STATE OF THE WORLD'S FORESTS

2003

Foreword

The *State of the World's Forests* reports every two years on the status of forests, recent major policy and institutional developments and key issues concerning the forest sector. This is the fifth edition of the publication, the purpose of which is to provide current and reliable information to policy-makers, foresters and other natural resource managers, academics, forest industry and civil society.

In line with the extensive preparations for the World Summit on Sustainable Development (WSSD), the last two years saw rich and stimulating discussions unfold in the international arena. The recent global economic downturn has contributed its own set of dynamics, and the forest and other sectors are struggling to absorb the impacts.

Choosing the topics for this edition of the *State of the World's Forests* from among the many options was a difficult task. In the spirit of collaboration, we took a slightly different approach from in the past and asked external authors to contribute whole chapters on major issues. The result is contributions from key intergovernmental and non-governmental organizations and from individuals contributing in their personal capacity, in addition to pieces researched and written by FAO staff. Such a mix is entirely consistent with the theme of the *State of the World's Forests 2003* – "partnerships in action" – and reflects how the forest sector must operate in today's environment.

An effort has been made to cover many subjects that are especially relevant to discussions taking place in international fora today. Part I presents recent developments and areas of current attention in forest resources; the management, conservation and sustainable development of forests; the institutional framework; and the international forest policy dialogue. Part II contains five chapters, each addressing a particular subject in more detail. The first examines the links between forests and poverty alleviation, a topic now being widely discussed in response to renewed interest in exploring the full potential of forests to bring about positive change. The second chapter notes the importance of forests in managing freshwater resources, the scarcity of which is becoming an urgent issue, as recognized by the United Nations designation of 2003 as the International Year of Freshwater. How the sustainable use of forests contributes to the conservation of biological diversity is dealt with in the third chapter as a supplement to ongoing and, at times, controversial deliberations. The fourth chapter examines issues related to imbalances in science and technology capacity between developing and developed countries and among different segments of the forest sector. The plight of Africa is given special attention in the last chapter, which describes trends in fiscal policies in forestry. The devastating impact of HIV/AIDS is also highlighted, as are recently published findings of the FAO Forestry Outlook Study for Africa.

Trying to strike a balance between including a sufficient number of key topics and doing them justice within the constraints dictated by length meant that coverage of some topics had to be general rather than exhaustive. In this regard, we would like to think that they provide grist for the mill for future editions of the *State of the World's Forests*.

The FAO Forestry Department is pleased to release the *State of the World's Forests 2003* and hopes that readers will find it informative and thought provoking. Comments are most welcome, as are suggestions for the next edition.

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Contents

PART II

SELECTED CURRENT ISSUES IN THE FOREST SECTOR

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Summary

PARTNERSHIPS IN ACTION

As the international policy dialogue continues, attention is now moving from words on paper to action on the ground. Through innovative partnerships and better linkages across sectors, governments, organizations and civil society are collaborating more than at any time in the past to resolve issues of fundamental importance to the environment and to the achievement of sustainable development. Alleviating poverty and improving food security are closely linked to these objectives, and forests are an integral part of the solution.

The United Nations Forum on Forests (UNFF), established in October 2000, will meet for a third time in May 2003 to consider ways to facilitate and promote further sustainable forest management worldwide, including through the implementation of the proposals for action of the Intergovernmental Panel on Forests (IPF) and the Intergovernmental Forum on Forests (IFF). At that time, participants will exchange experiences and lessons learned as they seek to overcome barriers to progress.

The *State of the World's Forests 2003* provides an overview of major developments in the sector in the past few years and focuses on selected key issues.

SITUATION AND DEVELOPMENTS IN THE FOREST SECTOR

Forest resources

In 2001, FAO published the most comprehensive assessment of global forest resources ever undertaken. Since the release of the Global Forest Resources Assessment 2000 (FRA 2000), an international meeting of experts has concluded that future FAO studies of this kind should remain broad and contain information on the range of forest goods and services. The *State of the World's Forests 2003* elaborates on two related areas: the link between agricultural expansion and deforestation; and the conversion and conservation of mangroves.

In coming years, enormous population increases, combined with growing per capita consumption, will continue to result in agricultural expansion on new lands, mostly through deforestation. Preliminary findings of an FAO study indicate that agricultural land is expanding in about 70 percent of countries, declining in 25 percent and roughly static in 5 percent. In two-thirds of the countries where agricultural land is expanding, forest area is decreasing, but in the other one-third forests are expanding. In 60 percent of the countries where agricultural land is decreasing, forests are expanding. In most of the rest (36 percent), forests are decreasing.

Pressure from dense populations in coastal areas has led to the conversion of many mangrove forests to other uses, and numerous case studies have described losses over time. It appears that mangrove deforestation continues, albeit at a slightly lower rate in the 1990s than in the 1980s, when large-scale conversion for aquaculture and tourism infrastructure took place in Asia, the Caribbean and Latin America. Now, most countries require environmental impact assessments prior to approving requests for conversion to other uses.

Management, conservation and sustainable development of forests

As forests are complex ecosystems that must be managed in a balanced and sustainable way, one of the main challenges today is to reconcile the often conflicting priorities of those who depend on forests for a variety of goods and services.

Trees are of critical importance in countries with low forest cover, in both urban and rural settings. Among other functions, they help combat desertification, provide basic necessities and protect biological diversity, crops, settlements and watersheds. A summary of six

case studies carried out in low forest cover countries (LFCCs) in 2002 describes the challenges that LFCCs face in enhancing the role of planted forests and trees outside forests; outlines the causes and effects of forest degradation; identifies common issues; and suggests potential ways forward.

Twenty-eight percent of the world's closed forests are mountain forests, and their importance for sustainable mountain development was highlighted during the International Year of Mountains – 2002. The need for better knowledge about their role in mountain ecosystems was also emphasized, as was the need for more integrated policies and management practices.

A look at forests in the Mediterranean basin reveals that measures must be taken to decrease the risk of wildfire in the northwest and to reduce deforestation and forest degradation in the southeast.

In a concerted effort to combat the negative consequences of forest fires, environment ministers of the Association of Southeast Asian Nations (ASEAN) signed an agreement, in June 2002, to strengthen cooperation and reinforce preventive measures in the region. Its implementation will complement the efforts of Project FireFight South East Asia, a joint initiative of the World Wide Fund for Nature (WWF) and the World Conservation Union (IUCN), to address harmful forest fires better through policy and law reforms.

In tropical forests, the unsustainable hunting of wild animals for meat and other products remains an alarming issue. Preliminary data from ongoing studies support concerns that wildlife, especially in Africa, is being drastically reduced, posing serious threats to food security, forests and their ecological integrity.

The *State of the World's Forests 2003* emphasizes the major roles of forests in the context of climate change: as a source of carbon dioxide (CO_2) when they are destroyed or degraded; as a sensitive indicator of a changing climate; as a source of biofuels for the substitution of fossil fuels; and as a CO_2 sink, when they are managed sustainably. It also notes the many issues that need to be resolved when negotiations for the next commitment period under the Kyoto Protocol begin in 2005.

Institutional framework

In recent years, the forest sector has undergone fundamental changes, largely as a result of restructuring, shifts in ownership patterns and wider recognition of the multiple benefits that forests provide. It is expected that by 2050, 40 percent of the world's forests will be managed or owned by communities and individuals. The amount of support that groups and institutions receive to increase their human, physical and financial capacity to take advantage of emerging opportunities needs to keep pace.

Recent emphasis on environmental protection, food security and poverty alleviation calls for new approaches to, among other things, forestry education. With today's changing imperatives, curricula need to be updated and modes of delivery modernized. In response, groups of universities are establishing consortia to offer issue-driven programmes to audiences around the world through courses, workshops, seminars and conferences.

Decentralization of authority and other responsibilities in the forest sector is expected to increase considerably in the coming years. The *State of the World's Forests 2003* identifies successful efforts to date, but also notes that resulting changes bring risk and raise new issues. In order to assess impacts more accurately, studies are under way to shed light on conditions that favour and hamper decentralization. Various promising approaches for sharing benefits from forest goods and services are also highlighted, as are the challenges associated with their implementation.

Issues related to illegal logging and corruption in the sector are being discussed more openly than ever before. Governments, private industry and non-governmental organizations (NGOs) are continuing their efforts to curb forest crime, while policy research institutions and agencies are stepping up analyses of its magnitude and impacts. Discussions around the world are generating additional pressure to take action.

Government policies in other sectors can have a profound impact on sustainable forest management, often in unexpected ways. Conversely, forests can provide an entry point to resolve issues that cross sectors, such as poverty alleviation, food security, corruption and illegal activities. When external interventions are likely to have undesirable effects on forests, the forest community needs to participate in problem solving before decisions are made. This requires institutional capacity building, empowerment of civil society and dissemination of the most current information to foster change.

International forest policy dialogue

With the establishment of UNFF in October 2000, attention is now turning to issues surrounding the implementation of sustainable forest management. While progress is encouraging, difficult matters are yet to be resolved such as financing, trade, capacity building, transfer of environmentally sound technology and future international arrangements. In April 2001, the Collaborative Partnership on Forests (CPF) was launched to support UNFF and to improve cooperation among members on forest issues. Less than a year later, it established the informal CPF Network to facilitate information exchange and to assist CPF in its work related to UNFF, especially pertaining to the IPF/IFF proposals for action.

The policy debate on forests and forest biological diversity has been unfolding in the past few years in both the Convention on Biological Diversity (CBD) and UNFF. The two fora consider their roles complementary and recognize the need to collaborate. In light of recent decisions, there is growing concern over potential duplication of efforts and lack of adequate resources to support extensive work programmes.

The overview of the international forest policy dialogue includes a review of developments over the past few years in forest-related conventions and in processes related to criteria and indicators for sustainable forest management.

In response to a call from the international forest community to consider national forest programmes as an important means for addressing key issues, a group of countries, institutions and NGOs established the National Forest Programme Facility. This focuses on information exchange, knowledge sharing and capacity building and seeks to link forest policy and planning with broader national strategies, particularly those related to poverty alleviation.

The World Summit on Sustainable Development (WSSD), held in Johannesburg in August/September 2002, recognized the significant contributions that forests make to the health of the planet and its inhabitants by noting the need for greater political commitment and better linkages with other sectors through effective partnerships. WSSD identified UNFF and CPF as key mechanisms to facilitate the implementation of sustainable forest management at the national, regional and global levels.

SELECTED CURRENT ISSUES IN THE FOREST SECTOR

Forests and poverty alleviation

An issue that has attracted renewed attention in recent years is the potential of forests to alleviate poverty, particularly in developing countries. The contribution that they make to poor households is often unrecorded in national statistics, so that much research needs to be done to shed light on the ways in which forests can help rural people avoid, mitigate or rise out of poverty. Research is also needed to show where forest conservation and poverty alleviation converge as policy goals, and where they diverge.

Changes that may favour a greater role for forests in alleviating poverty include decentralization of authority and other responsibilities; more secure forest tenure; better governance; increased access to markets; new technologies; and a greater willingness of society to pay for environmental services. Maximizing this potential requires, among other approaches, establishing a people-centred agenda; removing

regulatory restrictions; creating partnerships between poor people and forest enterprises; and integrating forestry into rural development and poverty reduction strategies.

At the dawn of the new millennium, certain enabling conditions present cause for optimism, although poor people are unlikely to benefit substantially unless they achieve a degree of political power and influence. Those who depend on natural forests stand to suffer most from their disappearance and degradation. Thus, such people could be an important constituency in mobilizing conservation efforts. The design of effective programmes will depend on greater understanding of the relationship between forests and rural livelihoods; of ways to increase income from forests; and of the significance of cross-cutting issues and political trends.

Role of forests in the management of freshwater resources

Warnings of freshwater scarcity put forth at the end of the twentieth century are proving to be accurate, to the point that lack of water now threatens food security, human health and livelihoods. Forests can have an important role in supplying freshwater, but their management must complement water management.

Mountainous forested watersheds require special attention as they are among the most important freshwater-yielding areas in the world but are also source areas for landslides, torrents and floods. Although land use and freshwater are inextricably linked, they are rarely managed in concert despite clear evidence of the connection between upstream and downstream uses of land and water.

While not a panacea, forests can provide real economic and environmental benefits that can best be identified within a watershed framework. Treating water as a commodity rather than a free good can result in economic incentives that translate into better management. Policies and institutions can provide incentives and means for achieving freshwater objectives, from the local watershed level to the river basin level.

Inequities in terms of who pays for and who benefits from changes in upland and downstream resource use can be resolved through intersectoral cooperation and expanded economic analysis. The new water economy will help justify land use changes to enhance water supplies. By the same token, inhabitants who improve forests or reduce downstream losses through other land uses will need to be adequately compensated.

