones of sub-tropical and tropical shores of Africa, Australia, Asia and the Americas. They line about 25 per cent of tropical coastlines. Mangrove forests are among the world's most biologically diverse and productive systems. They provide food and refuge for many species and nutrients for the marine environment. Mangroves also act as nursery grounds for fish and shellfish, and are prime nesting and migratory sites for hundreds of bird species (see photo). In Belize, for instance, more than 500 species of birds have been recorded in mangrove areas. Mangroves also help protect coastlines from erosion, storm damage and wave action, and protect coral reefs and sea grass beds from damaging siltation. Local communities are provided with timber and fuelwood from mangrove forests.

Mangroves are threatened by activities such as overharvesting, freshwater diversion, pollution, prolonged flooding and fluctuating sea levels. In addition, the charcoal and timber industries, tourism and other coastal developments are destroying mangrove forests. The rapidly expanding shrimp aquaculture industry poses the gravest threat — as much as 50 per cent of recent mangrove destruction has been due to clear-cutting for shrimp farms.

Thailand has lost more than half of its mangrove forests since 1960. In the Philippines, mangroves declined from an estimated 448 000 ha in the 1920s to only 110 000 ha in 1990. In Ecuador, the Muisne region has lost nearly 90 per cent of its mangroves. Globally, about half of the world's mangrove forests may have been lost.

Sources: Quarto 2002, UNDP, UNEP, World Bank and WRI 2000

Forests and climate change

Recent negotiations on the Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC) have focused considerable attention on forests in the context of climate change (IISD 2001a

and 2001b). Forests both influence and are influenced by climate change: they play an important role in the global carbon cycle, and their management or destruction could significantly affect the course of global warming in the 21st century.

Forests contain somewhat more than half of the carbon that is stored in terrestrial vegetation and soil organic matter with boreal forests accounting for 26 per cent of the total terrestrial carbon stocks. Tropical and temperate forests contain 20 and 7 per cent respectively (Dixon and others 1994). Although considerable uncertainties surround estimates of carbon release from deforestation, removal of forest biomass contributes significantly to net emissions of carbon dioxide to the atmosphere. During the 1980s and 1990s, emissions were estimated to be 1.6-1.7 gigatonnes (10^9 tonnes) of carbon a year (Watson and others 2000). If predicted climate changes materialize, the impacts on forests are likely to be regionally varied, dramatic and long-lasting, affecting both the distribution and composition of forests (IPCC 2001a, FAO 2001a).

The Kyoto Protocol may have a profound effect on the forest sector. Parties to the UNFCCC have recently reached agreement on rules and modalities of accounting for carbon sequestered by forests. This may open the way for developed countries to invest in afforestation and reforestation projects in developing countries in exchange for carbon emission reduction units under the Clean Development Mechanism, thereby reducing the cost of implementation of the Protocol (IPCC 2001b).

Forests and biodiversity

Forests are critically important for maintaining biological diversity. Estimated to contain half of the world's total biological diversity, natural forests have the highest species diversity and endemism of any ecosystem type. Tropical forests are particularly richly endowed (CIFOR and others 1998). Forest fragmentation exacerbates the impacts on biodiversity of overall deforestation and forest degradation by blocking migration routes and making access easier for further exploitation by humans and entry by invasive species (UNDP, UNEP, World Bank and WRI 2000). The remnant primary forests need to be identified, mapped, conserved and restored. In the tropics, where most remaining forests are still of natural origin, conservation combined with forest rehabilitation as well as development of local communities in and around the forests, could go a long way to achieve the goal of biological diversity conservation in spite of rising population pressure.

Forest protected areas are one of the keys to the conservation of biological diversity globally. An estimated 12 per cent of the world's forests are under protected area status (as defined by IUCN Categories I to VI). The Americas have the largest proportion, approximately 20 per cent, of forests under protected status. The effectiveness of on-the-ground management is what really matters, however. In many

Forest certification

Forest management certification has been strongly promoted by civil society over the past decade. It resulted from public disillusionment with the failure of governments and intergovernmental bodies to improve forest management or tackle deforestation effectively, and the lack of discrimination by forest industries about the source of their products.

Forest certification is a voluntary, market-based instrument that enables consumers to identify forest products with high environmental standards. By focusing on quality of forest management rather than the quality of forest products, it contributes to the growing trend to define production and process standards for social and environmental performance in resource management.

Three main certification approaches are in operation:

- Forest Stewardship Council (FSC) accreditation — an international system which requires producers to meet a global set of Principles and Standards for good forest stewardship and provides a trademark for product labelling;
- Certification of the Environmental Management System (EMS) under the International Organization for Standardization (ISO) 14000 series; and
- national certification schemes, some of which also incorporate elements of the FSC and ISO approaches.

By the end of 2000, about 2 per cent of the global forest had been certified for sustainable forest management. About 92 per cent of these forests were located in Canada, Finland, Germany, Norway, Poland, Sweden and the United States. At the same time, only four countries with tropical moist forests (Bolivia, Brazil, Guatemala and Mexico) had more than 100 000 ha of certified forests, with a combined total of 1.8 million ha. An increasing number of large retail 'do-it-yourself' chains in Europe and the United States and some major house-builders in the United States have announced that they will favour certified wood products in the future. Buyers' groups that have committed themselves to trading only in products from certified sources are also on the increase.

Many more millions of hectares are in the process of certification although the concept is still hotly debated in many countries. Producer countries and trade groups tend to consider it restrictive whilst consumer countries with strong environmental lobbies have stressed its potential benefits. Although there is little evidence as yet about the local and market impacts of certification the contribution of this voluntary procedure to good policy is evident. Setting up the system has provided a forum for stakeholders to discuss broader forest policy issues. It has also been successful in moving decision-making powers away from some minorities with vested interests.

Sources: FAO 2001b and 2001b, Mayers and Bass 1999

Forest fires in Australia, Brazil, Ethiopia, Indonesia (photo left), the eastern Mediterranean, Mexico and western United States have raised concern about wildfires, catalysed national policy responses and mobilized initiatives for fire prevention and suppression

Source: UNEP, Paulus Suwito, Topham Picturepoint

parts of the world there is a strong tendency towards 'paper parks' whose existence is largely theoretical and not reflected by substantive and durable conservation reserves on the ground (Vancly and others 2001). Furthermore, those sites that do exist are under increasing pressure from competing land uses.

The depletion of forest-based wildlife as a result of the commercial harvesting and trade of bushmeat is of growing concern. This has reached crisis dimensions in parts of tropical Africa, where many species of primates and antelopes, among others, are threatened (FAO 2001a). This difficult problem is being addressed at the local or national level by various stakeholders, as well as at the international level by CITES.

Forest damage

Large areas of forest around the world caught fire in 1997 and 1998, when intense El Niño-related drought conditions prevailed. Another serious spate of fires occurred in 1999-2000. The forest fires of the past five years in Australia, Brazil, Ethiopia, Indonesia, the eastern Mediterranean, Mexico and western United States have raised public awareness and concern about wildfires, catalysed national policy responses and mobilized regional and international initiatives for fire prevention, early warning, detection and suppression. The links between fires and land use policies and practices are now better understood (FAO 2001a).

Extreme weather events are another threat. The storms that struck Europe in December 1999 caused massive damage to forests and to trees outside forests. The total damage in Europe represented six months of the region's normal harvest while, in some countries, the equivalent of several years' harvest was blown down. Changes in forest management, such as increased reliance on natural regeneration, have been proposed in many countries to reduce the potential risk of storm damage in the future (FAO 2001a).

Forest governance

Forest governance systems are evolving rapidly, together with the respective roles and responsibilities of government, the private sector, indigenous communities and civil society. The concept of sustainable forest management — and efforts to achieve it — continued to gain momentum around the world during the past decade. Broader approaches to

forest management, such as integrated ecosystem and landscape management, are becoming more widely accepted and put into practice. These approaches recognize the dynamic nature of ecological and social systems, and the importance of adaptive management and collaborative decision-making. As of 2000, 149 countries were engaged in nine international initiatives to develop and implement criteria and indicators for sustainable forest management, covering nearly 85 per cent of the world's forest. At least 6 per cent of the total forest area in the developing countries is covered by a formal, nationally approved forest management plan, lasting at least five years. Some 89 per cent of the forests in industrialized countries are managed according to formal or informal management plans. An FAO survey of 145 countries found that 96 per cent of the countries had national forest programmes in various stages of development. Model and demonstration forest programmes are widely used to illustrate sustainable forest management in practice (FAO 2001a).

The involvement of local communities in joint forest management is now a significant feature of national forest policies and programmes throughout the world. Faced with inadequate financial and human resources, governments of developing countries are increasingly turning to local communities for assistance in protecting and managing state-owned forests. In some of these management schemes, the community provides the labour and protection, while gaining access to areas that were once restricted. Although several community-based management programmes have been successful, these systems are still evolving (FAO 2001a).

There is also growing awareness of the extent of illegal forest activities, including corrupt practices, and of the immense financial, environmental and social costs that these incur. Corruption, considered a taboo subject until recently, is now openly discussed in major international fora and is being actively tackled by governments, NGOs, the private sector and international organizations. Elements in the fight against crime and corruption include strengthened monitoring and enforcement systems, increased transparency in decision-making, simpler laws and more severe punishment (FAO 2001a).

At the international level, two major international initiatives followed publication of the *1980 Tropical Forest Resources Assessment.* The first was the establishment of the International Tropical Timber Organization (ITTO) in 1983 under UNCTAD, which aimed to bring together producer and consumer countries of tropical timber. ITTO works with projects and has permanent committees on reforestation, industries and markets. While not its original intention, ITTO has become a major platform for issues related to sustainable forest management (ITTO 2000).

The second was the Tropical Forestry Action Plan (TFAP). Launched in 1985 jointly by FAO, United Nations Development Programme (UNDP), World Bank and World Resources Institute, TFAP had four priority areas for action: forestry in land use; fuelwood and energy; conservation of tropical forest ecosystems; and institutions. Towards the end of 1990, TFAP came under major criticism for the way it was managed. Around 1995, TFAP was revamped, made more 'country driven', with a focus on strengthening of planning capacity of governments, and renamed the National Forestry Action Program (Sargent 1990, Persson 2000).

The forest resources assessments of 1980 and 1990 provided important background information for the UNCED process. The findings on deforestation (15.3 million ha annually during 1980-1990) and lack of country capacity in forest resources assessment were timely for framing national capacity building recommendations in *Agenda 21*. The overarching principles governing sustainable forest management, formulated during UNCED in the *Forest Principles* and Chapter 11 in *Agenda 21*, have been further elaborated during the past ten years. Three of the international conventions agreed at UNCED, the UNFCCC already mentioned, the Convention on Biological Diversity and the Convention to Combat Desertification, also have important bearings on the future of forests (FAO 2001a).

A common vision for the management, conservation, and sustainable development of all types of forests has been facilitated by the Intergovernmental Panel on Forests (IPF) (1995-1997) and Intergovernmental Forum on Forests (IFF) (1997-2000), both under the auspices of the United Nations Commission on Sustainable Development (UNCSD). The IPF/IFF process has resulted in nearly 300 agreed proposals for action and in the creation of the United Nations Forum on Forests (UNFF) in October 2000, a permanent high-level intergovernmental body with

universal membership. To support the UNFF and to enhance policy coordination and international cooperation, a Collaborative Partnership on Forests (CPF) was formed by 11 international forest-related organizations both within and outside the UN system. The main operative means of the UNFF is its multi-year programme of work and the plan of action for the implementation of the IPF/IFF proposals for action. Although it is possible that UNFF debates will stimulate national policies and trigger action by CPF organizations, the first session of the UNFF in June 2001 failed to create either a clear mandate or accountability for implementing the proposals for action (IISD 2001c).

An important international challenge, to both South and North, is to ensure sustainability of forest goods, services and biological diversity in all forest types.

The recognition of the importance of forest ecosystems and threats to their integrity by the Stockholm Conference was an important step. However, subsequent work has not halted the loss of valued forest. The assessments show continued deforestation and forest degradation. The concerted action required to control and reverse these trends — while also addressing the poverty which is so frequently associated with communities that remain dependent upon forest resources — is long overdue. Dealing successfully with forests as an issue on the international agenda will largely depend on the international community's ability to mobilize political, financial, scientific and technical support for sustainable forest management, particularly in developing countries.

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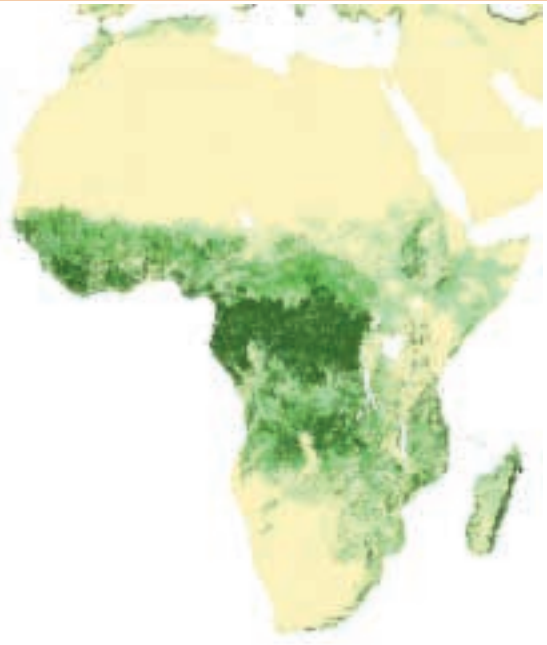
Forests: Africa

Africa's forest cover is estimated at 650 million ha, constituting 17 per cent of the world's forests (FAO 2001a). The major forest types are dry tropical forests in the Sahel, Eastern and Southern Africa, moist tropical forests in Western and Central Africa, sub-tropical forest and woodland formations in Northern Africa and the southern tip of the continent, and mangroves in the coastal zones. They include a number of international biodiversity hotspots (Mittermeier and others 2000). Only 1 per cent of forests in Africa have been planted.

African forests provide many goods and services. A study in Madagascar estimated the value of forest products to the local villages to be US$200 000 over ten years (Kremen and others 2000). In Ghana, it is estimated that 16-20 per cent of the local population's food supply is met from forest products, and as many as 150 animal and plant species are used. The Cross River State rainforest of Nigeria is home to more than 700 species of plants and animals, some 430 of which are used as non-timber forest products (ODA 1994).

Deforestation, both for commercial timber and to make room for agriculture, is the major concern and represents an enormous loss of natural economic wealth to the continent. Selective vegetation removal (during logging and woodfuel collection) contributes to loss of forest quality and biodiversity. Overharvesting of non-timber forest resources, including medicinal plants, adds to this problem. There is also concern that the bushmeat trade, which is prevalent in Central and Western Africa, may be endangering a number of forest-dwelling mammals. The pressures on forests and woodlands are exacerbated by the construction of access roads (by forestry and mining companies), which opens up closed forest areas, making the resources more accessible, and their trade more profitable.

Forest extent: Africa



Some 22 per cent of Africa is still forested but during 1990–2000 Africa lost more than 50 million ha, at an annual average rate of 0.7 per cent a year

Note: dark green represents closed forest, more than 40 per cent covered with trees more than 5 metres high; mid-green represents open (10–40 per cent coverage) and fragmented forest; light green represents other woodland, shrubland and bushland

Source: FAO 2001a

Change in forested land 1990–2000 by sub-region: Africa

	total land area (million ha)	*total forest 1990 (million ha)*	*total forest 2000 (million ha)*	*% of land forested in 2000*	*change 1990-2000 (million ha)*	*% change per year*
Central Africa	524.3	249.4	240.3	45.8	-9.1	-0.37
Eastern Africa	243.8	38.8	35.4	14.5	-3.4	-0.87
Northern Africa	851.0	77.1	67.9	8.0	-9.2	-1.22
Southern Africa	679.8	239.1	222.0	32.6	-17.1	-0.70
Western Africa	605.6	85.1	72.5	12.0	-12.6	-1.53
Western Indian Ocean	58.9	13.0	11.9	20.1	-1.1	-0.90
Africa	**2 963.3**	**702.5**	**649.9**	**21.9**	**-52.6**	**-0.7**

Source: compiled from FAO 2001b Note: numbers may not add due to rounding

Forest clearance

The annual rate of change in total forest area (land with at least 10 per cent tree cover and 0.5 ha area) from 1990 to 2000 for the whole of Africa was estimated to be -0.74 per cent, equivalent to losing more than 5 million ha of forest a year, an area roughly the size of Togo and the highest rate of any region. Countries with the highest annual deforestation rates are Burundi (9.0 per cent), Comoros (4.3 per cent), Rwanda (3.9 per cent) and Niger (3.7 per cent). In terms of area deforested during 1990–2000, Sudan tops the list with 9.6 million ha, followed by Zambia (8.5 million ha), Democratic Republic of Congo (5.3 million ha), Nigeria (4.0 million ha) and Zimbabwe (3.2 million ha). Only seven countries increased their forest areas over the same period (FAO 2001a).

Economic development strategies and lax implementation of forest protection regulations are the principal pressures on forest resources. Governments in Western and Central Africa have given concessions to private firms for logging selected species. The timber is mostly exported to earn foreign exchange. In countries such as Angola, the Democratic Republic of Congo and Sierra Leone political instability and war have further contributed to deforestation. Forest clearance has negative economic impacts through loss of future export opportunities, tourism revenue and pharmaceutical development options. The annual cost of deforestation in Uganda has been conservatively estimated at US$3-6 million (NEMA 2000).

Weak and ineffective policies have contributed to forest clearance. In Eastern Africa, for example, forestry departments throughout the 1980s were given a low priority, resulting in weak or outdated policies, laws and regulations governing forest management. In Southern Africa, most forestry policies and laws were enacted in the 1970s, and have since become obsolete with small and non-deterrent fines for non-compliance. Policy failures in Western Africa include lack of attention to developing alternative energy sources, inadequate funding of forestry departments, lack of support for private investment in sustainable forest management and reforestation, and out-dated concepts of forest conservation and community participation. However, levels of awareness on forestry issues have been greatly raised through international lobbying, extension services and the activities of NGOs. Several countries are now correcting these institutional weaknesses, and forest policies are being reviewed, revised or redrafted. Communities have become more involved in policy making, as well as in implementing forest management strategies. International cooperative initiatives have been developed in Southern and Central Africa (FAO 2001b).

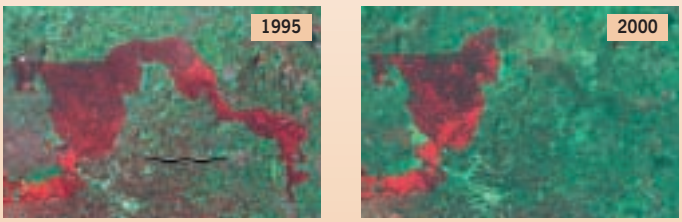
Clearing of forests for agriculture has played a significant role in deforestation. In Northern Africa, 13 per cent of forest cover was lost during 1972–92, and in Nigeria deforestation of riparian forests and savannahs for agricultural development was estimated at more than 470 000 ha a year during 1978–96 (DoF Nigeria 1996). In Africa as a whole, 60 per cent of the tropical forest cleared between 1990 and 2000 has been converted into permanent agricultural smallholdings (FAO 2001a).

Some large-scale reforestation programmes have been implemented but most have introduced monocultures without the biological diversity of the natural forests they replace. While some of the more arid countries have increased the size of their forests, reforestation programmes have done little to slow deforestation rates, particularly in moist tropical forests (ADB 2000, FAO 2001a).

Agricultural encroachment in Uganda and Kenya

In Mt Elgon National Park, on the Uganda/Kenya border, agricultural encroachment in the 1970s and 1980s laid bare more than 25 000 ha of virgin forest. In Kibale National Park, Uganda, encroachers cleared more than 10 000 ha of forest. In Mabira Forest Reserve, the Kanani Cooperative Farmers Society entered the forest in 1975. The district administration perceived them as a self-help project rather than as encroachers, and gave cultivation permits to 115 of their members. The permits specified that no more forested land should be cleared, valuable timber tree species should be preserved, and no buildings should be erected. Regulations were not enforced and by 1981 more than 1 800 people had moved in and degraded more than 7 200 ha of the reserve.

In Kenya, between 1995 and 2000, the whole of the indigenous forest in the Imenti Forest Reserve on the slopes of Mt Kenya was illegally converted into cropland. Designated as a forest reserve since 1932, under which no clearance activities were permitted, forest policies clearly failed to provide adequate protection. Landsat images below show loss of forest (red); each image is about 20 km wide.



Sources: NEMA 2000, KWS 1999, Landsat TM 17 March 1995, Landsat ETM 5 February 2000

Another response has been to designate forests as protected areas. Some 11.7 per cent of African forests have protected area status (FAO 2001a). While the establishment of protected areas has increased the availability and quality of information on forest resources, promoted public awareness and created refuges for endangered species, these areas will meet their objectives only if protection measures are enforced (see box on page 99).