How sustainable use of forests can contribute to conserving biological diversity

In the past few decades, the values that society attaches to the range of forest goods and services have changed more rapidly and profoundly than ever before. Such trends are expected to continue, if not to accelerate, and call for diverse approaches to forest management. The *State of the World's Forests 2003* explores the relationship between the sustainable use of forests and the conservation of biological diversity.

Forest practices can have different impacts on various components of biological diversity, benefiting some while harming others. Given the variability of natural systems and the lack of any single measure of biological diversity, developing appropriate indicators to help monitor the effects of forest management interventions with a view to improving prevailing practices is a major challenge. Work is under way, however, to design indicators for application at the national and forest management unit levels.

If local people benefit from enterprises that depend on the sustainable use of forest resources, they can reasonably be expected to support the conservation of these ecosystems and the biological diversity contained in them. A study of 39 sites in Asia and the Pacific concluded that a community-based enterprise strategy can indeed lead to conservation, as long as it is linked to external factors such as market access and as long as the enterprise is able to adapt to changing circumstances.

For sustainable forest management to include efficient conservation of biological diversity, both firm government action and alliances with

stakeholders are needed. The exact combination of goods and services to be provided from a particular forested region should take into account balanced resource use on a national scale and should be defined based on dialogue among government, industry, academic institutions, local communities and NGOs.

Science and technology in the forest sector

Improvements in science and technology are critical to the sustainable management of forests and their capacity to meet demand for goods and services. However, resources to maintain and strengthen research capacity are inadequate, with significant imbalances between developed and developing countries; government and industry; and different segments of the forest sector.

In many countries where forests could have a critical role in sustainable development and enhancing livelihoods, there is little research capacity. In addition, investment has traditionally gone towards improving wood production and processing technologies, so that other ecosystem functions and social dimensions, such as poverty alleviation, are often neglected. In many tropical countries, most forestry activities that involve a large number of people are in the informal sector, where there is very little investment in research. This raises the question of how the needs of small enterprises and local communities can be met, given their importance in providing basic goods, creating jobs and generating cash incomes.

If current weaknesses in forest science and technology persist, the gap between developed and developing countries is likely to widen. It will also be difficult to adopt sustainable forest management on a wider scale and to address the growing number of social and environmental issues related to forest resource use. Collaboration through networks can add value to research and development efforts. Some partnerships of this nature are making a positive difference, using limited resources effectively.

Recent trends in fiscal policies in the forest sector in Africa

Public expenditure on forestry in Africa is lower than in other regions, and a lack of available financial resources suggests that sustainable forest management will not be achieved on the continent in the foreseeable future. However, some changes are suggested that might help to improve the situation: stressing the socio-economic benefits of forests; setting forest charges based on market mechanisms; moving towards simpler charges; decentralizing revenue collection and expenditure; sharing costs and benefits with local people; and transferring more control and ownership of forest resources to the private sector, including local communities.

The extent to which sustainable forest management can be financed from private sources depends very much on the profitability and risks associated with investing in the sector. In the few countries in Africa that have well-developed private operations, it may be possible to encourage the private sector to finance a significant portion of investment. However, most production is small-scale and informal, so it is unrealistic to expect producers to finance activities to any great extent. Thus, it seems likely that the public sector and public financing will continue to play an important part in sustainable forest management.

Added to other problems that Africa faces in the forest sector is HIV/AIDS. As more people succumb to the infection, household resources will decline drastically, increasing the dependence on forests. Traditional knowledge and skills will be lost with the deaths of many professionals and technicians. High absenteeism from employment and declining economic productivity will severely limit the capacity to manage forests sustainably, and public investment in forestry will decrease as precious financial resources are diverted to combat the disease.

CONCLUSION

In recent years, despite high rates of deforestation in many regions, progress in

implementing sustainable forest management around the world has been steady and encouraging. However, if the full potential of forests and trees outside forests to provide environmental, economic, social and cultural benefits is to be realized, the pace of further improvements must be more rapid. Scientific and technological advances can do much to bring about required changes, but innovative partnerships within and across sectors are perhaps more critical in the search for meaningful long-term solutions. WSSD witnessed the renewal of commitments, at the highest political level, to restore the health of the planet and to strengthen efforts to achieve sustainable development. The extent to which leaders stand behind the Johannesburg Declaration and translate the Plan of Implementation into action will be a test of their willingness to bring about positive results. ◆

PART I
THE SITUATION AND DEVELOPMENTS IN THE FOREST SECTOR

Forest resources

In 2001, FAO published the Global Forest Resources Assessment 2000 (FRA 2000), the most comprehensive such survey ever undertaken. Largely based on information provided by the countries themselves and a remote sensing survey of tropical countries, it was supplemented by special studies undertaken by FAO. Among the outputs were two new global forest cover maps, estimates of forest cover, deforestation rates and forest biomass for each country, and several specialized studies on such topics as forest management and forest fires. After the release of FRA 2000 (FAO, 2001), an international meeting of experts was convened to review results and plan future steps. The present chapter highlights some of the recommendations arising from these discussions, notes trends pointing to continued deforestation as a result of pressure to increase agricultural production, and reports on the conversion and conservation of mangroves.

GLOBAL FOREST RESOURCES ASSESSMENT

FAO's Global Forest Resources Assessment is designed to serve countries, international processes and the public by providing information that can be used in policy-making, planning and evaluation of progress in achieving sustainable forest management. Forests and trees not only provide wood and non-wood products, but also provide numerous environmental goods and services such as conservation of biological diversity and mitigation of climate change, and they have a key role in alleviating poverty and improving food security. These multiple uses, especially local and gender-specific ones, have in the past been under-represented in forest assessments, and their inclusion will help determine the usefulness of future efforts. Key characteristics of the global assessment are:

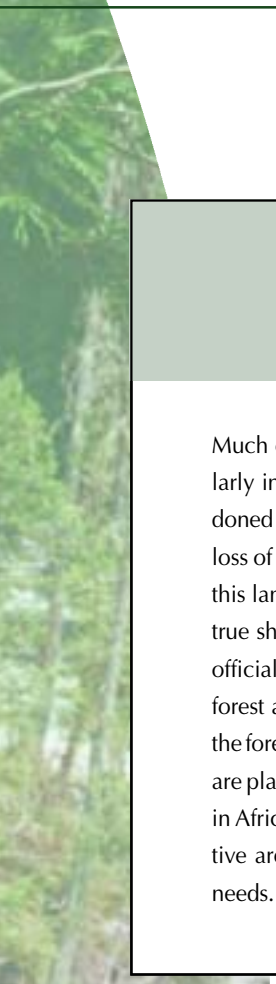
- agreed common sets of definitions for the most important parameters;
- close collaboration among international forest-related processes such as those related to criteria and indicators for sustainable forest management;
- the involvement of countries;
- the neutral role of FAO and its partners in implementation of the assessment.

Several initiatives along these lines have recently been taken: a global and interorganizational process to harmonize forest definitions met twice in 2002; the Collaborative Partnership on Forests (CPF) established a task force on monitoring, assessment and reporting; and steps have been taken to establish an advisory group on the Global Forest Resources Assessment.

More than changes in forest area

Assessments have shown for many years that the area of the world's forests is shrinking. Estimates have become more reliable over repeated assessments, particularly with the recent agreement that FRA 2000 use one definition for forest. According to current estimates (FAO, 2001), 0.38 percent of the world's forests were converted to other land uses (i.e. deforested) every year in the 1990s. At the same time, large areas reverted to forest, leaving a net annual loss of 0.22 percent. While these findings clearly show a substantial loss, particularly in the tropics, it is equally obvious that change in forest area is not the only indicator of the state of the world's forest resources or their capacity to supply goods and services.

Another way to describe declining forest resources is the extent to which they have been degraded (FAO, 2001). For example, poor silvicultural practices may have lowered wood production, unwisely managed harvesting may have led to reduced biological diversity, or overharvesting of fuelwood – in combination with grazing – may have negatively affected soil fertility. However, it is hard to obtain an accurate



Gaps in the forest estate

Much of the agricultural expansion on to forest lands, particularly in the tropics, is temporary, inasmuch as fields are abandoned three or four years after clearing because of a significant loss of nutrients and hence of agricultural productivity. Some of this land remains abandoned forest, while some, in the case of true shifting cultivation, becomes managed forest fallows. The official figures indicating the balance between the removal of forest and reforestation or afforestation miss these additions to the forest estate, as well as the millions of trees outside forests that are planted and tended by rural inhabitants. Many forest fallows in Africa and other tropical regions that appear to be unproductive are in fact well managed to meet a variety of basic local needs.

overall picture of forest degradation without also taking into account improvements that result in increased benefits. In this regard, future assessments will have to delve into aspects related to function, impact and potential, providing much more information than in the past. Weighing different benefits to determine whether the total is increasing or decreasing in a given forest stand therefore becomes an important element in the forest assessment equation. Similarly, there is a need to review the complementarity of products and services from different forest stands at the landscape and national levels. While it is generally agreed that forest degradation is more common than forest improvement in many countries, the lack of systematic data prevents a balanced calculation of positive and negative trends.

Although evaluating trends in local forest stands is a fairly straightforward matter, the challenge is to make such samples representative for a country or the world. It would therefore appear that the solution to complex national or global accounting of forest resources lies in systematic local observation and assessment.

Planning future direction

In July 2002, FAO and several partners convened a global expert consultation on forest assessments in Finland (entitled Global Forest Resources Assessments – Linking National and International Efforts, referred to in short as Kotka IV) to review the results of FRA 2000 and to plan the future direction of FAO global assessments. Among its many recommendations, Kotka IV agreed on the importance of capacity building, especially in developing countries, to increase the quality, timeliness and usefulness of forest inventories and assessments. Kotka IV also concluded that national forest inventories and assessments should be driven by the needs of national policy processes.

In addition, the meeting noted that global forest assessments should continue to be broad, including information on all aspects of forest resources. This means that the wide range of forest goods and services must be assessed and the quantitative and qualitative values of the benefits studied, so far as possible. The provision of industrial wood and conditions for biological diversity, for example, should therefore be reported.

Precedents for assessing all benefits from forests have already been set with the Millennium Ecosystem Assessment, a four-year initiative designed to provide decision-makers and the public with relevant scientific information on the condition of ecosystems, expected consequences of ecosystem change and options for response; and the United Nations Environment Programme (UNEP) Global Environmental Outlook studies which, while focusing on environmental issues, also place trends in the context of forest benefits.

As many countries lack the capacity to conduct systematic assessments and generate the information required to meet policy and planning needs, FAO has a programme to support national forest assessments and build country capacity. The programme focuses on support for systematic field measurements and observations of forests and their use in order to obtain national-level statistics. A balanced use of remote sensing and field sampling is essential, as

is close collaboration among national institutions and the newly established National Forest Programme Facility (see p. 55).

AGRICULTURAL EXPANSION AND DEFORESTATION

Over the years, researchers have identified agricultural expansion as a common factor in almost all studies on deforestation. Indeed, much of the increase in food production has been at the expense of hundreds of millions of hectares of forest. Although there are no solid estimates of how much farm and grazing land was originally under forest, the point remains that a large portion was cleared for agriculture, and that additional land will be cleared in the future. Efforts are therefore under way to gain a better understanding of the relationship between the two sectors.

Added pressure from population increases and growing consumption

Large population increases and growing per capita consumption will place unprecedented strains on resources and present new challenges to the sustainable management of forests, including other wooded land.

- About 50 percent of the world's inhabitants, mostly in developing countries, are likely to suffer malnutrition and poverty in the next 50 years unless technologies to increase current levels of agricultural productivity are developed in time (IIASA and FAO, 2002).
- Capital formation per agricultural worker has remained stagnant or declined in countries where more than 20 percent of the population is undernourished and where agriculture is essential to alleviate poverty and improve food security (FAO, IFAD and WFP, 2002).
- By 2050, the global population is expected to increase by about 3 billion to a total of about 9 billion, with growth occurring primarily in developing countries where the potential to increase arable land is minimal (IIASA and FAO, 2002).
- The net impact of climate change on agriculture in developing countries is expected to be negative and more significant than in industrialized countries (IIASA and FAO, 2002).

Such extreme conditions over the next 50 years are likely to result in significant incentives to expand agriculture, mostly but not entirely on new land cleared through deforestation. In many industrialized countries, however, the area under agriculture is shrinking, and land thus abandoned is being converted to forest.

Relationship between forested and agricultural areas

To shed light on whether there is a clear relationship in the dynamics between forested and agricultural areas, FAO analysed qualitative temporal change trends on the basis of global statistics. However, this analysis excluded the identification of factors that drive agricultural expansion or contraction and the processes that facilitate such changes.