Commercial forestry management has evolved towards a more sustainable philosophy. The forest ecosystem is becoming the focus of management, rather than timber extraction, and non-timber forest resources are given consideration. In Southern Africa, there is a growing realization of the importance of trade in forest products from sustainably managed forests, and a small proportion of forests in Namibia, South Africa and Zimbabwe have been certified by the Forest Stewardship Council (FAO 2001a).

Community-based forest management schemes are also being established, with considerable benefits to community income levels and forest conservation. In Eastern Africa, agroforestry schemes are being introduced to meet the dual need for agricultural production and tree products from smallholdings. In Kenya, afforestation and reforestation at household and commercial scale have been able to supply people with fuelwood, poles, sawn wood, wood-based panels, and pulp and paper.

Loss of forest quality

Fuelwood collection and charcoal production contribute significantly to degradation of forests and wooded areas such as savannahs. In many countries of Central and West Africa, more than 80 per cent of domestic energy requirements are met from woodfuel (FAO 2001a). In sub-Saharan Africa, traditional fuels accounted for 63.5 per cent of total energy use in 1997 (World Bank 1999). Use of wood for fuel in Eastern Africa amounts to 1-2 kg/person/day, and in Madagascar and Comoros collection of wood for fuel is the largest cause of forest clearance (UNEP 1999). Wood collection often changes the species composition of forest or woodland. In addition, nutrients are removed from the ecosystem, and animals may be deprived of shelter and nesting material (DEA&T 1999). In Zambia, some 430 km^2 of woodland are cleared annually to produce more than 100 000 tonnes of charcoal (Chenje 2000). This generates about US$30 million, and is the sole income for about 60 000 people (Kalumiana 1998). Rural electrification is being promoted in some countries but the rural poor often cannot afford the tariffs or the costs of electrical appliances (Chenje 2000).

Commercialization of crafts such as basket making is also causing the disappearance of some plant species. The major source of weaving material in Botswana, Mozambique, Namibia, South Africa and Zimbabwe is fibre from palm leaves and brown dye from *Berchemia* bark. In Botswana, the traditionally conserved *Berchemia* trees are fast becoming scarce (SADC, IUCN & SARDC 2000). Tatamaca, ebony and baobab have almost become extinct from the Western Indian Ocean islands due to selective overexploitation (UNEP 1999).

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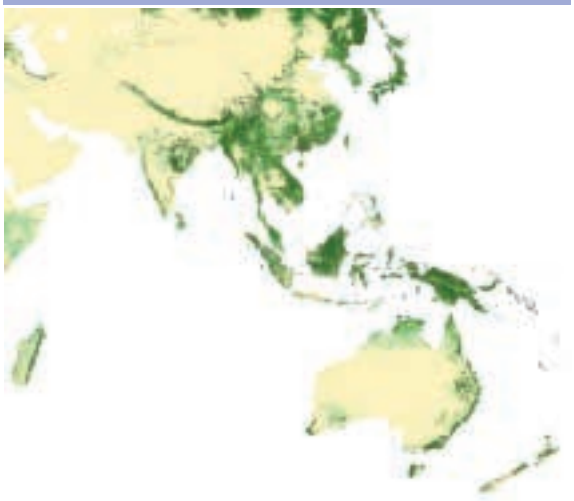
Forests: Asia and the Pacific

Asia and the Pacific region accounts for 18.8 per cent of global forests. Within the region, Northwest Pacific and East Asia has the largest forest area (29.3 per cent of the regional total), followed by Southeast Asia (29.1 per cent), Australia and New Zealand (22.3 per cent), South Asia (11.7 per cent), South Pacific (4.8 per cent) and Central Asia (2.7 per cent) respectively. Average per capita availability of forest area in the region in 2000 was 0.2 ha, less than one-third of the world average of 0.65 ha per person (FAO 2001a).

Forest degradation and deforestation

Deforestation and forest degradation are critical issues, threatening biodiversity, ecosystem stability and the long-term availability of forest products as well as depleting the natural resource base underpinning many national economies (UNESCAP and ADB 2000). Population pressure, heavy dependence on fuelwood, timber and other products, as well as conversion of forests to agricultural, urban and industrial land are the underlying factors for deforestation in the region. Forest degradation and deforestation has also resulted from overgrazing and shifting cultivation. In addition, as forests have become degraded, so fire, pests, diseases and natural disasters have caused greater damage. Construction of irrigation schemes, dams and reservoirs as well as mining are further causes of deforestation (ADB 2000a) while armed conflict has also taken a toll in some countries (UNESCAP and ADB 2000).

Forest extent: Asia and the Pacific



Some 21 per cent of Asia and the Pacific is still forested and deforestation, while continuing, is at a relatively low rate — an annual average of 0.1 per cent a year

Note: dark green represents closed forest, more than 40 per cent covered with trees more than 5 metres high; mid-green represents open (10–40 per cent coverage) and fragmented forest; light green represents other woodland, shrubland and bushland

Source: FAO 2001a

The latest *Global Forest Resources Assessment* (FAO 2001a) showed that, within the region, annual deforestation rates were highest in Southeast Asia at 1 per cent (equivalent to 2.3 million ha per year), whereas Northwest Pacific and East Asia had an increase of 1.85 million ha annually, due mainly to afforestation in China.

More that 40 per cent (and the highest diversity) of the world's mangroves grow along the coasts of South and Southeast Asia. A further 10 per cent grow in the Pacific. Mangrove forests provide numerous benefits to people and the environment but they are disappearing at an alarming rate in this region. More than 60 per cent (some 11 million ha) of Asia's mangroves have already been converted to

Change in forested land 1990–2000 by sub-region: Asia and the Pacific

	total land area (million ha)	*total forest 1990 (million ha)*	*total forest 2000 (million ha)*	*% of land forested in 2000*	*change 1990-2000 (million ha)*	*% change per year*
Australia and New Zealand	795.0	164.9	162.5	20.4	-2.4	-0.1
Central Asia	391.6	16.6	19.3	4.9	2.7	1.6
Northwest Pacific and East Asia	1 147.8	195.2	212.7	18.5	17.4	0.9
South Asia	640.3	86.3	85.3	13.3	-1.0	-0.1
Southeast Asia	434.5	234.7	211.4	48.7	-23.3	-1.0
South Pacific	53.9	36.4	35.1	65.2	-1.2	-0.4
Asia and the Pacific	**3 463.2**	**734.0**	**726.3**	**21.0**	**-7.7**	**-0.1**

Source: compiled from FAO 2001a *Note: numbers may not add due to rounding*

aquaculture and more have been cleared to make way for rice farming or urban and industrial land use. Those that remain are exploited for timber, fuelwood, tannin and food items (UNESCAP and ADB 2000).

Drivers of forest degradation

Many countries are highly dependent on wood to meet national energy needs and this use accounts for some three-quarters of total roundwood production (UNESCAP and ADB 2000). The contribution of fuelwood to total energy consumption varies widely, from less than 5 per cent to more than 85 per cent. In Nepal, for example, fuelwood accounts for 70 per cent of the country's total energy demand (Bhatta and Shrestha 1996). Where fuelwood collection relies primarily on natural forests, it can be a major contributor to forest degradation and depletion. Over-harvesting in steep areas is a particular cause for concern as it may impair the forest's protective functions of safeguarding watersheds and river flow (UNESCAP and ADB 2000).

Commercial logging, as here in Myanmar, is an important cause of deforestation in parts of Asia and the Pacific

Source: UNEP, Aye Myint Than, Topham Picture point

Fire is an important and recurring phenomenon in many forest ecosystems. In Asia and the Pacific, the severity of forest fires has been exacerbated by droughts and by land clearance. As a result, forest fires have become a major cause of deforestation in many countries, especially in East and Southeast Asia. The Indonesian fires of 1996-97 are the best known example but serious forest fires have also occurred in Australia, China and Mongolia in recent years. In response, fire detection and monitoring systems are now in place in several countries and the Association of Southeast Asian Nations (ASEAN) has established a Forest Fire Management Centre in Thailand to provide training and research (FAO 2001a).

Much forest degradation in the Pacific Island countries (PICs) stems from commercial logging. While providing substantial income to some countries, large-scale operations have degraded large proportions of the islands, affecting biodiversity, changing the hydrochemical balance and reducing food availability. New Zealand and Australia have also lost large amounts of their native forest and vegetation. Nearly 70 per cent of New Zealand was covered with native forest before the Europeans arrived in the early 19th century; it now covers only 16 per cent of the land area (MFE New Zealand 1997). In the 1970s and 1980s, the Government of New Zealand introduced subsidies to clear forests for agricultural production and exotic forestry which, compounded with artificially low stumpage fees, encouraged overexploitation of forests. The subsequent removal of these subsidies has resulted in some marginal pasture reverting to scrub and forest.

Policy responses

The downside of forest clearance and degradation has been widely recognized and many governments have implemented forestry legislation and programmes that aim at conservation and afforestation. Some countries are also opting to control the clearance of land outside conservation and protection areas. Logging bans now exist on 10 million ha but have met with mixed success. In countries such as Cambodia, Indonesia and Thailand, implementation has been inadequate whereas bans in New Zealand and Sri Lanka which have shifted harvesting to alternative sources have proved effective (FAO 2001b). Zero burning policies have been adopted by Thailand and Malaysia. Some countries have introduced economic instruments for the conservation of forest resources. For example, afforestation fees and licences are used in China to strengthen the cultivation, protection and management of forests. In Lao PDR, logging quotas are issued and distributed to the provinces as provincial quotas (ADB 2000b). Government commitment to the protection of forests is best exemplified by the case of Bhutan where, in 1995, it was mandated that the country must keep at least 60 per cent of its total land area under forest cover.

The region contains 60 per cent of the world's plantation forests. Whilst plantation forests are usually a poor substitute for natural forests in terms of maintaining biodiversity, they can supplement and

substitute wood and other supplies from natural forests, thereby reducing pressure on and disruption to the latter. They also perform many of the environmental services of natural forests, including carbon sequestration, watershed protection and land rehabilitation, and they provide income and employment. A number of governments are increasing plantations to reap these benefits (see box).

Local community participation in the management of forests has been gaining pace since the late 1970s. In Nepal, regulations for handing over particular forest areas to groups of forest users were drawn up in 1974. Forest users' groups protect, manage, use the forest area, share all benefits among users and possess exclusive rights to forest income (ADB 2000a). Of Nepal's total forestry sector investment, 36 per cent is earmarked for community forestry. In India, Joint Forest Management was introduced in 1990 and about 45 000 village communities in 21 states are involved in managing more than 11 million hectares of degraded forests (MoEF 1999). The community provides any labour required to improve degraded areas and protects the forest while it regenerates. In time the state gains a revitalized forest and the income from selling its products. A portion of the income from selling timber is given to the community in addition to the right to gather non-wood forest products (FAO 2001b)

In Viet Nam, more than 500 000 ha of well-stocked, national forests have been turned over to local communities, mostly of indigenous people, while in the Philippines a system of Integrated Protected Areas attempts to protect biodiversity and involve communities as stakeholders in managing forests.

Forest plantations: Asia and the Pacific

The Chinese government began afforestation programmes in the 1970s. Forest coverage increased from 13.9 per cent in 1993 to 17.5 per cent in 2000. By 2001, the total afforested area in China had reached 46.7 million ha.

Several countries have ambitious plans for the future:

- Viet Nam has set a target to create 5 million ha of additional forest area in the next 10 years;
- the Philippines Master Plan for Forestry has set a target for 2.5 million ha to be planted between 1990 and 2015;
- China plans to establish 9.7 million ha of plantations between 1996 and 2010; and
- Australia aims to treble its plantation area to 3 million ha by 2020.

Sources: Chan and others (2001), FAO (2001a), UNESCAP and ADB (2000)

The PICs have also emphasized the establishment of community-based conservation areas but some countries still lack formal legislation or institutionalized programmes prohibiting the cutting of trees and forests outside protected areas. For some PICs, where customary management is still very strong, there are traditional practices that protect areas from land clearance.

Both Australia and New Zealand are committed to sustainable forest management. These commitments are formalized in Australia's Nation Forest Policy State of 1992 and New Zealand's Resource Management Act of 1991. In both countries the felling of trees and clearing of bush generally requires formal assessment and approval. In New Zealand, more than 99 per cent of annual roundwood harvests came from plantations in 1997 and several forests have received certification through the Forest Stewardship Council (FAO 2001a).

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Forests: Europe

Europe's 1 051 million ha of forests comprise 27 per cent of the world's total forested area and cover 45 per cent of the European landscape. Forest cover ranges from 0.3 per cent in Iceland to 72 per cent in Finland (FAO 2001a). A wide variety of boreal, temperate and sub-tropical forest types are represented, as well as tundra and montane formations. Since the 1970s, afforestation has gradually increased the area under forests: between 1990 and 2000 almost 9.3 million ha were added (FAO 2001a). However, old growth forests and forests of indigenous tree species are decreasing. Forest practices, relying on monocrop plantations and even-aged stands of exotic species, have not been conducive to maintaining biological diversity.

Some countries, particularly those with extensive forest cover (Finland, France, Germany and Sweden), consider their forests in an integrated context with landscapes and biodiversity. In theory, this means a broader, more responsible approach to forest practices. Others, particularly those with little forest cover (for example, Ireland and Spain), are more interested in rapid forest growth for commercial or watershed protection purposes. Sustainable forest management remains a challenge for many European countries.

Loss of natural forests and forest degradation

In the Baltic States and western part of the Former Soviet Union (FSU), most deforestation from felling took place in the first half of the 20th century. After World War II, enormous reforestation programmes were carried out alongside industrial logging. In the Russian Federation, there has been a sharp decline in the extraction of forest products in recent years linked to the general decline of industry throughout the FSU. In the late 1990s, total removals amounted to only between one-quarter and one-third of the amounts extracted in the 1970s and 1980s (FAO 2001a).

Significant areas of forest were nationalized as early as 1918 in the FSU and in the 1950s in the countries of Central and Eastern Europe (CEE), and protected categories of forest were established (OECD and World Bank 1993). With increasing poverty in these countries and a loss of traditional communist era livelihoods, protected areas and forests in CEE are now under pressure from illegal tree felling which, in some places, has pushed some rare species to the

Forest extent: Europe

The forested area of Europe increased by more than 9 million ha — or nearly 1 per cent — during 1990–2000

Note: dark green represents closed forest, more than 40 per cent covered with trees more than 5 metres high; mid-green represents open (10–40 per cent coverage) and fragmented forest; light green represents other woodland, shrubland and bushland

Source: FAO 2001a

Change in forested land 1990–2000 by sub-region: Europe

	total land area (million ha)	*total forest 1990 (million ha)*	*total forest 2000 (million ha)*	*% of land forested in 2000*	*change 1990-2000 (million ha)*	*% change per year*
Central Europe	209.3	48.9	50.3	24.0	1.3	0.3
Eastern Europe	1 789.3	870.7	875.1	48.9	4.4	0.0
Western Europe	360.8	122.4	125.9	34.9	3.6	0.4
Europe	**2 359.4**	**1 042.0**	**1 051.3**	**44.6**	**9.3**	**0.1**

Source: compiled from FAO 2001a Note: numbers may not add due to rounding

brink of extinction. An increasing trend towards privatization in many countries since 1990 is also reducing the area of protected forest (EEA 1995), although vast forested lands in the Komi Republic and the Lake Baikal basin have recently been designated as UNESCO World Heritage Sites, effectively halting planned major logging operations (RFSCEP 2000).

Significant forest degradation has been caused by industrial pollution. Vast tracts of forests in CEE still suffer the lingering consequences of acidification, although SO_2 emissions and 'acid rain' have been reduced (see 'Atmosphere' section) and the deteriorating situation appears to have stabilized (EEA 1997 and UNECE and EC 2000). Degraded forests are found in the Russian Federation around industrial centres in the Urals, the Kola Peninsula and Siberia, with more than 500 000 ha damaged in the Siberian region of Norilsk alone (Mnatsikanian 1992). Chernobyl affected about 1 million ha of forests in the Russian Federation as well as large areas in Belarus and Ukraine. They will be excluded from use and public access for the foreseeable future (FAO 2001a).

In the mid-1990s, large areas of forests were lost in the Russian Federation from causes other than logging. Insects were responsible for 46 per cent of the damage, forest fires 33 per cent and unfavourable weather 16 per cent (MoNP Russian Federation 1996). The future of the Russian Federation's 850 million ha of temperate and boreal forests (22 per cent of the world's total and the largest forest area in any one country) is important not just for the country but for the entire region because of its role as a carbon sink (see 'Polar Regions', page 116). All forests in the Russian Federation are state owned and are divided into three groups for management purposes (see box).

Forest clearance for agricultural land, terracing and the creation of fruit orchards has had adverse consequences on the environment and biodiversity in southeastern Europe, especially Albania, Bosnia and Herzegovina, and Macedonia. Forest ecosystems, particularly those close to rural settlements, have been significantly degraded due to overexploitation for fuelwood and overgrazing (REC 2000). The severe energy crisis in the mid-1990s in Armenia and Georgia also caused illegal logging on a large scale for home heating and cooking (Radvadnyi and Beroutchachvili 1999). The affected forests include oak and other tree stands which are characterized by high biological diversity in comparison with other types of forests.

Managing the world's most extensive forests: forest estate in the Russian Federation

GROUP I *Protection forests*	*GROUP II* *Multipurpose forests*	*GROUP III* *Forests for commercial use*
21 per cent of total forest area	6 per cent of total forest area	73 per cent of total forest area
Strict felling regimes	Harvesting restricted to amount of annual growth	Clear cutting allowed
Changes in proportion of forest area 1966–88:		
increasing	increasing	decreasing

Source: FAO (2001a)

The harvesting of coastal shrubs and forests has also created problems, especially for birds, which use these habitats for nesting (REC 2000).

Around the Mediterranean, forests have been degraded since historic times, from overgrazing and wood removal, and little undisturbed forest now remains (FAO 2001a). Fire is one of the great enemies of Mediterranean wooded areas due to the climatic conditions (dry air and strong winds) and the combustibility of the plant cover; it is estimated that on average 500 000 ha are burned each year. The fires are almost always caused by humans: in traditional herding areas, 'pastoral fires' are still frequent, especially in scrubland, while elsewhere the majority are due to negligence rather than criminal intent. The number of fires rises rapidly in dry years, especially in tourist areas.

Striving for sustainable forest management

Sustainable forestry was practised in Central Europe in the 19th century and the culture of sustainable use has survived until today in some parts of the region, particularly in Slovenia. In many parts of Western and Central Europe, however, monocultures, especially those consisting of fast-growing commercially valuable coniferous species, have displaced indigenous broad-leaved forest species; they are unable to support high biodiversity and are more vulnerable to acidification.

All countries in the region are making efforts to decrease wood production from natural forests and enhance biological diversity and other environmental services and protection functions by managing them in a more sustainable manner. To support these efforts, a

Pan-European criteria for sustainable forest management

'Sustainable management means the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems' (Resolution H1, 2nd meeting, Ministerial Conference on the Protection of Forests in Europe (MCPFE)).

Criteria for sustainable forest management adopted by MCPFE in 1998:

- maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles;
- maintenance of forest ecosystem health and vitality;
- maintenance and encouragement of productive functions of forests (wood and non-wood);
- maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems;
- maintenance and appropriate enhancement of protective functions in forest management (notably soil and water); and
- maintenance of other socio-economic functions and conditions.

Source: MCPFE Liaison Unit (2000)

framework for Pan-European Forest Certification (PEFC) provides a voluntary mechanism for forest certification and makes provision for mutual recognition of different European national systems and non-European schemes. National PEFC governing bodies have been established in 15 European countries (FAO 2001b).

Another solution to the problem of deforestation is the imposition of fines and other economic instruments on illegal as well as legal cutting. In Croatia, Czech Republic, Hungary, Lithuania and Poland revenue for forest protection and reforestation activities is generated through timber extraction charges or fines. In Romania, however, the abolition of self-imposed restrictions on wood exports in 1995, combined with increased prices for sawn timber, have led environmentalists to fear increases in illegal cutting and overexploitation (REC 2000).

In addition to national actions, European countries are parties to international collaborative efforts which directly or indirectly address forest issues. Several broad international agreements covering the protection of species, such as the CBD, CITES and RAMSAR Convention, also indirectly protect forests. The European Community Council Directive 92/43/EC on the conservation of natural habitats of wild fauna and flora (the Habitats Directive) entered into force in June 1994. However, two of its requirements — incorporation in national legislation and the submission of national lists of Natura 2000 candidate sites — have not been fulfilled by all Member States.