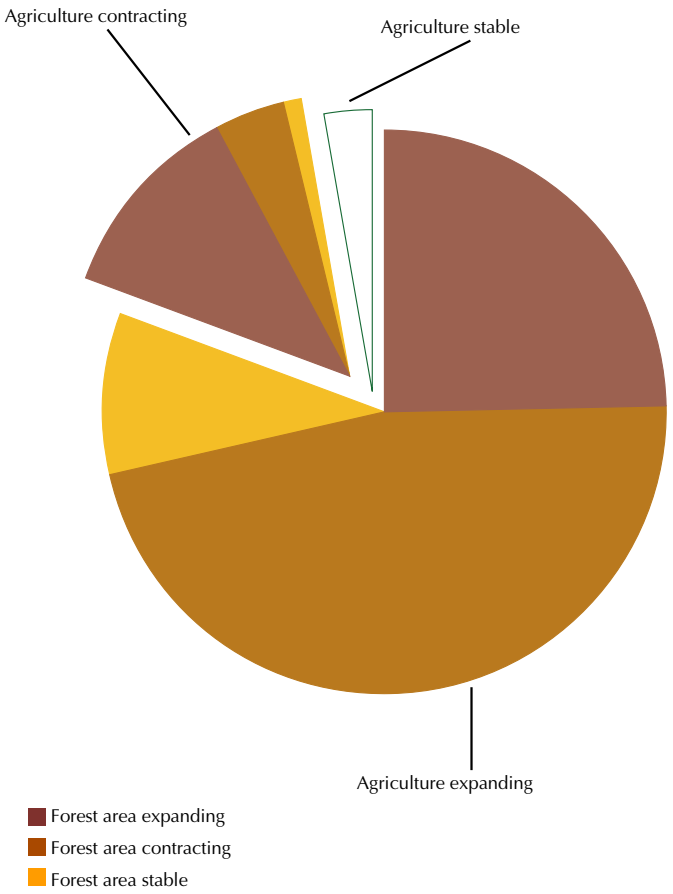
Preliminary findings indicate that agricultural land is expanding in about 70 percent of countries, declining in 25 percent and roughly static in 5 percent (Figure 1).

- In two-thirds of the countries where agricultural land is expanding, forest area is decreasing, but in the other one-third, forests are expanding.
- In 60 percent of the countries where agricultural land is decreasing, forests are expanding. In most of the rest (36 percent), forests are decreasing.

Other wooded lands (shrub and forest fallows) have roughly maintained their share of the land. However, given the dynamic nature of land use, some land might revert to secondary forests over time.

Because other wooded lands may be a buffer for changes in land use, it is important to understand changes in these areas. Integrated assessment and monitoring of trees outside forests is necessary to draw meaningful inferences for wider cross-sectoral policy interventions in the forest, agriculture and environment sectors (IIASA and FAO, 2002). As agricultural expansion into forests seems inevitable (FAO, 2001), a key question for future

FIGURE 1
Expansion and contraction of agriculture and forests: percentage of global area



Forestry and agriculture are inseparable

"It is rightly said that the solution to problems of deforestation and forest land degradation lies outside the forests. ... FAO is fully convinced, based on its many years of experience, that it is essential for forestry and agriculture to work hand in hand."

Dr Jacques Diouf, FAO Director-General
Ministerial Meeting on Forestry,
Rome, 8 to 9 March 1999

sustainable livelihoods, food security and sustainable forest management is the extent to which this buffer can absorb or cushion the expected increase in the demand for agricultural production.

Improved agricultural technology and its impact on forests

It is equally important to recognize that many technological innovations to intensify agricultural production since the green revolution have had a positive impact on forest area. Without them, much more land would be needed to produce today's amounts of wheat, maize, rice and other major food crops.

Indeed, the more agriculture is intensified on a sustainable basis, the less pressure there will be to deforest in order to provide new areas for agriculture. This point has significant implications in terms of forging links among environmental interests, agricultural research and intensification efforts. The following are particularly needed:

- direct policy linkages between forest and agricultural uses of land, perhaps through national or regional land-use policy initiatives;
- new initiatives to support agricultural research, technological development and activities that help bring about sustainable increases in yields per hectare of farmland;
- increased support for forestry research, the development of planted forests and land-use policies that can help to reduce pressure on ancient and fragile forests – areas that are also linked to economic aspects of forest production, industry development and trade.

MANGROVE CONVERSION AND CONSERVATION

Mangroves are found along sheltered coastlines in the tropics and subtropics, where they fulfil important functions in conserving biological diversity and providing wood and non-wood forest products (NWFPs); coastal protection; and habitat, spawning grounds and nutrients for a variety of fish and shellfish, including many commercial species. High population pressure in

Forestry and agriculture face similar challenges

Today, agriculture and the forest sector are more inextricably linked than ever before as they face similar challenges in coping with poverty and food insecurity. While these problems contribute to forest destruction and degradation, the solution for alleviating them and for minimizing the negative impacts of agriculture on the environment involves a complex set of factors, using the best of old and new technologies, innovative ideas and modern institutional arrangements. The sustainable management of forests and trees, including the use of agroforestry and watershed management, is an integral part of the effort to reduce food insecurity, alleviate poverty and improve environmental quality for the rural poor. Technological innovations and new management methods that increase agricultural and forest yields per hectare can also have a significant positive impact on the world's forests.

coastal areas has led to the conversion of many mangrove areas to other uses, including infrastructure, aquaculture, rice growing and salt production. Numerous case studies have described mangrove losses over time. However, information on global-level status and trends is scarce. The first attempt to estimate the total mangrove area in the world was undertaken as part of the FAO/UNEP Tropical Forest Resources Assessment in 1980, when the world total was estimated as 15.6 million hectares. More recent estimates range from 12 to 20 million hectares (Table 1). In many of these studies, countries with small areas of mangroves were excluded because of a lack of information and because their combined area of mangroves would not significantly affect the world total.

A recent initiative by FAO aims at facilitating access to comprehensive information on the past and present extent of mangroves in all the countries and areas in which they exist. This builds on the earlier FAO/UNEP assessment and on the recent FRA 2000, for which all countries were asked to provide information on current forest area according to forest type, using their own classification systems. Because mangroves are a distinct and relatively easily defined forest type, most countries that have mangroves were able to provide information about them.

TABLE 1
Previous estimates of global mangrove area

Reference	Reference year[a]	Number of countries included	Estimated world total *(ha)*
FAO & UNEP, 1981a, b, c	1980	51	15 642 673
Saenger, Hegerl & Davie, 1983	1983	65	16 221 000
FAO, 1994	1980–1985	56	16 500 000
Groombridge, 1992	1992	87	19 847 861
ITTO/ISME, 1993[b]	1993	54	12 429 115
Fisher & Spalding, 1993	1993	91	19 881 800
Spalding, Blasco & Field, 1997	1997	112	18 100 077
Aizpuru, Achard & Blasco, 2000	2000	112[c]	17 075 600

[a] For FAO & UNEP, 1981a, b, c and Aizpuru, Achard & Blasco, 2000, the reference year is the average for all the estimates included, weighted by the area of each estimate. For all other sources, the reference year is the date of the publication(s).
[b] Combined figure from three publications: Clough, 1993; Diop, 1993; and Lacerda, 1993.
[c] New data were provided for 21 countries. For the remaining countries the estimate is based on Spalding, Blasco & Field, 1997.

An extensive literature search yielded additional information. More than 2 800 national and subnational data sets have been collected so far, covering 121 countries and areas where mangroves are known to exist, with the earliest estimates dating back to 1918. The information

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Red mangroves
(Rhizophora mangle)
in the Caribbean

has been analysed with the assistance of mangrove experts throughout the world. One of the results is an updated list of the most reliable, recent estimates for each country, based mainly on inventories or the analysis of remote sensing imagery. Regression analyses based on earlier data provided estimates for 1990 and 1980 and an extrapolated estimate for 2000 to each country. The regional and world totals are shown in Table 2, while Table 3 shows results for individual countries. Three examples of the trend analysis generated from the data are given in Figure 2.

As can be seen from the results, mangrove deforestation is continuing, albeit at a slightly lower rate than in the 1980s. The relatively high mangrove deforestation rates in Asia, the Caribbean and Latin America in the 1980s reflect the large-scale conversion of mangroves for aquaculture and tourism infrastructures. Most countries have now banned the conversion of mangroves for aquaculture purposes and require environmental impact assessments prior to any large-scale conversion of mangroves to other

TABLE 2
Status and trends in mangrove area by region

Region	Most reliable recent estimate		1980 *('000 ha)*	1990 *('000 ha)*	Annual change 1980–1990 *(%)*	2000 *('000 ha)*	Annual change 1990–2000 *(%)*
	('000 ha)	Ref. year[a]					
Africa	3 390	1993	3 659	3 470	-0.5	3 351	-0.3
Asia	6 662	1991	7 857	6 689	-1.5	5 833	-1.2
North and Central America	2 103	1994	2 641	2 296	-1.3	1 968	-1.4
Oceania	1 578	1995	1 850	1 704	-0.8	1 527	-1.0
South America	2 030	1992	3 802	2 202	-4.2	1 974	-1.0
World	**15 763**	**1992**	**19 809**	**16 361**	**-1.7**	**14 653**	**-1.0**

[a] Weighted average of all the countries in the region.

TABLE 3
Status and trends in mangrove area

Country/area	Most reliable recent estimate		1980 *(ha)*	1990 *(ha)*	Annual change 1980–1990 *(%)*	2000 *(ha)*	Annual change 1990–2000 *(%)*
	(ha)	Ref. year					
Africa	**3 390 107**	**1993**	**3 659 322**	**3 469 844**	**-0.5**	**3 350 813**	**-0.3**
Angola	60 700	1992	125 000	71 400	-4.3	59 700	-1.6
Benin	1 700	1989	4 400	1 400	-6.8	1 080	-2.3
Cameroon	227 500	2000	267 000	248 000	-0.7	229 000	-0.8
Comoros	2 600	1976	2 600	2 600	n.s.	2 600	n.s.
Congo	12 000	1995	30 000	20 000	-3.3	11 900	-4.1
Côte d'Ivoire	15 000	1995	89 000	40 000	-5.5	12 700	-6.8
Dem. Rep. of the Congo	22 600	1995	60 600	35 300	-4.2	22 100	-3.7
Djibouti	1 000	1985	1 000	1 000	n.s.	1 000	n.s.
Egypt	482	1998	500	500	n.a.	480	n.a
Equatorial Guinea	25 700	1995	26 700	26 000	-0.3	25 300	-0.3
Eritrea	6 400	1997	6 700	6 500	-0.3	6 300	-0.3
Gabon	115 000	2000	140 000	127 500	-0.9	115 000	-1.0
Gambia	59 600	1993	64 300	61 700	-0.4	59 100	-0.4
Ghana	10 000	1995	12 000	11 000	-0.8	9 000	-1.8
Guinea	296 300	1995	285 000	292 500	0.3	290 000	n.s.
Guinea-Bissau	248 400	1990	245 000	245 000	n.s.	245 000	n.s.
Kenya	52 980	1995	54 400	53 100	-0.2	51 600	-0.3
Liberia	19 000	1995	19 000	19 000	n.s.	19 000	n.s.
Madagascar	325 560	1987	327 000	320 000	-0.2	314 000	-0.2
Mauritania	104	1993	140	112	-2.0	84	-2.5
Mauritius	7	1991	7	7	n.s.	7	n.s.
Mayotte	668	1989	670	670	n.s.	670	n.s.
Mozambique	392 749	1997	402 800	396 600	-0.2	390 500	-0.2
Nigeria	997 700	1995	999 000	998 000	n.s.	997 000	n.s.
Sao Tome and Principe	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Senegal	182 400	1985	175 000	175 800	n.s.	176 700	0.1
Seychelles	2 000	1995	2 400	2 100	-1.3	1 900	-1.0
Sierra Leone	156 500	1986	165 600	150 500	-0.9	135 300	-1.0
Somalia	10 000	1975	9 500	8 500	-1.1	7 500	-1.2
South Africa	673	1991	1 200	720	-4.0	667	-0.7
Sudan	500	1995	605	535	-1.2	465	-1.3
United Rep. of Tanzania	143 284	1987	140 700	152 500	0.8	164 200	0.8
Togo	1 000	1999	1 500	1 300	-1.3	960	-2.6
Asia	**6 661 717**	**1991**	**7 856 500**	**6 689 280**	**-1.5**	**5 832 737**	**-1.3**
Bahrain	100	1992	100	100	n.s.	100	n.s.
Bangladesh	622 482	1992	596 300	609 500	0.2	622 600	0.2

n.a. = not available.
n.s. = not significant.
Notes: The 1980, 1990 and 2000 estimates are based on regression analysis of existing estimates over time for each country extrapolated to 2000. Where insufficient information was available, i.e. only one estimate within the last 30 years (less than 1 percent of the total mangrove area), the area was assumed to have remained constant unless qualitative information indicated otherwise. Where recent information was unavailable (about 5 percent of the total mangrove area), the extrapolation to 2000 was based on the overall forest change rate as reported in FRA 2000 (FAO, 2001) applied to the latest reliable estimate.
For detailed information on methodology, see FAO, 2002a; and FAO, 2002b.
The reference year given for the regional totals of the most reliable recent estimates is the weighted average of all the countries reported.
All primary data sets are available on the Internet at www.fao.org/forestry/mangroves.