There have been three Ministerial Conferences on the Protection of Forests in Europe (MCPFEs) since 1990. The second (Helsinki 1993) agreed on a common definition of sustainable forest management (see box). The third (Lisbon 1998) put special emphasis on the socio-economic aspects of sustainable forest management. Resolutions were adopted on People, Forests and Forestry, on Pan-European Criteria (see box) and on Indicators and Operational Guidelines for Sustainable Forest Management (MCPFE Liaison Unit 2000). The resolutions are now being integrated into an overall work programme (FAO 2001a).

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Forests: Latin America and the Caribbean

Forests have many important socio-economic functions in Latin American and Caribbean countries. These include supplying the wood industry with inputs for domestic consumption and export, providing local communities with essential non-wood forest products and providing forest-dwelling indigenous communities with opportunities to continue their traditional livelihoods. They also provide environmental goods and services, acting as natural shields against disasters, affording watershed protection, biodiversity preservation and prevention of soil erosion, and serving as a sink for carbon dioxide.

Latin America and the Caribbean is one of the most important forest regions, with nearly one-quarter of the world's forest cover (FAO 2001a). The region contains 834 million ha of tropical forest and 130 million ha of other forests, both temperate and dry, coastal and montane, covering 48 per cent of the total land area (FAO 2001a). Argentina, Bolivia, Brazil, Colombia, Mexico, Peru and Venezuela contain 56 per cent of the regional total (FAO 2001a). The region's forests contain more than 160 billion m^3 of wood, one-third of the world total. Guatemala and Panama are among the world's highest in terms of standing volume per hectare (FAO 2001a).

The Amazon Basin contains the world's most extensive tropical rainforest. It includes at least 20 different rainforest types, and is considered to be the world's richest ecosystem in terms of biodiversity (FAO 2001a).

The rate of deforestation is one of highest in the world at an annual average of 0.48 per cent (varying from 1.2 per cent in Meso-America to 0.4 per cent in South America and a net gain of 0.3 per cent in the Caribbean). Of the 418 million ha of natural forest lost worldwide over the past 30 years, 190 million ha were in Latin America (FAO 2001a). Total forest area in the region was reduced by around 46.7 million ha between 1990 and 2000.

Forest extent: Latin America and the Caribbean

The most heavily forested region, Latin America and the Caribbean lost nearly 47 million ha during 1990–2000, second only to Africa

Note: dark green represents closed forest, more than 40 per cent covered with trees more than 5 metres high; mid-green represents open (10–40 per cent coverage) and fragmented forest; light green represents other woodland, shrubland and bushland

Source: FAO 2001a

Causes of deforestation and forest degradation

The major problems are deforestation and degradation of the forest ecosystem, including fragmentation and biodiversity loss. These are caused by conversion of forest land to other uses and non-sustainable use of

Change in forested land 1990–2000 by sub-region: Latin America and the Caribbean

	total land area (million ha)	*total forest 1990 (million ha)*	*total forest 2000 (million ha)*	*% of land forested in 2000*	*change 1990-2000 (million ha)*	*% change per year*
Caribbean	22.9	5.6	5.7	25.0	0.1	0.3
Meso-America	241.9	82.7	73.0	30.2	-9.7	-1.2
South America	1 752.9	922.7	885.6	50.5	-37.1	-0.4
Latin America and the Caribbean	**2 017.8**	**1 011.0**	**964.4**	**47.8**	**-46.7**	**-0.5**

Source: compiled from FAO 2001a *Note: numbers may not add due to rounding*

forests. Forest fires, always a natural force in forest ecosystems, have also become a major problem (see box).

The expansion of the agricultural frontier has been one of the main causes of deforestation (FAO 2001a). Commercial farmers have cleared large areas for soybean exports in Brazil, Bolivia and Paraguay, for coffee in Brazil, and for bananas in Central America, Colombia, Ecuador and the Caribbean (Contreras-Hermosilla 2000). Small-scale farmers also cause deforestation by employing slash-and-burn practices to extend their agricultural lands into forests.

Land tenure regulations are part of the problem. In Amazonia and Central America, local communities own significant proportions of forests while in Argentina, Chile and Uruguay virtually all forests are privately owned. Elsewhere, the state is a major forest owner. When legal property rights over land are not clear, people tend to clear and build on areas to establish a claim to them. Forest cover may also be removed to keep areas accessible when forest communities fear that forests may be declared protected areas, limiting community rights to use the forest. This happened in Costa Rica when the government intended to expand its protected area system (Contreras-Hermosilla, 2000).

Deforestation has worsened in some countries because of policies designed to increase economic growth. Subsidies are a contributing factor. For example, subsidies directed towards improving the productivity of existing agricultural lands should ease the pressure for more land and therefore reduce the pressure for clearing more forests. However, agricultural incentives can result in higher land ownership and more mechanized, capital-intensive methods of production which displace farm workers. Unemployed workers have migrated into forests in the Amazon, in the Cerrados of Brazil, in Santa Cruz, Bolivia, and parts of Paraguay, causing further forest clearance (Contreras-Hermosilla 2000). Livestock expansion and mechanized agriculture account for more loss of forest cover than wood production, which is concentrated in relatively few countries.

Timber exploitation may also cause deforestation by opening up previously forested areas to small-scale farming. In addition, selective logging can eliminate certain tree species, changing forest composition. The construction of roads also contributes to loss of forest cover — 400–2000 ha of forest may be removed for each kilometre of new road built through it. In the Brazilian state of Pará, deforestation due to road construction increased from 0.6 per cent to 17.3 per cent of the state's area during 1972-1985 (Contreras-Hermosilla 2000). In Ecuador, Peru and Venezuela, mining corporations and individual miners clear large areas of forests (MineWatch 1997, Miranda and others 1998). Additionally, biological phenomena such as the proliferation of pests are a cause of irreversible damage to some forests (Monge-Nájera 1997).

Forest fires in Latin America and the Caribbean

Fire is a traditional land use tool for opening up new land to agriculture and making hunting easier. Uncontrolled wildfire is now a major concern: forest fires can destroy up to 50 per cent of the forest's surface biomass, with severe effects on forest fauna (UNEP 2000).

Forests were particularly vulnerable to fire in 1997–99 due to seasonal droughts associated with El Niño and decline in forest quality. In Central America, more than 2.5 million ha of land caught fire in 1998 with the greatest losses in Honduras, Guatemala, Mexico and Nicaragua (Cochrane in press). In Mexico alone, there were 14 445 separate fires (FAO 2001a). The same year, large-scale fires also affected many South American countries.

Social and economic costs of fires are high, when full account is taken of medical costs, airport closures, and timber and erosion losses. The damage resulting from the 1998 forest fires in Latin America has been crudely estimated at US$10-15 billion. The first South American Seminar on the Control of Forest Fires was held in Brazil in 1998, and policy makers are starting to realize that emergency response needs to be coupled with better land-use practices. In Mexico, for instance, the Ministries of Agriculture and Forestry have been collaborating since 1998 to reduce the threat of agricultural burning to forests (FAO 2001a).

Effects of altering forests

The effects of deforestation, forest degradation and forest fires represent a permanent loss of the potential capacity of forest resources to generate economic benefits (CDEA 1992). These impacts are more severe in some countries than others. Most Caribbean countries have depleted forest resources so much that they must now import forest products, creating an additional need for foreign exchange. In countries with extensive forest resources, such as Brazil, deforestation has had less overall impact, although at the local level the impact can be very significant.

Improving forest regulations and policies

A number of countries have recently adopted new forest regulations. For example, Bolivia adopted a new forestry law in 1996 (Law 1700) which makes state-owned forests available to private companies through concessions provided that local and indigenous populations are involved (Tomaselli 2000). The

amount of forest land under protection is also increasing — from less than 10 per cent of total forest area in tropical South America in 1990 to more than 14 per cent in 2000 (FAO 2001a).

Market-based instruments such as certification can also contribute to sustainable forest management, and Bolivia, Brazil, Guatemala and Mexico now have 1.8 million ha of forests certified by the Forest Stewardship Council (see page 94) — far exceeding the area of tropical moist forests certified anywhere else in the world (FAO 2001a). Shade-grown coffee is another example where such instruments have the potential to protect environmental resources and to address local concerns (see box).

The area of plantations increased from about 7.7 million ha in 1990 to about 11.7 million ha in 2000. These plantations, composed of mainly *Pinus* and *Eucalyptus* species, are concentrated in the Southern Cone and in Brazil, Peru and Venezuela (FAO 2001a). Regional policies on forestry plantations are mainly oriented towards recovering degraded land. In some countries, there are a few areas where plantations have played a key part in increasing forest cover and bringing in large amounts of foreign exchange. In other areas, plantations are an economic alternative to other land uses (such as agriculture) and thus help to reduce deforestation. However, plantations contain significantly less biodiversity than native forests (Cavelier and Santos 1999).

Most governments receive international support to formulate environmental policies, strengthen institutions, and establish structures and mechanisms to improve monitoring and evaluation. Most of the internationally supported programmes and projects are linked to global concerns such as biodiversity conservation and climate change. Examples of such initiatives include the PPG 7 Pilot Project in Brazil, the BOLFOR Project in Bolivia (FMT 2002) and the Iwokrama International Centre in Guyana. International organizations are active in the region and efforts to address problems through regional collaboration are gaining ground. The Central American Council for Forests and Protected Areas advises on policies and strategies for sustainable use of forest resources and conservation of biodiversity while the Treaty for Amazonian Cooperation between eight South American countries fosters collaboration on activities in the Amazon Basin (FAO 2001b).

Shade-grown coffee — harnessing the market for sustainable development

When North American consumers pay a premium for shade-grown coffee, incentives can be created for Mexican farmers to maintain the biodiversity of the land on which they traditionally grow coffee in the shade of the existing forest canopy. By relying on inherent natural predators and barriers to protect their crops from pests and on the natural fertility of the soil to nurture the plants, they avoid costly and often damaging fertilizers and pesticides. Their diverse agrosystems can continue to provide habitat for migratory songbirds, insects and other fauna that may otherwise be threatened by conversion to large plantations of sun-grown coffee, while preserving the cultural values, livelihoods and integrity of small communities. By realizing the market value of shade-grown coffee, the economic logic for clearing forests is drastically reduced, while incentives to conserve and sustainably use the forest increase (Vaughan, Carpentier and Patterson 2001).

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Forests: North America

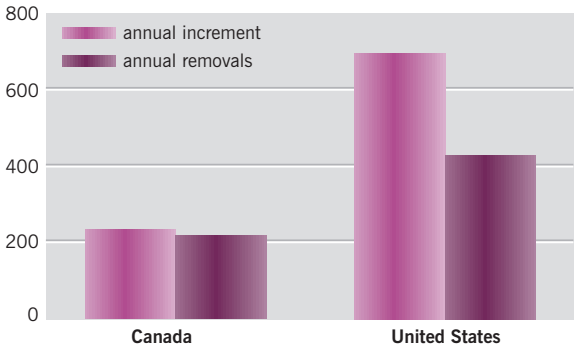
Forests cover about 26 per cent of North America's land area and represent more than 12 per cent of the world's forests. North America has more than one-third of the world's boreal forests as well as a wide range of other forest types. Some 96 per cent are natural forests. After the Russian Federation and Brazil, Canada has more forest than any other country, with 244.6 million ha. The United States is the fourth most forested country, with 226 million ha (FAO 2001). While Canada's forest area remained static during the past decade, in the United States it has increased by almost 3.9 million ha, approximately 1.7 per cent.

Estimates show that North America now grows 255.5 million m^3 more timber annually than is harvested (UNECE and FAO 2000). The region accounts for about 40 per cent of the world's production and consumption of industrial wood products (Mathews and Hammond 1999).

The land area under plantation is also increasing in both countries. In Canada, the area regenerated by planting increased from a little less than 100 000 ha in 1975 to nearly 400 000 ha in 1997 (REGEN 2002), while the United States has about 21 million ha of plantations or some 4.5 per cent of its forest land base (UNECE and FAO 2000).

In Canada, 94 per cent of forests are publicly owned, with the provinces responsible for 71 per cent of forest land (NRC 2000). In contrast, some 60 per cent of forests in the United States are privately owned, 35 per cent are publicly owned and managed by the federal government, and the 50 states own and manage 5 per cent (FAO 2001).

Timber increments and removals (million m^3/year): North America



North America currently grows some 255 million m^3 more timber than it harvests

Source: UNECE and FAO 2000

Forest extent: North America

Forests cover about 26 per cent of North America, and their area — though not their quality — is increasing

Note: dark green represents closed forest, more than 40 per cent covered with trees more than 5 metres high; mid-green represents open (10–40 per cent coverage) and fragmented forest; light green represents other woodland, shrubland and bushland

Source: FAO 2001

Forest health

In the past, a forest was deemed healthy if it was free from disease and was growing vigorously (NRC 1999). Over the past 20 years, however, the long-term sustainability of the forest ecosystem has become the primary measure of forest health (UNECE and FAO 2000). A forest may be considered healthy when it maintains biodiversity and resilience, provides wildlife habitat, ecological services and aesthetic appeal, and maintains a sustainable supply of timber and non-timber resources (NRC 1999). In many areas, forests are becoming increasingly fragmented, biologically impoverished, and weakened or stressed (Bryant, Nielsen and Tangley 1997).

Human intervention and demand for timber and paper are the primary drivers of forest modification. Poor harvesting practices, the introduction of exotic species and suppression of natural disturbances have created large forested landscapes with an unnatural tree distribution and age structure, which has increased the forest's vulnerability to drought, wind, insects, disease and fire (USDA 1997).

Air pollution is increasingly recognized as a contributing factor to forest degradation (Bright 1999). It has played a role in the major die-off of spruce-fir forests in the southern Appalachians, a region that has been the focus of concern for the US Forest Service (USDA 1997, Mattoon 1998). Although pollution regulation has reduced acid rain in the northeast, there is evidence that reduced growth in some tree species is linked to the long-term effects of acid precipitation (Driscoll and others 2001).

An emerging issue in maintaining healthy forests is the potential impact of climate change and the connections between climate change and other damaging influences (NRC 1999). North America's forests, particularly its broadleaf ecosystems that appear to have a large capacity for carbon absorption, are unlikely to maintain their absorption attributes in an unhealthy state (Bright 1999). As management practices place greater value on non-timber attributes, as more forested lands are protected from logging, and as a weakened forest's ability to absorb carbon is questioned, it becomes increasingly important to reduce North America's consumption of both wood products and fossil fuels.

Old growth forests

Old growth forests, which are characterized by stands of large and old trees, a distinct species composition, a multilayered canopy, and a large build up of organic matter (Lund 2000), have many positive attributes. They are a source of high-value timber, contain large amounts of carbon, harbour a large reservoir of genetic diversity, provide habitat for many species, regulate hydrological regimes, protect soils and conserve nutrients, and have substantial recreational and aesthetic value (Marchak, Aycock and Herbert 1999). Much of the interest in old growth forests stems from the powerful images which they project of rich biodiversity and timeless stability. Visitors often sense a form of spirituality and grandeur in such forests and most people place a high value on them.

Old growth forests once occurred in all North American ecosystems although it is now difficult to determine their exact extent. Remnant old growth forests and stands still remain, especially in the Pacific Northwest and down the Pacific coast to California. The classic old growth forest in this area contains redwoods, cedars, Douglas fir, hemlock and spruce. The region probably still contains about half the world's remaining unlogged coastal temperate rainforest, with the greatest share in British Columbia.

The majority of old growth lost in the eastern and lower elevations of North America was due to conversion of land to agriculture and urban environments. In the west (see bar chart) and mountainous regions, loss has been due to harvesting of timber and conversion to younger more vigorously growing stands along with recent catastrophic events such as the eruption of Mount St Helens and the Yellowstone fires (Harmon 1993, H. John Heinz III Center 2001).

The decline in old growth forest was largely driven by increasing worldwide demand for timber and high prices in the 1970s (Mathews and Hammond 1999). In recent years, losses due to timber harvesting have slowed because of increasing environmental concerns including the desire to preserve natural forests and to prevent further destruction of critical wildlife habitat and biological diversity.

Natural forests are still deemed by some to be essential to Canada's industrial timber supply. Canada harvests about 175 million m^3 of timber annually (NRC 2000) from approximately 1 million ha, or 0.5

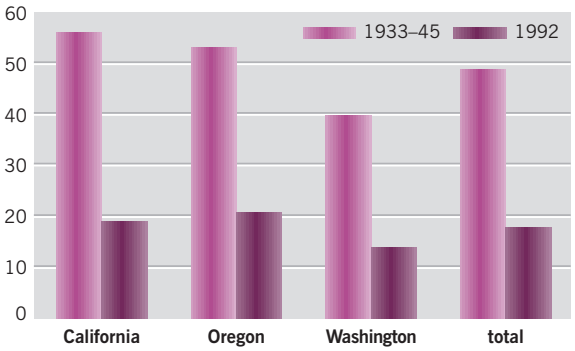
Clayoquot Sound

Clayoquot Sound, a 1 000 km^2 wilderness on Vancouver Island, became the focus of a well publicized debate over old growth logging. Beginning in 1984, environmentalists and the Nuu-chah-nulth First Nation protested against clear-cutting by blocking logging roads, among other tactics. During 1989–93, government task forces attempted to resolve the conflict and large tracts of coastal temperate rainforest were set aside for protection (MSRM 2002). Claiming that logging was still permitted on 70 per cent of the Sound, the protesters continued their actions, and brought national and international attention to the issue.

In 1995, in recognition that the Nuu-chah-nulth had not been adequately consulted, public negotiations began on a settlement with the First Nation peoples. Recommendations were formulated and adopted by the provincial government (May 1998). A 4 000 km^2 model forest was also established.

Progress was subsequently made in resolving the remaining conflicts. One of Canada's largest forest products companies announced in 1998 that it would phase out clear-cutting in British Columbia and design a new strategy focusing on old growth conservation (MacMillan 1998). An agreement was struck between First Nations and environmentalists to set aside most of the western coast of Clayoquot Sound and to promote economic development through small-scale logging, non-timber forest products and ecotourism. With the January 2000 designation of Clayoquot Sound as a UNESCO Biosphere Reserve, industry, environmentalists, governments and First Nations established a new form of governance based on shared responsibility for the ecosystem (ENS 1999, Clayoquot Biosphere Trust 2000).

Decline of old growth forest (percentage of total)



Old growth forests have declined rapidly since the middle of the 20th century

Source: H. John Heinz III Center 2001

per cent of the nation's commercial forest base. There is little mature second growth forest and so logging continues mainly from mature natural forests.

The paradigm shift towards the ecosystem approach to managing North America's old growth forests reflects the combined power of scientific knowledge, the action of voluntary groups, public awareness, market pressures on industry, and governmental response (see box on page 111).

Policy responses

Canada's commitment to sustainable forestry is reflected in its 1998-2003 National Forest Strategy, the Canadian Council of Forest Ministers' set of criteria and indicators of sustainable forest management, and the research performed by the Canadian Forest Services (NRC 2000). The US Forest Service has also incorporated the concept of sustainable forestry and in 1999 it began to develop criteria and indicators for sustainable management (UN 1997).

Many state and provincial initiatives also reflect a shift to sustainable ecosystem management. Largely in response to public pressure, forest management over the past 20 years has incorporated a new emphasis on maintaining wildlife habitat, protecting soils, and retaining natural landscape characteristics. Large tracts of North American forests, including old growth, have been designated as protected areas. Canada has protected about 32 million ha (13 per cent) of its forested lands, and 67 million ha (30 per cent) of forests in the United States have some status of protection (University of Waterloo 1998, FAO 2001).

Export markets increasingly require that timber products be certified as originating in well-managed forests. Many companies and governments are becoming involved (Travers 2000). By 2002, more than 3 million ha of North American forests had been certified by the Forest Stewardship Council (FSC 2002).

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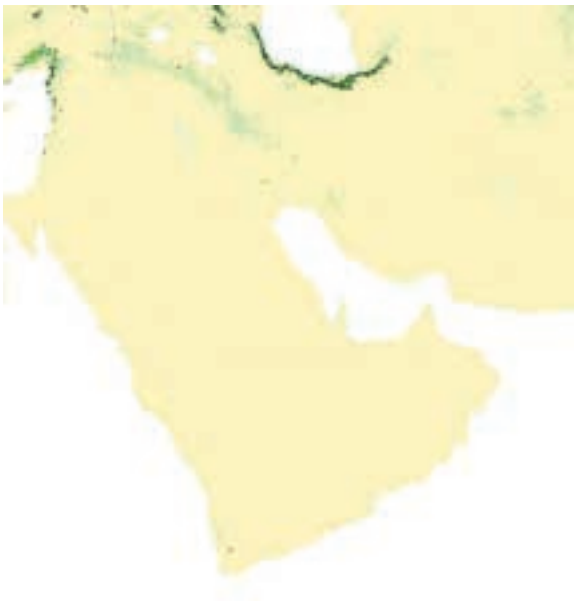
Forests: West Asia

Forests and woodlands of West Asia occupy only 3.66 million ha or 1 per cent of the region's land area and account for less than 0.1 per cent of the world's total forested area (FAO 2001a). The majority of forest cover (62 per cent) is in the Arabian Peninsula with the remainder scattered in the mountains and hills of northern Iraq, Jordan, Lebanon, Syria and the Occupied Palestinian Territories. The best stands of closed forests are found on the uplands near the Mediterranean. Tracts of mangrove forests grow along the coasts of the Arabian Peninsula. Forest resources are state-owned and administered centrally (FAO 1997).