Country/area	Most reliable recent estimate		1980 (ha)	1990 (ha)	Annual change 1980–1990 (%)	2000 (ha)	Annual change 1990–2000 (%)
	(ha)	Ref. year					
Brunei Darussalam	17 100	1992	18 300	17 300	-0.5	16 300	-0.6
Cambodia	72 835	1997	83 000	74 600	-1.0	63 700	-1.5
China	36 882	1994	65 900	44 800	-3.2	23 700	-4.7
India	487 100	1997	506 000	492 600	-0.3	479 000	-0.3
Indonesia	3 493 110	1988	4 254 000	3 530 700	-1.7	2 930 000	-1.7
Islam. Rep. of Iran	20 700	1994	25 000	21 000	-1.6	20 000	-0.5
Japan	400	1980	400	400	n.s.	400	n.s
Kuwait	2	2000	n.a.	n.a.	n.a.	2	n.a.
Malaysia	587 269	1995	669 000	620 500	-0.7	572 100	-0.8
Maldives	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Myanmar	452 492	1996	531 000	480 000	-1.0	432 300	-1.0
Oman	2 000	1992	2 000	2 000	n.s.	2 000	n.s.
Pakistan	207 000	1990	345 000	207 000	-4.0	176 000	-1.5
Philippines	127 610	1990	206 500	123 400	-4.0	109 700	-1.1
Qatar	500	1992	500	500	n.s.	500	n.s
Saudi Arabia	20 400	1985	20 400	20 400	n.s.	20 400	n.s
Singapore	500	1990	2 700	500	-8.1	500	n.s.
Sri Lanka	8 688	1992	9 400	8 800	-0.6	7 600	-1.4
Thailand	244 085	2000	285 500	262 000	-0.8	244 000	-0.7
Timor-Leste	3 035	2000	4 100	3 600	-1.2	3 035	-1.6
United Arab Emirates	4 000	1999	3 300	3 600	0.9	4 000	1.1
Viet Nam	252 500	1983	227 000	165 000	-2.7	104 000	-3.7
Yemen	927	1993	1 100	980	-1.1	800	-1.8
North and Central America	**2 102 886**	**1994**	**2 641 289**	**2 296 400**	**-1.3**	**1 968 397**	**-1.4**
Anguilla	90	1991	90	90	n.s.	90	n.s.
Antigua and Barbuda	1 175	1991	1 570	1 200	-2.4	900	-2.5
Aruba	420	1986	420	420	n.s.	420	n.s.
Bahamas	141 957	1991	170 000	145 000	-1.5	140 000	-0.3
Barbados	14	1991	30	16	-4.7	10	-3.8
Belize	65 767	1995	75 000	68 800	-0.8	62 700	-0.9
Bermuda	16	1992	17	16	-0.6	15	-0.6
British Virgin Islands	587	2001	660	630	-0.5	590	-0.6
Cayman Islands	7 268	1991	7 300	7 300	n.s.	7 200	n.s.
Costa Rica	41 330	1992	41 000	41 000	n.s.	41 000	n.s.
Cuba	529 700	1992	530 500	529 800	n.s.	529 000	n.s.
Dominica	10	1991	40	13	-6.8	9	-3.1
Dominican Republic	21 215	1998	33 800	26 300	-2.2	18 700	-2.9
El Salvador	26 800	1994	47 200	35 600	-2.5	24 000	-3.3
Grenada	255	1992	295	262	-1.1	230	-1.2
Guadeloupe	2 325	1997	3 900	2 500	-3.5	2 300	-0.8
Guatemala	17 727	1998	19 800	17 800	-1.0	15 800	-1.1
Haiti	15 000	1990	17 800	15 000	-1.6	10 000	-3.3
Honduras	54 300	1995	156 400	103 300	-3.4	50 000	-5.2
Jamaica	9 731	1997	23 000	10 800	-5.3	9 300	-1.4
Martinique	1 840	1998	1 900	1 900	n.s.	1 800	n.s.
Mexico	488 000	1994	640 000	543 000	-1.5	440 000	-1.9
Montserrat	5	1991	5	5	n.s.	5	n.s.
Netherlands Antilles	1 138	1980	1 140	1 138	n.s.	1 130	n.s.
Nicaragua	282 000	1992	336 000	280 000	-1.7	214 300	-2.3

Country/area	Most reliable recent estimate		1980 (ha)	1990 (ha)	Annual change 1980–1990 (%)	2000 (ha)	Annual change 1990–2000 (%)
	(ha)	Ref. year					
Panama	158 100	2000	230 000	166 000	-2.8	158 000	-0.5
Puerto Rico	6 410	2001	6 500	6 400	-0.2	6 400	n.s.
Saint Kitts and Nevis	79	1991	84	80	-0.5	75	-0.6
Saint Lucia	200	2002	200	200	n.s.	200	n.s.
Saint Vincent and Grenadines	51	1991	60	52	-1.3	45	-1.3
Trinidad and Tobago	7 150	1991	9 000	7 200	-2.0	6 600	-0.8
Turks and Caicos Islands	23 600	1991	23 600	23 600	n.s.	23 600	n.s.
United States	197 648	2001	263 000	260 000	-0.1	203 000	-2.2
United States Virgin Islands	978	1991	978	978	n.s.	978	n.s.
Oceania	**1 577 967**	**1995**	**1 850 068**	**1 703 949**	**-0.8**	**1 526 924**	**-1.0**
American Samoa	52	1976	51	50	-0.2	50	n.s.
Australia	955 277	1997	1 150 000	1 050 000	-0.9	955 000	-0.9
Fiji	42 464	1991	47 000	43 000	-0.9	37 000	-1.4
Guam	70	1993	88	74	-1.6	60	-1.9
Kiribati	258	1995	260	260	n.s.	250	n.s.
Marshall Islands	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Micronesia	8 564	1983	8 500	8 500	n.s.	8 500	n.s.
Nauru	1	1993	2	1	-5.0	1	n.s.
New Caledonia	20 250	1987	20 500	20 100	-0.2	20 000	n.s.
New Zealand	22 200	1996	24 000	22 000	-0.8	19 900	-1.0
Niue	3 000	1981	3 000	3 000	n.s.	3 000	n.s.
Northern Mariana Islands	7	1984	7	5	n.s.	5	n.s.
Palau	4 708	1985	4 700	4 700	n.s.	4 700	n.s.
Papua New Guinea	464 000	1993	525 000	492 000	-0.6	425 000	-1.4
Samoa	752	1993	1 000	809	-1.9	618	-2.4
Solomon Islands	52 500	1995	61 200	55 400	-0.9	49 500	-1.1
Tokelau	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Tonga	1 305	1990	1 300	1 300	n.s.	1 300	n.s.
Tuvalu	40	1993	60	50	-1.7	40	-2.0
Vanuatu	2 519	1993	3 400	2 700	-2.1	2 000	-2.6
Wallis and Futuna Islands	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
South America	**2 030 330**	**1992**	**3 801 600**	**2 202 000**	**-4.2**	**1 974 300**	**-1.0**
Brazil	1 012 376	1991	2 640 000	1 150 000	-5.6	1 010 000	-1.2
Colombia	379 954	1996	440 000	396 600	-1.0	354 500	-1.1
Ecuador	149 688	1999	193 000	166 400	-1.4	147 800	-1.1
French Guiana	55 000	1980	55 000	55 000	n.s.	55 000	n.s.
Guyana	80 400	1994	91 000	83 400	-0.8	76 000	-0.9
Peru	4 791	1992	7 600	5 000	-3.4	4 700	-0.6
Suriname	98 121	1998	115 000	105 600	-0.8	96 300	-0.9
Venezuela	250 000	1986	260 000	240 000	-0.8	230 000	-0.4

n.a. = not available.
n.s. = not significant.
Notes: The 1980, 1990 and 2000 estimates are based on regression analysis of existing estimates over time for each country extrapolated to 2000. Where insufficient information was available, i.e. only one estimate within the last 30 years (less than 1 percent of the total mangrove area), the area was assumed to have remained constant unless qualitative information indicated otherwise. Where recent information was unavailable (about 5 percent of the total mangrove area), the extrapolation to 2000 was based on the overall forest change rate as reported in FRA 2000 (FAO, 2001) applied to the latest reliable estimate.
For detailed information on methodology, see FAO, 2002a; and FAO, 2002b.
The reference year given for the regional totals of the most reliable recent estimates is the weighted average of all the countries reported.
All primary data sets are available on the Internet at www.fao.org/forestry/mangroves.

FIGURE 2
Mangrove area changes over time – three examples

uses. The study did not provide information on the rate of mangrove degradation.

Another valuable source of information on mangroves is the Global Mangrove Database and Information System created by the International Society for Mangrove Ecosystems with support from the International Tropical Timber Organization (ITTO). It contains information on institutions, projects and people working with mangroves, as well as an extensive database on mangrove-related documents. See www.glomis.com for details.

Other developments include:

- ITTO's Mangrove Workplan 2002–2006, which was presented to the International Tropical Timber Council (ITTC) in May 2002 to support the sustainable management and conservation of mangrove forest ecosystems over the next five years;
- a workshop organized by the South Pacific Regional Environment Programme, held in Fiji in 2001, which identified key threats to mangrove wetlands in the Pacific islands and actions to address these;
- a meeting in Guatemala in August 2002 to consider how to incorporate the evaluation of the goods and services provided by mangroves into national and regional mangrove management strategies, along with mechanisms to pay for environmental services and provide for broader public participation in mangrove management. ◆

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Management, conservation and sustainable development of forests

As forests are complex ecosystems requiring balanced and sustainable management, one of the main challenges today is to reconcile the often conflicting priorities of those who depend on them for a whole range of goods and services. It is also necessary to take into account the ways in which forests affect and are affected by policies outside the forest sector. Such a comprehensive approach requires innovative partnerships and better linkages at all levels and across sectors. Indeed, this imperative has never been greater, as demonstrated by the examples in this chapter.

A summary of six case studies in developing countries with low forest cover shows that various government departments, organizations and other interested parties need to work together to resolve issues related to planted trees in arid and semi-arid zones, in urban as well as rural areas. In 2002, the International Year of Mountains drew attention to the contributions that mountain forests make to hundreds of millions of people, and the forestry community welcomed a new international alliance for sustainable mountain development. The chapter also highlights integrated management plans for forests in the Mediterranean basin, which have long called for the involvement of stakeholders in their development and implementation. Forest fire management around the world also requires collaborative approaches, and international interest in coordinating responses and sharing personnel and equipment in emergency situations is growing. Solutions to unsustainable hunting in tropical forests, especially in Africa, are being sought through a number of collaborative arrangements. Lastly, in the context of international agreements on climate change, in which the unique role of forests is recognized, partnerships between and among countries from the North and the South are the basis on which Joint Implementation and the Clean Development Mechanism are built.

ROLE OF PLANTED TREES IN DEVELOPING COUNTRIES WITH LOW FOREST COVER: FINDINGS FROM SIX CASE STUDIES

Deforestation and forest degradation, coupled with difficult ecological conditions in several parts of the world, have seriously reduced forest cover in many countries. The situation is exacerbated where low rainfall slows regeneration and reforestation and where forest land is subject to pressures from shifting cultivation, livestock grazing and the uncontrolled gathering of fuelwood. In developing countries, natural and planted forest land is critical to rural communities, and the loss of forest productivity and biological diversity is a serious threat to livelihoods and the quality of life.

FAO's Global Forest Resources Assessment 2000 (FRA 2000) estimated that 56 countries are low forest cover countries (LFCCs), having less than 10 percent of their area classified as forest (Table 4). In contrast, the global forest area is almost 30 percent of total land area (FAO, 2001a). LFCCs, which are found primarily in arid and semi-arid zones of Africa and the Near East, often reflect severe ecological degradation that directly affects people's lives. The LFCCs have a total land area of 2 726 million hectares and a total population of about 900 million, of which 64 percent lives in Asia. Of these 56 countries, only 13 have more than 0.1 ha of forest per capita. However, low

forest cover does not always coincide with country borders, so the problem might be more widespread. In addition, some countries, such as China, have more than 10 percent forest cover yet a low area of forest per person.

In LFCCs in Africa, Asia and the Near East, planted forests account for only a small proportion of the forest cover. Algeria, Bangladesh, Ireland, the Islamic Republic of Iran, Morocco, Pakistan, South Africa and Uruguay are the only countries with more than 500 000 ha of planted forests and trees, whereas half the countries have less than 10 000 ha. Most tree planting programmes were started between 1960 and 1980, although in Denmark, Ethiopia and South Africa large-scale efforts began earlier. The annual new planting rate is substantially higher in Asia and the Near East than in Africa, but there is considerable variation among countries. Only ten of the developing countries plant 10 000 ha or more per year.