The forests and woodlands of the region are generally composed of slow-growing species of poor quality and of little economic value (Nahal 1985, FAO 1997). Harsh climatic conditions limit forestry potential and restrict regeneration once forests are degraded (Abido 2000a). Under rainfed conditions, average forest productivity varies from 0.02 to 0.5 m^3/ha/year, although it reaches 2.9 m^3/ha/year in the natural forests of *Pinus brutia* of northern Syria (Nahal 1985, GORS 1991). By contrast, the productivity of irrigated eucalyptus plantations may exceed 17 m^3/ha/year (Abido 2000b). Nevertheless, forests play a vital role in protecting the region's water and soil resources, especially in steep and mountainous terrain, and in areas prone to desertification. They also afford protection from dust storms and stabilize dunes and river banks (FAO 1997).

All countries in the region depend on imports to meet the bulk of their wood product needs. The total value of forest product imports increased nearly fourfold between 1972 and 1996, from US$131 million to more than US$500 million (FAOSTAT 1998) while exports of forest products totalled US$36.6 million between 1996 and 1998 (UNDP, UNEP, World Bank and WRI 2000).

Forest extent: West Asia



The least forested region, West Asia has only 0.1 per cent of the world's forest and only 1 per cent of its land area is forested

Note: dark green represents closed forest, more than 40 per cent covered with trees more than 5 metres high; mid-green represents open (10–40 per cent coverage) and fragmented forest; light green represents other woodland, shrubland and bushland

Source: FAO 2001a

Degradation and overexploitation

The region's forests and woodlands have suffered from a long history of degradation and overexploitation. Extensive land clearing for human settlements and agriculture in mountainous areas along the coasts of the Mediterranean in Lebanon and Syria has been carried out throughout history (Thirgood 1981). Traditional sheep and goat herding is still practised in *Juniperus excelsa* forest ecosystems in the Anti-Lebanon mountains and on the Syrian steppes where relics of *Pistacia atlantica* trees still remain (Nahal 1995, Abido 2000a).

Change in forested land 1990–2000 by sub-region: West Asia

	total land area (1 000 ha)	*total forest 1990 (1 000 ha)*	*total forest 2000 (1 000 ha)*	*% of land forested in 2000*	*change 1990-2000 (1 000 ha)*	*% change per year*
Arabian Peninsula	300 323	2 292	2 281	0.8	-11	-0.05
Mashriq	72 069	1 383	1 382	1.9	-1	-0.01
West Asia	**372 392**	**3 675**	**3 663**	**1.0**	**-12**	**-0.03**

Source: compiled from FAO 2001a Note: numbers may not add due to rounding

Over the past 30 years, natural forest areas have been fragmented and isolated and turned into a mosaic with agricultural fields in Syria, and with urban dwellings in Lebanon and Syria (World Bank and UNDP 1998, GORS 1991, Government of Lebanon 1995). It is difficult to provide a precise estimate of the level of forest degradation in the region over the past 30 years due to the inaccuracies of earlier estimates and the problems associated with comparing data from different countries due to different calculation methods employed. However, the data that are available indicate a 44 per cent reduction in the region's forest cover from 1972 to 2000.

Dragon's blood tree (*Dracaena draco*) growing in arid surroundings in Yemen; more than half Yemen's population depends on limited fuelwood supplies for cooking

Source: UNEP, Mohamed Moslih Sanabani, Topham Picturepoint

In Lebanon up to 60 per cent of forests were lost between 1972 and 1994 (Government of Lebanon 1995) while the small area of forest in the Occupied Palestinian Territories decreased by 50 per cent during the 1980s and 1990s (Palestinian Authority 1999, FAOSTAT 1998). However, in the past ten years the total forest area in West Asia has remained almost stable (see table on page 113). Significant changes have occurred only in Yemen, where forest area has decreased by 17 per cent, and in the United Arab Emirates, where plantation forests increased the total area by 32 per cent (FAO 2001a).

Several countries have a high proportion of planted forests (100 per cent in Kuwait, Oman and Qatar, 97.8 per cent in the United Arab Emirates and approximately 50 per cent in both Jordan and Syria) (FAO 2001b). Afforestation programmes increased the forested area in Jordan by 20 per cent during the 1980s and 1990s (FAOSTAT 1998).

Population growth, urbanization, economic developments (including tourism) and conflict (for example in Iraq, Lebanon and Syria) are among the external factors that significantly affect forests. Fire, overgrazing and overcutting of wood products have contributed locally to forest degradation (FAO 1997). Poverty and inappropriate forest policies are over-riding factors contributing to forest and woodland deterioration in the Mashriq countries and Yemen. Until recently, poor demarcation of public and private lands in and around some forests and protected areas has led to ownership disputes and conflicts, providing the opportunity for some people to increase their private land holdings at the expense of public forests.

Rural communities, especially in mountainous areas, depend heavily on forest resources for their supply of timber, fuelwood, charcoal and non-wood forest products, putting enormous pressure on the limited resources available. It is estimated that 57 per cent of families in Yemen depend on forest resources to satisfy their domestic needs for fuel. The average consumption of 0.5 m^3 per person a year far exceeds average annual growth in the country's forests (Government of Yemen 2000). Iraq, Jordan, Lebanon, Saudi Arabia and Syria also use a significant proportion of their wood production for domestic fuel (FAO 2001a). Excessive cutting and wood collection have rendered fragile forest ecosystems prone to soil erosion and desertification (World Bank and UNDP 1998, Government of Lebanon 1995, Government of Yemen 2000). However, rapid urbanization and industrialization in West Asia are resulting in seasonal and permanent rural migration into urban areas (FAO 1997) and this trend is expected to reduce pressure on rural forests in terms of fuelwood collection and grazing.

The average area destroyed each year by forest fires has doubled in parts of the Mediterranean basin since the 1970s (Alexandrian, Esnault and Calabri 1999) and increased by almost 40 per cent in Jordan in the 1980s and 1990s compared to the 1970s (Government of Jordan 1997). In Lebanon, around 550 ha of forest area were lost each year between 1961 and 1997 due to a variety of causes including fire, cutting and urban encroachment. In Syria, as much as

8 000 ha of forests were converted to other land uses by burning between 1985 and 1993, and an additional 2 440 ha of forests were converted to farmland during the same period. Since the 1970s, more than 20 000 ha of coastal forests were burnt in northwestern Syria, resulting in soil erosion of up to 20 tonnes/ha/year on steep slopes (World Bank and UNDP 1998).

Constraints to sustainable forest management

Traditionally, forests and woodlands were looked on as a source of timber, fuelwood and grazing sites, and forest policy was designed to protect these resources, with forestry departments in the region acting as resource guardians. Since 1992, in most countries forests have been demarcated, forest regulations revised and forest activities incorporated within the countries' national development strategies. These policies include new concepts such as integrated management of forest resources and recognition of the socio-economic values of these resources. However, some policies are still poorly defined, lack measurable objectives, and are not coordinated with land use policies (FAO 1997). Most importantly, the trend of decentralization, which would facilitate public participation in decision-making processes, is rather slow, and policies are rendered ineffective because of lack of financial support. New international initiatives are starting to address the linkages between rural communities and forest resources but the results are not yet available; adoption of community forestry models is still at an early stage (FAO 1997).

West Asian governments have only recently recognized the ecological importance of forests (FAO 1997). There is now a positive trend towards conservation of biological diversity and development of ecotourism industry in the region — for example in Jordan, Lebanon, Oman and Saudi Arabia. Some countries have declared forest reserves but these initiatives have been politically motivated with little involvement of stakeholders, and lack the support of local communities.

If sustainable forest management is to be achieved, further efforts are needed to mobilize resources and involve local communities, NGOs and other stakeholders in forest management.

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Forests: the Polar Regions

The northern boreal forest system circles the globe through Russia, Scandinavia and North America, covering approximately 13.8 million km^2 (UNECE and FAO 2000). It is one of the two largest terrestrial ecosystems on Earth, the other being the tundra — a vast treeless plain that lies north of the boreal forest and stretches to the Arctic Ocean. The boreal forests are an important resource for the Arctic countries and are discussed as an entity here, although they do extend well beyond the Arctic sub-region (see figure).

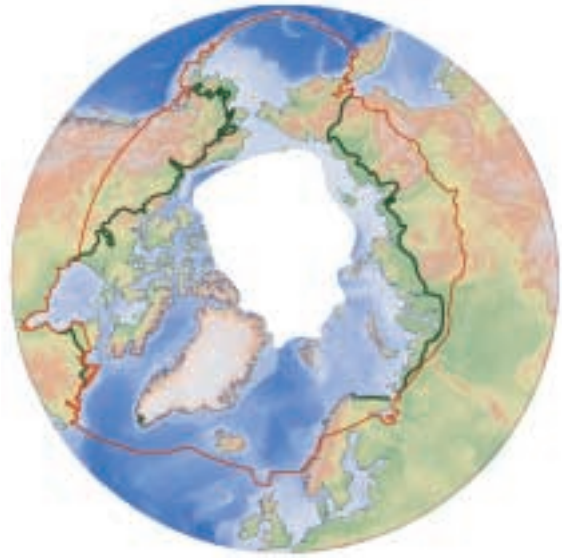
In contrast to the overall decline in tropical forest cover, boreal forest cover has expanded by more than 560 000 ha since 1990 due to reforestation, afforestation and improved forestry management practices — although in the Russian Federation there are reports of massive clear cuts and unsustainable forest practices (FAO 2001a, Hansen, Hansson and Norris 1996). The main boreal trees are coniferous spruce, pine, fir and larch species. Some species are deciduous and include birch, alder, willow, maple and oak. A large portion of the boreal forest of Canada, Alaska and the Russian Federation remains relatively undisturbed by humans (FAO 2001a, FFS 1998) whereas the long period of forestry activities in Scandinavia has left almost no old growth forest (CAFF 2001).

Values and uses of boreal forest

The boreal forest is an important contributor to the global resource base and to national and global economies. Wood processing has been a key economic activity of the Nordic countries since industrialization and an important export for Finland and Sweden (Hansen, Hansson and Norris 1996) while the Russian Federation is one of the largest exporters of industrial roundwood in the world. Since 1990, production has been stable or increased in all boreal countries except the Russian Federation, which has experienced a severe decline. For example, roundwood production halved from 227.9 million m^3 in 1992 to 115.6 million m^3 in 1998, reflecting the country's economic, social and infrastructure problems linked to economic transition (FAO 2001a).

Other uses and products of boreal forests include recreation, hunting, reindeer husbandry, fodder and forage, edible plant products (nuts, wild fruits and berries, mushrooms, maple syrup), medicinal plants, Christmas trees and wild floral decorations (FAO 2001a). The forests also provide important wildlife habitat. The environmental functions of the boreal forests include stabilizing fragile northern soils, filtering pollutants and acting as a carbon sink and an indicator of climate change.

Arctic treeline



Boreal forest occurs only to the south of the treeline (dark green line). Arctic area, as defined by the Arctic Monitoring and Assessment Programme (AMAP), is limited by the orange line

Source: GRID Arendal 2002

Forest loss and degradation

Major threats to the northern boreal forest include fragmentation (see box opposite), forest fires and insect outbreaks. Spruce bark beetles have killed a significant portion of the spruce forests in Alaska, and decadal outbreaks of the autumn moth *Epirrita autumnata* in Fennoscandia have caused large-scale defoliation (CAFF 2001). Insects can leave dry, dead timber more susceptible to fire, the occurrence of which is already increasing as a result of an increase in temperature and decrease in precipitation. The impacts of insect outbreaks and fires can be severe. For example, in Canada, 6.3 million ha were affected by insect defoliation and 0.6 million ha were burnt in 2000 (Natural Resources Canada 2001).

Policy and management responses

Some of the Arctic countries have long-established legislation to address the problems associated with

forest degradation. Finland enacted the Forest Zones Protection Act in 1922, to prevent soil erosion and protect vulnerable regions of its northern forests while Sweden's 1909 Protection of Nature Act has resulted in the establishment of some 800 crown forest reserves. The more recent 1974 Beech Forest Law and 1993 Deciduous Forests Law strictly regulate the management of these reserves. The Russian Federation adopted the Russian Forest Code in 1997, which established 35 national parks on forest lands, totalling 6.9 million ha (All-Russian Research and Information Centre 1997). A 1999 report of the Canadian Senate recommended dividing boreal forests into three categories to meet competing demands for economic resources, supplying the needs of local communities and preserving biodiversity (see box on page 105). In this way 20 per cent would be managed for timber production, up to 20 per cent would be protected and the remainder would be reserved for multiple use (FAO 2001a). While protected areas in the Arctic have increased, most forests still remain outside these areas (Lysenko, Henry and Pagnan 2000, CAFF 1994).

Reforestation and afforestation are occurring in all boreal countries although many species being used for reforestation are not native to the area. For example, in Iceland, where native forests have been depleted through unsustainable cutting and grazing practices, replanting is conducted with species such as lodgepole pine, Sitka and white spruce, Siberian larch, and poplar (FAO 2001b). New forest management guidelines in many Fennoscandian countries are calling for more natural regeneration and application of forestry management at the landscape level (CAFF 2001). However, regeneration favouring coniferous trees over broadleaf species has changed the tree species composition of some Arctic forests, and resulted in the decline of many invertebrate species that live on deciduous trees (CAFF 2001).

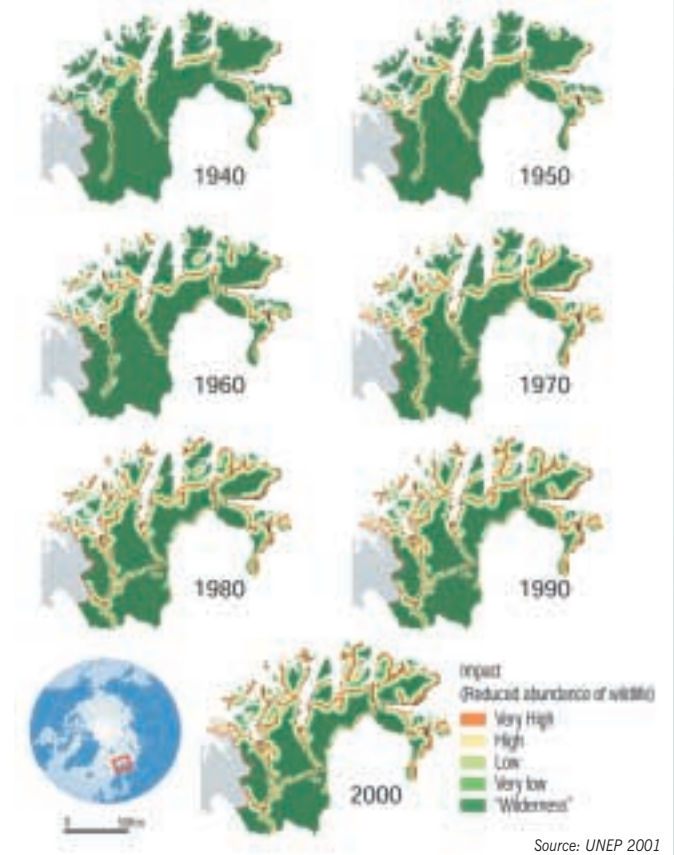
Forest fire management regimes have traditionally suppressed fires, which has resulted in a decrease in fire-dependent species and has also meant that there is more available fuel and consequently a likelihood of fiercer fires once they do occur. Fire is now being increasingly viewed as a management tool since problems of total fire exclusion have been recognized (FAO 2001a).

Forest fragmentation in the Arctic

Fragmentation, which hinders ecosystem functioning and results in loss of important wildlife habitat, and encroachment are serious threats to Arctic boreal forests, including the forested regions of the Russian Federation (FFS 1998, Lysenko, Henry and Pagnan 2000). In Scandinavia, there has been a long-term trend of converting forest land to other uses, especially agriculture, and ditch digging has increased the leaching of nutrients and run-off from soils. This in turn has caused siltation in rivers and lakes, decreasing their productivity as spawning areas for fish (CAFF 2001).

The coastal areas of Finnmark, Norway, are important calving and summer feeding grounds for the semi-domesticated reindeer of the Saami indigenous people. The maps below illustrate the gradual fragmentation of these areas as a result of expanding road networks. Hydroelectric installations, power lines, military bombing ranges and tourist resorts have had additional impacts (UNEP 2001).

Spread of road networks in Finnmark, northern Norway, 1940–2000



Source: UNEP 2001

The fragile forest-tundra

Between the northern edge of the boreal forest, where trees actively regenerate, and the treeless tundra is a dynamic transition zone known as 'forest-tundra'. This zone can range from a few kilometres in North America to more than 200 kilometres in Europe

(Stonehouse 1989). It is naturally fragmented and contains patches of relatively heavy forest cover punctuated by areas of lichen-heath as well as areas of very sparse tree growth. It supports more species than either the boreal or the tundra systems since it contains species from both systems (CAFF 2001). The trees of the forest-tundra are often poorly formed and stunted, and regeneration is slow. Traditionally, this has made commercial exploitation of timber impractical although the ecosystem has provided indigenous peoples over the centuries with wood for fuel and construction (CAFF 2001). As world pressure on resources escalates, however, the tundra-forest could become a larger commodity producer. In fact logging operations in Fennoscandia and northwest Russia crept close to the forest-tundra in the 1960s and 1990s (CAFF 2001).

In winter, the forest-tundra provides important habitat for some populations of North American caribou and for European reindeer, in turn supporting the traditional reindeer husbandry activities of indigenous peoples such as the Saami of Scandinavia. The zone also supports sheep farming, fishing and harvesting of non-timber products. Important physical functions of the forest-tundra system are to stabilize and protect fragile soils and nutrients, to prevent erosion, to conserve water resources and watershed capability, to filter pollutants, to act as an indicator of climate change and, together with the boreal forest proper, to act as a carbon store (see box above).

Arctic forests and climate change

Any significant change in the area of boreal forests could have a considerable effect on the level of CO_2 in the atmosphere. With 26 per cent of total carbon stocks, boreal forests account for more carbon than any other terrestrial ecosystem – 323 gigatonnes (Gt, 10^9 tonnes) in the Russian Federation, 223 Gt in Canada and 13 Gt in Alaska (Dixon and others 1994).

Conversely, it has been calculated that boreal forests will experience greater temperature increases from climate change than any other forest type. The warming, which is expected to be greater in winter than in summer, will shift climate zones north by as much as 5 km a year. Boreal forests will advance northwards while their southern edges will experience die back or replacement by temperate species. During summer, soils will be drier, and fires and drought more frequent. Local species loss may be significant although few tree species are expected to become extinct (UNEP-WCMC 2002).

Models used to predict the long-term changes in vegetation distribution have not conclusively shown whether the overall area of boreal forest will expand or decrease. However, one of the most comprehensive models of climate change forecasts that the northward expansion of forest will reduce the area of tundra by about 50 per cent by 2100 (White, Cannell and Friend 2000).

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OUR CHANGING ENVIRONMENT: Rondônia, Brazil

To decentralize the Brazilian population and develop new regions, the Brazilian government completed the Cuiabá-Pôrto Velho highway through the province of Rondônia in 1960. The road provided access to tropical rainforest previously occupied only by indigenous people.

Two main factors increased immigration to the province. First, the World Bank decided in December 1980 to invest in paving the Cuiabá-Pôrto Velho highway, making travel easier. Second, economic hardship near the southern coast encouraged emigration to the area where immigrants hoped to acquire new land. The 1975 and 1986 images show substantial settlement in the Ariquemes area, near the highway. The predominant 'fishbone' pattern on the landscape is the result of logging operations which provide access to new land. Primary land uses are cattle ranching and annual crop farming. More sustainable perennial crops such as coffee, cacao and rubber occupy less than 10 per cent of the agricultural land.

Despite encroachment, programmes are now attempting to preserve the land for multi-use functions providing a wider array of income-producing products for farmers that should eventually result in less impact on the tropical rainforest.

Landsat data: USGS/EROS Data Center Compilation: UNEP GRID Sioux Falls