Many LFCCs in the developing world, particularly those in arid zones, rely on trees to prevent erosion, halt desertification and protect biological diversity, crops, settlements and watersheds. In addition, their rural populations depend on trees for fuel, poles, construction wood and a range of non-wood forest products (NWFPs) such as fodder, food and medicine. In these countries, there is little potential for producing industrial wood, so it is nearly impossible to fund development of the sector from the sale of wood.

Case studies

In 2002, regional workshops were held in the Near East (Iran) and Africa (Kenya) to develop strategies, action plans and proposals to enhance the role of planted forests and trees outside forests in LFCCs. In preparation for the workshops, visiting FAO teams undertook case studies in six countries in Africa and the Near East: Ethiopia, Iran, Mali, Namibia, Oman and Tunisia. The case studies (to be published in 2003) focused on countries where problems were the most serious because of dry climate and low forest cover. Ethiopia, Iran and Mali are representative of large countries, Namibia is medium-sized, and Oman and Tunisia are relatively small. Ethiopia is densely populated,

TABLE 4

Estimated planted forest areas and annual planting rates in low forest cover countries, by region[a]

Region	Number of countries	Total land area *(million ha)*	Total forest[b] *('000 ha)*	% forest cover	Planted forests[c]		Annual planting *('000 ha)*
					('000 ha)	*(% of total forest area)*	
Africa	20	1 407	55 985	4.0	3 739	6.7	85
Asia and Oceania[d]	27	1 238	46 067	3.7	4 976	10.8	141
Americas	5	57	1 503	2.7	656	43.6	53
Europe	4	24	1 470	6.0	944	64.2	n.a.[e]
Total	**56**	**2 726**	**105 025**	**3.9**	**10 315**	**9.8**	

[a] Low forest cover countries are defined as those countries with less than 10 percent of their land area under forest.
[b] Forest land is defined as having more than 10 percent crown cover and an area of more than 0.5 ha, and excludes land predominantly used for agriculture.
[c] Planted forests do not include plantations of less than 0.5 ha in area or less than 20 m in width, and thus some agroforestry plantings and trees outside forests are excluded.
[d] Includes the Near East, Asia and the Pacific.
[e] Not available.
Source: FAO, 2001a.

very rural and very poor. At the other extreme, Oman is largely urban and the people are wealthier. Arid and semi-arid climates dominate, although different types of climate do exist within each country. All the countries have deserts, and animal herding on rangeland is more common than agriculture.

Each case study outlined the causes and effects of forest degradation, described lessons and proposed strategies and methodologies to address issues. This section summarizes the main findings and observations (Table 5).

Findings: common features and issues

Environmental degradation. Although not always well documented, the six countries studied had all experienced substantial deforestation, forest and soil degradation and an increase in the area of bare land over the years. The need for fuelwood and grazing is the main cause of forest degradation, frequently leading to loss of forest cover and biological diversity, erosion, desertification and reduced water resources. The situation is especially serious in the countries with large rural populations and high birth rates (Ethiopia, Mali and Namibia). In all the countries except Oman, the herding of animals on rangelands that are often partly forested is a major land use. Rural populations rely on forests and woodlands for energy and fodder rather than for timber. These resources are also important for poles, craft materials, shade and NWFPs such as fruits and medicine. In addition, they support wildlife, hunting and tourism, and are rich in biological diversity.

Forest resources assessment data. The lack of reliable data on natural and planted forests, except in Tunisia, poses a significant constraint to formulating and implementing national forest policies and plans, and to monitoring and reporting current conditions and trends. Until data are improved, analysis of future scenarios may not provide a true assessment of the potential of planted forests.

Change in forest cover. Tunisia was the only country to increase its forest cover (+ 0.2 percent) between 1990 and 2000 (FAO, 2001a). The annual loss in Ethiopia, Mali and Namibia was 0.7 to 0.9 percent, while in Iran and Oman there was no substantial change. Except possibly in Tunisia and Iran, natural forests were under serious threat. In this regard, the studies noted the need to conserve and protect representative samples of natural ecosystems and unique forest types.

TABLE 5
Data for the six low forest cover countries studied

Country	Land area ('000 ha)	Total forest ('000 ha)	Forest (%)	Annual forest cover change		Planted forest ('000 ha)	Population per km²	Rural population (%)	GNP per capita (1997 US$)	Predominant climate
				('000 ha)	(%)					
Ethiopia	110 430	4 593	4.2	-40	-0.8	216	61.1	83	112	Arid to temperate
Iran	162 201	7 299	4.5	n.s.	-	2 284	41.2	39	1 581	Continental/arid
Mali	122 019	13 186	10.8	-99	-0.7	15	9.0	71	259	Arid to semi-arid
Namibia	82 329	8 040	9.8	-73	-0.9	0.3	2.1	60	2 196	Arid to semi-arid
Oman	21 246	1	0	n.s.	-	1	11.6	18	9 500	Primarily arid
Tunisia	16 362	510	3.1	+1	+0.2	202	60.9	35	2 092	Mediterranean

n.s. = not significant.
Source: FAO, 2001a and FAO, country case studies (in preparation).

FAO/15859/R. FAIDUTTI

Millet cultivation under **Acacia albida** *in Mali's parkland agroforestry – the trees improve nutrient cycling and alter microclimate, increasing crop production while providing fuelwood, fodder, pods and shade for animals*

Role and extent of planted forests. The areas of planted forests in Ethiopia, Mali, Namibia and Oman are small compared with the size and needs of these countries. Both farmers and the public sector plant forests for non-industrial uses, primarily fuelwood and poles, but the survival and productivity of the trees are often low. While the current expansion of planted forests is about 2 000 and 700 ha per year in Ethiopia and Mali, respectively (FAO, 2001a), it does not compensate for the loss of natural forests.

In Tunisia, the loss of forest area has largely stabilized as a result of forest planting, other land management changes and a decreasing rural population. The difficulty in distinguishing between planted and natural forests for some native species and the lack of a recent inventory mean that the total area of planted forests is not known. However, the annual planting rate is estimated at about 14 000 ha.

Planted forests in Iran cover 2.3 million hectares and are expanding at 63 000 ha per year. They include a wide variety of indigenous and introduced hardwood species. Industrial purposes account for about 10 percent of the total, with the remainder used for environmental protection, soil stabilization, fuelwood and poles. As a result of the government's promotion of fast-growing industrial planted forests, the area of poplar plantations is estimated at between 110 000 and 150 000 ha (FAO, 2000a).

Role of trees outside forests. Trees outside forests take a variety of forms, with agroforestry, village and urban plantings, roadside plantings and orchards being the most widespread.

Between 1986 and 2000, Mali's agrosilvicultural and silvipastoral activities consisted of the planting of 4 000 km of shelterbelts, 14 000 ha of woodlots and 5 000 ha around water points and in pastures. Mali is also noted for its parkland agroforestry based on natural trees, a formation that covers 39 percent of the country. In traditional Sahelian parklands, millet and sorghum are often grown with *Acacia albida*. On these infertile soils, production of crops grown within a 5- to 10-m radius of the trees has doubled or trebled over that of crops grown in the open, because of improved nutrient cycling and a changed microclimate. In addition to increasing crop yields, the trees provide fuelwood, fodder, pods and shade for animals during the dry season. There are also extensive areas of other parkland systems in Mali where indigenous trees such as karité (*Vitellaria paradoxa*) produce oil, while *Acacia senegal* produces gum arabic.

Namibia has similar parkland systems. In the north, where most people live, trees that produce fruits, oils, nuts, medicinal products or craft materials also improve soil fertility or provide shade, and are therefore often left standing in agricultural fields. Law and customary practice acknowledge their importance, imposing penalties and fines on people who cut them down. In addition, shade and fruit trees are planted around homesteads and farm woodlots

and as living fences. The Directorate of Forestry is currently promoting tree planting in woodlots.

In Tunisia, agroforestry practices include the planting of *Acacia*, *Atriplex* and *Medicago* species for browse and forage within and beyond forest areas, and the planting of windbreaks, which were protecting around one-eighth of irrigated agricultural land by 2000. Emphasis is also being placed on planting multipurpose species (such as walnut, pistachio, pecan, hazel and carob), particularly in mountainous areas and in forest clearings.

Establishing woodlots in villages and near urban centres relieves pressure on natural forests for fuelwood, poles and fodder. In cities, tree planting is stressed for aesthetic and recreational benefits. While urban, peri-urban and roadside planting is promoted in all the countries studied, Tunisia has perhaps been the most active. Initiatives include establishing a green belt around Tunis, creating parks, lining boulevards and motorways, planting coastal esplanades and implementing a national programme for heritage trees.

In Mali, about 22 000 ha of plantations have been established in villages and urban areas since 1986, and there has been additional planting along roadways. Iran has been active as well, with a network of urban and peri-urban planted forests and parks. Often, however, problems arise when irrigation cannot be sustained in the long term because of water shortages. The use of treated wastewater from cities is therefore seen as an opportunity for urban and peri-urban tree planting in several countries.

Combating desertification. Combating desertification is a major objective for all the countries, with Iran and Tunisia seeming to make the most progress. Iran has established 140 desertification control stations since 1963. Now, after 40 years of concerted effort, it reports that it has controlled one-fifth of its seriously affected lands. In Tunisia, 17 200 ha of planted forests were established to fix dunes between 1990 and 1999, with an additional 5 700 ha planted as windbreaks and shelterbelts.

Institutional capacity and national planting plans. Problems of poor records and underfunded government institutions without clear strategies to address forest issues were particularly noticeable in Ethiopia and Oman. Tunisia, on the other hand, is aiming to plant 70 million trees annually, and Iran also has a major planting programme. Namibia, independent only since 1990, has developed bold forest policies and legislation advocating tree planting and recognizing the role of forests and woodlands. Mali has a relatively small planting programme, preferring to focus on managing natural forests.

Centralized decision-making, restricted landownership and a lack of research are other common issues identified in the countries studied. In addition, it was noted that several agencies sometimes deal with the same problems in an uncoordinated manner, thereby hindering results.

Planting trees enhances urban environments

In the next three decades, rapid urban population growth will become a major issue, possibly affecting more than 50 percent of the African and Asian population and 75 to 80 percent of people living in Central and South America (FAO, 1999a). This fast expansion, often on erosion-prone hillsides or in swampy areas, means that most settlers live in poor conditions and face food insecurity, lack of clean drinking-water, inadequate energy for domestic use, shortage of construction materials, air pollution and unsanitary disposal of waste and sewage.

Since the quality of the urban environment is closely linked to the economic and social regeneration of cities, tree planting for amenity brings several benefits, with beautification stimulating outside investment, business development and, hence, employment. Using treated sewage water for tree planting also improves urban environments. While wastewater storage and disposal problems are reduced, the planting protects reservoirs from erosion and siltation, stabilizes hilly or sloping urban areas, provides additional green spaces and generates income. Notable improvements to the environment and human health can thus be achieved.

Lessons

The following observations are based on the case studies.

- The loss and degradation of forests and woodlands and subsequent soil erosion and desertification are largely the result of human activities, aggravated by arid and semi-arid conditions and compounded by the many rural and poor people who depend on scarce natural resources, have large animal herds and use fuelwood in an unmanaged way. Water scarcity and unpredictable droughts add to the problem.
- Strong government policies, strategies and institutions are required, in addition to a decentralized approach, and need to be supported by competent and knowledgeable personnel.
- Intersectoral and interdisciplinary approaches are needed to address problems of forest loss and environmental degradation that are not solely forestry driven but result from such factors as demographic changes, competing land uses (e.g. grazing and agriculture), lack of alternative income, food insecurity and low levels of education.
- Participatory processes, emphasizing the needs of local people and traditional knowledge, are essential.
- Planting new forest resources or regenerating and sustainably managing natural forests and woodlands will reduce pressure for fodder and fuel, as well as possibly providing or diversifying household income and improving the environment.
- Planting trees on farms (agroforestry) and other activities outside forests offer employment opportunities and immediate benefits to smallholders and the rural poor for subsistence, provide refuges for wildlife, improve the local climate and enhance landscapes.
- Programmes to plant trees, coupled with efforts to reduce the impoverishment of forests, can stabilize and reverse deforestation and degradation in arid climates. Two of the six countries studied, Tunisia and Iran, illustrate this point well.
- Large government planting programmes can be successful, but this approach alone will not necessarily assist the rural poor or solve the problem of overgrazing in forests or rangelands. In this regard, agroforestry practices and community planting programmes, coupled with improved animal and crop management, are very important.
- In addition to participatory approaches, families and communities need to have secure land tenure and to benefit from planting trees. Farmers will seldom plant trees for fuelwood alone, as there are usually other immediate energy alternatives. They are far more likely to be interested if they know that they will also draw benefits in the form of food, fodder, shelter, shade or income.
- In arid and semi-arid environments, planting trees can be difficult and costly. Labour shortage can also be a constraint, since the planting period usually coincides with that in the agricultural sector. Tunisia and Iran have shown that land can be rehabilitated by planting trees, but planted trees currently have a minor role in the other countries studied.

In Tunisia, forest planting at the rate of about 14 000 ha per year has helped stabilize and reverse deforestation and degradation

FAO/13985/I.ISAAC

The way forward

The following suggestions, among others, may help to improve the contribution of trees to the environment and to sustainable livelihoods in developing countries with low forest cover.

- Integrated and holistic approaches must be implemented in order to reduce pressure on forest and range resources. The planting of trees, whether as forests or tree clusters, is part of the solution, as are the regeneration and management of natural forests.
- With regard to providing rural people with an alternative income, approaches include large-scale planted forests for industrial purposes, commercial orchards, small-scale projects for NWFPs and tourism.
- Most LFCCs need better information on the status of their resources so that they can monitor change and develop integrated

Urban forest watershed management: an example of partnership

TreePeople, a non-profit organization based in Los Angeles, United States, demonstrates the benefits of partnerships in providing cities with sustainable water supplies. The following is TreePeople's account of a successful project to help Los Angeles meet half of its water needs through urban watershed management, while at the same time improving the quality of life. The project builds on ten years of research, design, cost-benefit analysis, demonstration projects and multistakeholder processes.

FLAWS IN TRADITIONAL MANAGEMENT OF INFRASTRUCTURE SYSTEMS

Most cities were not designed, organized or managed as part of the natural ecosystem. Water supply, wastewater, solid waste and storm water infrastructure systems are managed by separate government agencies that typically do not coordinate operations. As cities expand, these systems often grow further apart, compete for scarce funds and unwittingly undermine each other's efforts as they struggle individually to cope with increased flooding, polluted storm water runoff and water shortages. As the problems and costs accrue, solutions become increasingly elusive and fewer resources are available to meet other social needs. Through integrated approaches based on the urban forest watershed, cities can achieve environmental, economic and social sustainability.

Los Angeles is seeking technical and economically feasible solutions for the range of problems associated with urban infrastructure management. An average annual rainfall of 15 inches (381 mm) provides the city with up to half the water it needs for the year. However, because nearly three-quarters of its area has been rendered impermeable by sprawl (buildings, parking lots, paving) and building codes require all runoff to be directed to storm drains, more than 85 percent of the city's rainfall has become a toxic and dangerous flood threat. To deal with this, various agencies planned separate construction projects which would have totalled more than US$20 billion but did not, taken together, offer sustainable solutions.

A PARTNERSHIP APPROACH

In 1992, TreePeople proposed using watershed management practices to resolve these problems, but the proposal was rejected as too expensive for the single purpose of flood control. To counter the fact that relevant agencies did not have the tools or the authority to take into account such additional benefits as water supply, pollution prevention, energy conservation and economic development, TreePeople assembled a multi-agency partnership in 1994, consisting of the United States Forest Service, the Los Angeles Department of Water and Power, the Los Angeles Stormwater Management Division, the United States Environmental Protection Agency, the Metropolitan Water District, the City of Santa Monica and the Los Angeles County Flood Control District. The project, known as the Trans-agency Resources for Environmental and Economic Sustainability (TREES), designed best management practices to overhaul and manage the city's use of watersheds, tested the technical viability of the designs through pilot projects, created a cost-benefit modelling tool and conducted a cost-benefit analysis, and then applied the results more broadly.

RESULTS OF AN INNOVATIVE APPROACH

The information and demonstrations of the TREES Project resulted in substantial changes in Los Angeles public works agencies and

management policies and plans. Tunisia has made the most progress in this regard, and its approach could be used as a model for others.

- Countries with similar problems need to share experiences and adapt approaches to local conditions. Both Tunisia and Iran offer insights here, as do Australia, South Africa and the United States. The expertise of international agencies such as FAO, the United Nations Environment Programme (UNEP), the World Agroforestry Centre (ICRAF) and the Center for International Forestry Research (CIFOR) should also be tapped.
- An alternative to using scarce irrigation water, especially in urban and peri-urban planting programmes, is to utilize treated wastewater from cities. FAO (2001b) is a good source of information for arid countries, drawing from its own experience and that of current projects in Egypt, Jordan, Kuwait and Yemen.

local policies. By 2000, the Los Angeles County Flood Control Agency had changed its name to the Watershed Management Division, reflecting its changed mission. The City of Los Angeles followed suit a year later, transforming its Stormwater Management Division into the Watershed Protection Division.

The TREES Project was awarded a contract to remodel a 1 100-ha 8 000-household urban subwatershed of the Los Angeles River. After a lengthy feasibility study, the Los Angeles County Watershed Management Division is developing the management plan, environmental impact documents and large pilot projects for the Sun Valley watershed. Engineers originally planned to build a US$42 million storm drain to combat one of the county's largest and most intractable flooding problems. Instead, the new urban forest watershed may cost as much as US$100 million, but can produce in excess of US$400 million in benefits, including nearly US$180 million in conserved water, 370 new jobs, energy savings, cleaner air and "green" schools. Best management practices under consideration include capturing, cleaning and infiltrating storm water in such locations as parks, schoolyards, commercial parking areas and, potentially, the lawns of individual homes.

Successful implementation of the Sun Valley watershed scheme requires an extensive multi-agency partnership to design, fund, manage and monitor the project. It also requires a new spirit of collaboration among government, individuals, families, businesses and community organizations. Recognizing this, Los Angeles County is committed to the stakeholder planning process and is conducting an unprecedented community education and outreach programme.

Further information on TreePeople and its projects can be found on the Internet: www.treepeople.org.

The greening of the paved grounds of an elementary school near Los Angeles, California

TREEPEOPLE

A meeting of LFCCs in Tehran in 1999 (FAO, 2000b) emphasized the need for concerted action, government commitment and collaboration among countries with similar problems. The declaration establishing the Tehran Process calls for increased investment from within the region, the donor community and international agencies. It also suggests that non-governmental organizations (NGOs), the private sector, research and training institutions and the rural poor could have a positive role, especially at the local level. The Tehran Process has much potential to make a real difference in the future, particularly if efforts are geared to national forest planning, forest management and planting programmes aimed at increasing forest cover and meeting the needs of rural people.

MOUNTAIN FORESTS AND SUSTAINABLE MOUNTAIN DEVELOPMENT

Twenty-eight percent of the world's closed forests are mountain forests (FAO, 2001a) (see Table 6), and their importance for sustainable mountain development is increasingly recognized. Indeed, mountain issues are receiving more attention than ever as a result of the observance of the International Year of Mountains in 2002.

As part of highly complex ecosystems, including watersheds, mountain forests capture and store rainfall and moisture, maintain water quality, regulate river flow, reduce erosion and protect against landslides, avalanches, falling

International Year of Mountains: building partnerships

In 1998, the United Nations General Assembly declared 2002 the International Year of Mountains and invited FAO to be the lead agency in preparing and coordinating activities to:

- increase awareness of and knowledge about mountain ecosystems;
- encourage conservation and sustainable development of mountain resources;
- promote and defend the cultural heritage of mountain communities;
- find solutions to the conflicts that frequently arise in mountain areas.

At the World Summit on Sustainable Development in 2002, the Government of Switzerland, on behalf of several countries, UNEP and FAO, launched the International Partnership for Sustainable Development in Mountain Regions. Its objectives are to promote and strengthen cooperation among donors, implementing agencies, NGOs, the private sector, mountain communities and others. Operating on the basis of common goals, commitments and priorities, the partnership addresses such issues as poverty, conservation of biological diversity, food security and key institutional concerns. FAO has been active in the partnership since its inception, and also organized a satellite meeting during the 2002 World Food Summit: five years later conference, at which participants formally declared their support.

Further information on the International Year of Mountains and the partnership can be found on the Internet at www.mountains2002.org.

FAO FORESTRY DEPARTMENT/FO-0279/T. HOFER

The Himalayas in Nepal

TABLE 6
Mountain forest types by area and by dominant region

Mountain forest types	Total area		Main regions
	('000 km²)	*(%)*	
Tropical and subtropical moist mountain forests	2 237	25	Tropical Andes, Central America, East Africa and Madagascar, Southeast Asia
Tropical and subtropical dry mountain forests	534	6	Southern Africa, India
Temperate and boreal evergreen conifer mountain forests	2 762	30	North America, Europe, Central Asia, Himalaya
Temperate and boreal deciduous conifer mountain forests	1 317	14	Central Asia, Northeast Asia
Temperate and boreal broad-leaved and mixed mountain forests	2 247	25	North America, southern Andes, Europe, Himalaya, East Asia
Total	**9 097**	**100**	

Source: UNEP-WCMC, 2000.

rocks and floods. They often have higher biological diversity and endemism than adjacent lowland forests, although the value of this has not yet been fully understood. On the other hand, mountain forests are sensitive to fluctuations in climate, which could influence – both positively and negatively – their capacity to continue providing important services to mountain inhabitants and hundreds of millions of people living downstream. Hence there is a need to improve understanding of possible climate changes so that planning for the potential impact can begin.

In mountain communities, forests are often part of multiple land-use systems as pastures and sources of organic material for agriculture. In many mountain areas, particularly in developing countries, wood is the main fuel source for local inhabitants as well as for people in nearby settlements in the foothills and plains. Mountain forests also provide NWFPs and recreational facilities, and add to the scenic beauty of landscapes, national parks and protected areas. In many regions, they also enshrine sacred groves and trees, and are thus culturally important.

In many industrialized countries, mountain forests consist of overmature planted species that are underexploited today because fuelwood has been replaced by other sources of energy and because they are not economically viable to harvest. As a result, the vitality of these forests is reduced and their protective function impaired. In many developing countries, the opposite holds true: forests are overexploited because of high demand for fuelwood and agricultural land, unsustainable forest practices and the excessive granting of timber concessions.

Mountain forests need to be managed as an integral part of mountain ecosystems, and the involvement of local communities is essential. There are a number of examples, particularly in mountainous parts of Europe, where community forestry has been practised for centuries, creating employment and generating income. Today, community forestry is also being implemented successfully in the mountain areas of many developing countries.

As a major event of the International Year of Mountains, the Fourth International Consultation on Mountain Forests was held in Navarra, Spain, in June 2002. One of its main conclusions was that the fate of mountain forests often depends on government policies and incentives in other sectors, such as agriculture, energy and trade. For example, mountain forests

in Europe are at present recovering because of reduced pressure from grazing, decreased air pollution and a general improvement in the rural mountain economy as a result of tourism and other activities (see also EOMF, 2000).

To safeguard mountain forests and ensure their multiple contributions, forest policy and practices need to integrate better their productive, protective, social and cultural functions. This requires improved knowledge about the roles of forests in mountain ecosystems and about their benefits, including those that reach beyond mountain areas. Lastly, opportunities need to be expanded for capacity building and training related to the management, conservation and development of mountain forests. The establishment of the first post-graduate course in mountain forestry at the University of Vienna's Soil Science Institute is a step in the right direction.

International Association for Mediterranean Forests: a multidisciplinary approach

The International Association for Mediterranean Forests (IAMF) fosters the exchange of knowledge and experience to address problems related to Mediterranean forests. It uses national networks of experts from across sectors to find solutions, including ways for policies to reflect action that needs to be taken. In partnership with the European Community, national and regional governments and others, IAMF recently led a project that culminated in the Marseilles Declaration on Mediterranean Forests. This declaration draws attention to the poor understanding of the characteristics of Mediterranean forests and the lack of coordinated decision-making on matters pertaining to their sustainable management. It also calls for a first Mediterranean conference on forests and natural land environments in 2003, with a view to consolidating the effectiveness of the networks so that greater consideration can be given to Mediterranean forests in drafting sustainable land-use and management policies.

Further information on IAMF and on Mediterranean forests is available on the Internet at www.aifm.org.

FORESTS AND WOODED LANDS IN THE MEDITERRANEAN BASIN

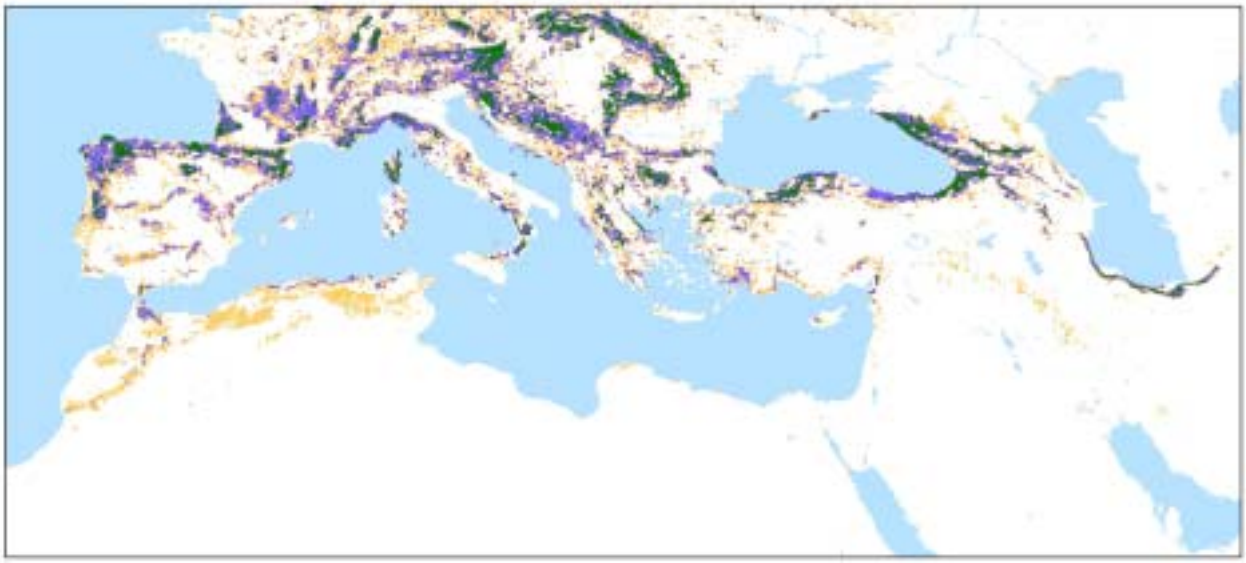
Vegetation in countries within the Mediterranean basin is fragmented into a mosaic of different types as a result of variations in climate, topography and soils, as well as a long history of human activity. Landscapes range from unexploited natural ecosystems to those shaped by centuries of human habitation. The rich flora includes some 25 000 higher plant species, of which approximately half are endemic (FAO, 1999b). Of significant ecological, historical and cultural value, the forests and wooded lands are mostly managed for a wide variety of non-wood products (fruits, seeds, gums, resins, bark, fodder) rather than for wood. They also control erosion, help restore soil fertility and maintain suitable conditions for agriculture.

Forests in the northwestern Mediterranean area are currently facing an increasing risk of wildfire because of the lack of management, encroachment and the abandonment of agriculture. On the other hand, heavy pressure on forests in the southeast is resulting in deforestation and forest degradation.

Working from the premise that issues can be resolved only after considering the institutional, social and economic conditions of people living in or near forests, Mediterranean foresters were among the first to design truly integrated multipurpose forest management plans that call for collaboration among administrations, local and national institutions, NGOs and the private sector. Cooperation among countries in the region has long been the norm, reinforced by the efforts of international organizations and, more recently, the European Community (EC) and local governments.

The Committee on Mediterranean Forestry Questions – *Silva Mediterranea*, a committee of the African Forestry and Wildlife Commission, the European Forestry Commission and the Near East Forestry Commission – has been supporting various aspects of forestry in the Mediterranean for more than 50 years. *Silva Mediterranea* recently underwent a reorganization to enable it to respond better to emerging needs and concerns. During its eighteenth session, it identified priority activities that FAO and other partners will undertake in areas that include the socio-

FIGURE 3
Forests of the Mediterranean basin



Closed forest – land covered by trees with a canopy cover of more than 40 percent and height exceeding 5 m. Includes natural forests and forest plantations.
Open and fragmented forest – land covered by trees with a canopy cover of between 10 and 40 percent and height exceeding 5 m (open forest), or mosaics of forest and non-forest land (fragmented forest). Includes natural forests and forest plantations.
Other wooded land – land either with 5 to 10 percent canopy cover of trees exceeding 5 m in height, or with shrub or bush cover of more than 10 percent and height less than 5 m.

Source: FAO, 2001a.

economic aspects of sustainable management, desertification control and the application of research results (FAO, 2002a).

COORDINATED RESPONSES TO FIGHTING FOREST FIRES

An International Expert Meeting on Forest Fire Management, organized by FAO and the International Tropical Timber Organization (ITTO) in 2001, emphasized the importance of a coordinated international response to forest fire management. As a follow-up to the experts' recommendations, FAO is reviewing mechanisms for establishing inter-State agreements to promote and facilitate the sharing of resources, personnel and equipment in emergencies. To this end, it has compiled an inventory of international agreements dealing with forest fires, particularly in cases of emergency, and identified common elements. The results of this analysis were used as the basis for a standard outline on which countries can draw when they wish to develop a forest fire agreement. However, the relevance of each element to individual countries and to specific environments depends on the particular conditions of the parties entering into an agreement and on the type of agreement desired. The outline includes the following elements:

- parties to and purpose of the agreement;
- definition of terms;
- executive bodies involved;
- financial responsibilities;
- information and coordination requirements;
- operating plans and guidelines;
- border-crossing modalities;
- liabilities and compensation;
- general and final provisions covering such matters as duration, amendment, termination and dispute settlement.

FAO has also inventoried national legislation specific to forest fires, as well as forest-related legislation covering forest fires. In addition, the

Fighting fires in Southeast Asia

In June 2002, environment ministers of the Association of Southeast Asian Nations (ASEAN) signed an agreement to increase cooperation and reinforce measures to prevent forest fires in the region. In the past, such fires have led to huge clouds of haze and cross-border pollution. The agreement establishes early warning systems and calls for stronger fire-fighting forces. Its implementation will complement ongoing efforts of Project FireFight South East Asia, a joint initiative of the World Wide Fund for Nature (WWF) and the World Conservation Union (IUCN). Initiated in March 2000 with the support of the European Community, the project operates at the national and regional levels to address harmful forest fires more effectively through policy and law reforms. It has published several reports on the state of knowledge in its three programme areas: economics of fire uses; community-based fire management; and legal and regulatory aspects of forest and land fires.

Addressing unsustainable hunting practices

A recent review of hunting in tropical forests (Bennett and Robinson, 2000) identified actions that could be taken to address unsustainable practices. The following are some examples.

- Governments could offer land tenure and resource rights as incentives for local communities to use bushmeat sustainably.
- The development sector could quantify the value of bushmeat and include this in rural livelihood assessments.
- Various sectors could jointly develop alternative livelihood strategies, agreeing that protected areas are the best means of conserving biological diversity.
- The private sector could reduce the illegal hunting and sale of bushmeat within its concessions.

Global Forest Fire Assessment 1990–2000, including country forest fire profiles, is available on CD-ROM.

Working with partners, FAO will continue to expand its network, strengthen country capacity, assist governments in developing strategies and policies in forest fire management and respond to requests for help in drafting agreements.

Further information is available on the Internet at www.fao.org/forestry/fire.

HUNTING WILD ANIMALS FOR MEAT: A THREAT TO SUSTAINABILITY

The sustainability of hunting in tropical forests, especially in Africa, is a major forest wildlife issue today. For example, the quantity of meat from wild animals (bushmeat) being harvested annually in the Congo basin is calculated at about 5 million tonnes (Fa, Peres and Meeuwig, 2002), indicating an extraction rate that is double the production rate. In comparison, about 0.15 million tonnes of bushmeat are harvested in Amazonia, corresponding to an extraction rate that is 0.081 of the production rate – 30 times lower than in the Congo basin.

Although these figures are indicative and provisional, they support concerns expressed during a number of regional and international discussions that wildlife in Africa's tropical forests is severely threatened. In the absence of remedial action, forest wildlife will be drastically reduced, with serious consequences for food security, forests and their ecological integrity.

Recognizing the urgent need to seek solutions, the eleventh Conference of the Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), held in April 2000, established a working group to study the bushmeat crisis (see p. 51). Other international responses include the

formation of the Ape Alliance, a coalition of conservation NGOs concerned with the plight of primates, and the United States-based Bushmeat Crisis Task Force, a consortium of conservation organizations and scientists dedicated to conserving wildlife populations threatened by commercial hunting.

In September 2001, FAO and partners held an international workshop to identify future steps. FAO is also assisting with the development of national bushmeat action plans in Cameroon and Gabon, as well as working with several organizations and agencies to strengthen protected area management and law enforcement in Central Africa and to engage local communities in managing and protecting forest wildlife.

RECENT DEVELOPMENTS IN FORESTS AND CLIMATE CHANGE

Forests in climate change negotiations

Following continuous negotiations since agreement was reached on the Kyoto Protocol in 1997, the parties to the United Nations Framework Convention on Climate Change (UNFCCC) set a new landmark in the battle against climate change with the signing of the Marrakech Accord at the seventh Conference of the Parties (COP-7) in November 2001. The parties acknowledged the four major roles of forests in climate change: as a source of carbon dioxide when destroyed or degraded; as a sensitive indicator of a changing climate; as a source of biofuels to replace fossil fuels; and as a carbon sink, when managed sustainably. By removing carbon dioxide from the atmosphere, storing it in biomass, soils and products, and offering a sustainable alternative to fossil fuels, forests provide a unique environmental service.

Failure to reach agreement about forests ranked high among the issues contributing to the collapse of negotiations at COP-6 in November 2000. It also threatened the successful conclusion of resumed discussions in July 2001, and forests remained controversial up to the final hours of COP-7 in Marrakech. Now, however, they may contribute the lion's share to the parties' commitments during the first commitment period (2008–2012) (Figure 4).

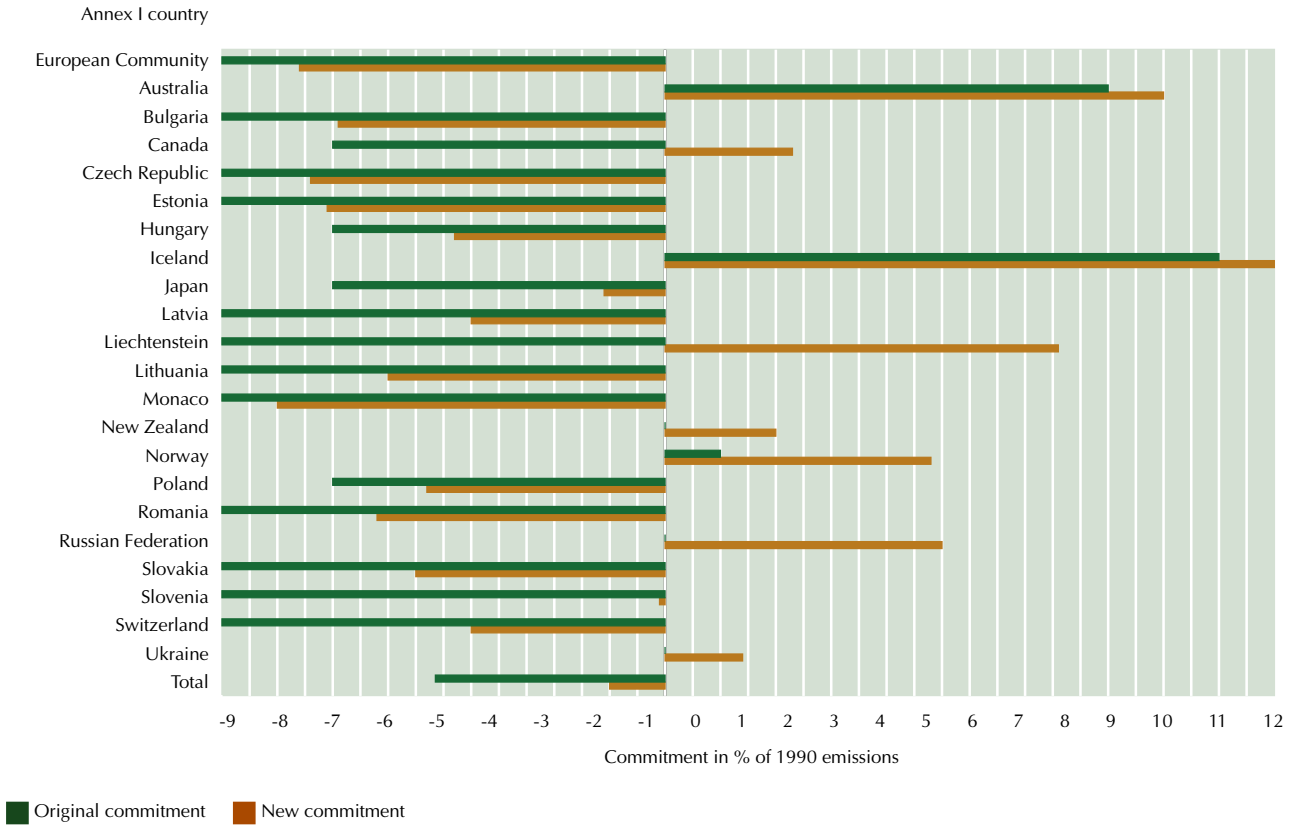
Third Assessment Report

The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2001) lifts some of the uncertainty still shrouding climate change and highlights its current and future dimensions, its causes and the perils to terrestrial ecosystems and society. Changes observed in the world's forest ecosystems during the past decades may foreshadow events to come.

The IPCC report also highlights the need for adaptation. Forests may be advanced in this respect because, given the natural longevity of most forest trees and the long rotations employed in their management, most of the forests established today will experience many changes in climate over their lifetime. Foresters have devised and implemented strategies for shielding forests from, and adapting management to, climate change (Spiecker, Lindner and Kahle, 2000). In many instances, these practices also represent good management under current conditions, and climate change merely accentuates their importance.

At times, the adaptation that is taking place today may reduce future timber yields and maximal carbon storage, but may enhance the permanence of carbon storage and biological diversity (see chapter on forests and biological diversity, p. 86). This occurs, for example, when highly productive but risk-prone Norway spruce (*Picea abies*) is replaced by less productive but low-risk native oak (*Quercus petrea, Q. robur*) or beech (*Fagus silvatica*) in many parts of central Europe (see Figure 5). Douglas fir (*Pseudotsuga menziesii*) is an exotic species in Europe that has a long, successful history there, producing durable timber at high growth rates. It is well adapted to summer droughts and mild winters. While some may contend that planting this exotic species on suitable sites will have an impact on biological diversity, doing so combines adaptation, climate change mitigation and economics. Given the possibility of irreversible interactions in the spheres of climate, ecology and socio-economics, such early adaptation seems necessary. However, the assessment report

FIGURE 4
Contribution of forests towards country commitments in the Marrakech Accord



Carbon sequestration in land use and forestry

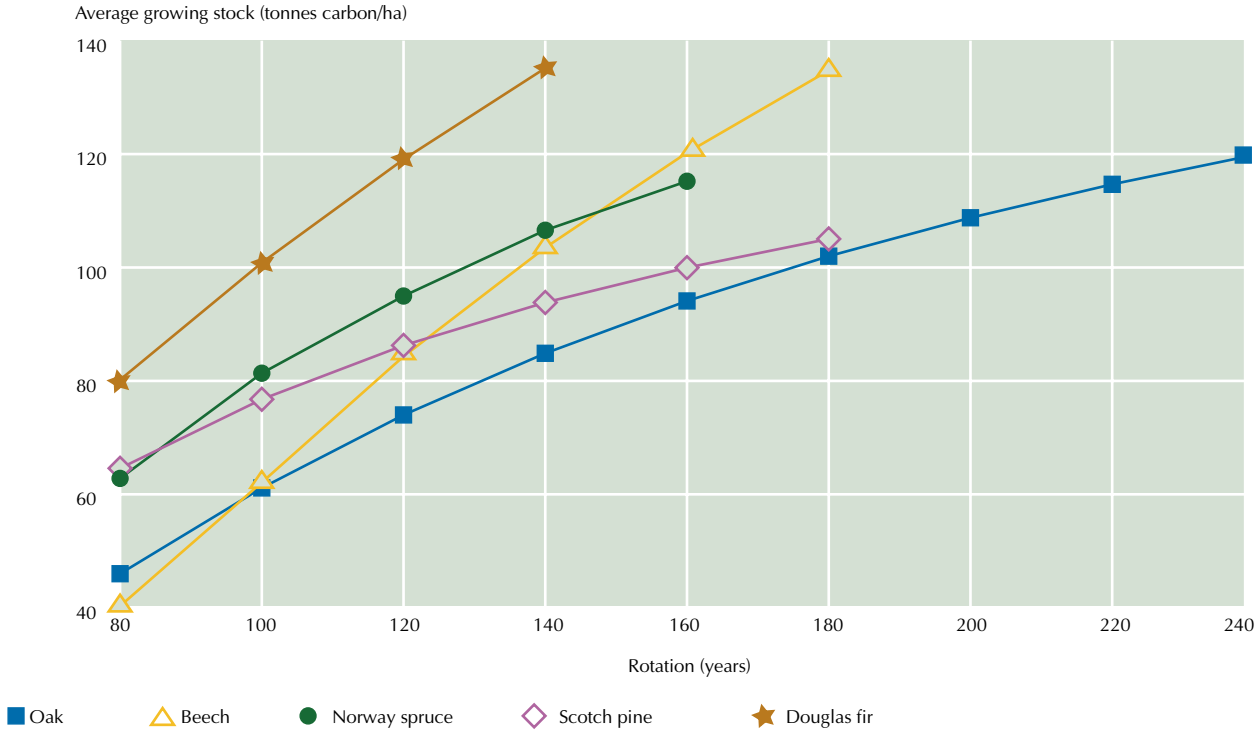
Forests, agricultural land and other terrestrial ecosystems offer significant potential for storing carbon. The conservation and sequestration of carbon, although not necessarily permanent, may provide enough time to exercise other options. The cumulative global potential of options related to biological mitigation of climate change is in the order of 100 gigatonnes of carbon by the year 2050, equivalent to 10 to 20 percent of projected fossil fuel emissions. The largest potential is in tropical and subtropical regions. Cost estimates vary significantly from US$0.1 to $20 per tonne of carbon in tropical countries and from US$20 to $100 in non-tropical countries (IPCC, 2001).

clearly states that adaptation cannot replace climate change mitigation. In this context, the panel specifically points out the important role of forests.

Biomass energy, particularly wood energy, constitutes a vital component of future strategies to mitigate greenhouse gas emissions, with a potential contribution of up to 30 percent of total emission reductions between 2030 and 2050. Many Annex I countries (industrialized countries and countries in transition to a market economy) consider wood energy an important component of their emission reduction efforts. The European Commission, for example, has launched an ambitious programme to enlarge the share of renewable energy, including bioenergy, in overall energy use from 5 to 12 percent by 2010. Bioenergy from agricultural and

FIGURE 5

Increase in mean carbon storage as a function of rotation for various species, calculated for a site in Germany



Source: *Schoene and Schulte, 1999.*

Measures for adapting silviculture and forests to climate change

- Select provenance and species, including perhaps suitable exotics
- Match species and provenance to sites
- Adapt planting densities
- Favour mixed, structurally diverse and uneven-aged forests, where possible
- Avoid monocultures
- Promote wind resistance
- Adapt tending and thinning
- Adapt rotations
- Adapt harvesting techniques
- Adapt stand nutrition to match enhanced growth
- Adapt fire management to changes in climate and forest growth
- Rehabilitate degraded forests
- Gradually replace off-site stands
- Eliminate additional stresses
- Reduce forest fragmentation
- Survey pests and pathogens
- Prepare for calamities and timber salvage
- Adapt regeneration to altered reproduction and competition
- Protect and maintain rare habitats
- Protect genetic stocks

Forest ecosystems respond to changes in climate

PERMAFROST THAWING IN CENTRAL ALASKA THREATENS NATURAL LOWLAND BIRCH FORESTS

The degradation of permafrost is widespread, for example in China, Mongolia, Canada and the state of Alaska, United States. When layers of ice in fine-textured soil horizons melt under the influence of warmer temperatures and enhanced snow cover, soils settle unevenly, forming a pitted landscape referred to as "thermokarst". In Alaska, it was observed that natural stands of paper birch (*Betula papyrifera*) on these soils die and aquatic species invade, forming lowland fens and bog meadows within 30 to 40 years. Contrary to expectations, the collapse of the permafrost layers and the associated forest ecosystem enhances carbon sequestration, as organic matter accumulates rapidly in these bogs, more than compensating for the carbon loss from trees. However, bogs emit methane, a greenhouse gas with a global warming potential 21 times higher than that of carbon dioxide, making the overall feedback to global warming hard to predict (Jorgenson *et al.*, 2001).

FOREST GROWTH CHANGES IN MANY WORLD REGIONS

Enhanced photosynthesis and/or tree growth has been observed in many regions of the world. In Austria, the annual increment of Norway spruce (*Picea abies*) increased by about 17 percent, mainly as a consequence of increased temperature and the temperature-related lengthening of the growing season during the period 1961 to 1995 (Hasenauer, 2000). However, forest growth may be enhanced only temporarily and in site-, age-, species- and genotype-specific patterns (Egli *et al.*, 2001). Growth may also be reduced, for example in boreal forests, if warming is accompanied by drought stress (Lloyd and Fastie, 2002). Competitive balance in mixed forests may change, species may become more or less prone to breakage, and self-pruning may be delayed (Spinnler *et al.*, 2001). The effects of greenhouse gases may have an impact on the phenology of forest trees, affecting such processes as budding, flowering, fruiting, leaf senescence, frost hardiness, wood quality, branching and insect susceptibility, in a highly species-specific manner (Jach, Ceulemans and Murray, 2001).

T. JORGENSON

Where permafrost has been degraded in central Alaskan lowlands, collapsing birch forests are being replaced by floating mat fens and bogs of **Sphagnum** *moss*

forestry residues and energy crops would then supply about 7 percent of the total energy consumed.

An emerging regime for forests in climate change

Together, UNFCCC, the Kyoto Protocol and the Marrakech Accord provide rules and modalities for forest and land use to mitigate climate change, as well as to record, monitor, report and verify carbon stock changes and fluxes in all relevant sectors (Torvanger, 2001a). In addition, detailed guidelines (IPCC, OECD and IEA, 1996), which are now being updated, establish methods for assessing carbon stock changes and propose formats for reporting on land use and forestry.

All parties to the convention must file periodic national communications in which they also report on forests. In addition, developed countries must provide information on carbon inventories on a yearly basis. These annual reporting requirements are rigorous in that developed countries may lose their eligibility to participate in the flexible mechanisms, including emissions trading, if they fail to report adequately on forests.

During the commitment periods from 2008 onwards, all industrialized countries will accumulate credits and debits for carbon stock changes from afforestation, reforestation and deforestation since 1990. During the first commitment period, special waivers apply to debits from harvesting short-rotation forests, and also to net debits that occur for many parties when newly established young forests cannot offset debits from clearing established, usually older, forests.

Besides cropland, grazing land management and revegetation, parties may designate the management of forests established prior to 1990 as an eligible activity. However, specific allowances (see Figure 4) limit the credits that countries may acquire or lose annually from forest management. For most parties, these allowances reflect the lower of two values: 15 percent of the annual forest carbon stock change, or 3 percent of total carbon emissions in 1990. Allowances are considerably higher for Canada, Japan and the Russian Federation.

In discounting carbon increases by 85 percent in forests established prior to 1990, the Marrakech Accord seeks to factor out benefits from routine planting of the young, rapidly growing forests that are dominant in most developed countries, as well as indirect, human-induced growth enhancement from carbon dioxide, nitrogen emissions and global warming. Countries are free to fulfil these forest management allowances through business-as-usual activities or through additional projects that enhance carbon sequestration.

The Kyoto Protocol also establishes flexible implementation mechanisms. Of these, Joint Implementation and the Clean Development Mechanism include forestry projects. With Joint Implementation, developed countries undertake projects in other developed countries and repatriate credits. Such projects, except those involving afforestation and reforestation, lower the host party's allowance for credits from domestic forest management.

A separate allowance, amounting to 1 percent of 1990 emissions, limits the credits that developed countries can claim for undertaking afforestation and reforestation in developing countries under the Clean Development Mechanism. Such projects can accumulate credits retroactively from 2000, provided that they meet prerequisites, which are to be defined by 2003. By then, definitions, rules, guidelines and modalities for clean-development forestry projects must also be decided, covering particularly the social, environmental and developmental aspects of projects and safeguarding against the possible reversal of carbon sequestration in trees.

While afforestation and reforestation remain the only eligible forestry activities under clean development during the first commitment period, forest conservation, adaptation and rehabilitation projects may receive financial assistance from the Special Climate Change Fund, the Least-Developed Countries Fund and the Adaptation Fund.

Future directions

Negotiations for the next commitment period will begin in 2005. Issues will include the treatment of carbon stored in wood products, forest-related definitions and differentiation between direct human-induced carbon stock changes and those from other causes. Countries will have to establish domestic regimes for climate change mitigation and to decide how these will integrate forests and their owners. Aiding this process, the harmonization of definitions (FAO, 2002b) and methods for measuring forest carbon stocks and their changes are rapidly becoming new fields in forest resources assessment (Brown, 2001; MacDicken, 1997).

In March 2001, the United States announced that it would not ratify the Kyoto Protocol, and in February 2002 it established its own Climate Change Initiative, containing, among other measures, voluntary emission intensity reductions. Nevertheless, United States companies may purchase credits from parties to the Kyoto Protocol (Torvanger, 2001b). Alternatively, the United States may establish its own type of carbon offset project abroad.

The role of forests and forest products in climate change and in emerging carbon markets will evolve, commensurate with prices for carbon; the extent to which adaptation and mitigation measures are perceived to be urgent; further progress in negotiations; and provisions for forests and wood energy in domestic regimes. Forest-related decisions taken at UNFCCC COP-7 and new insights from IPCC's Third Assessment Report may significantly affect the future state and management of the world's forests and the use of their products. ◆

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Institutional framework

In recent years, the forest sector has undergone a fundamental transformation, largely as a result of restructuring, downsizing, changes in ownership and increased recognition of the multiple benefits that forests provide. One of the most significant trends is increased management by groups of people and by individuals. In addition to the 22 percent of the world's forests that are now privately owned, community ownership accounts for about 11 percent, a figure expected to reach 40 percent by 2050. Consistent with this pattern, the number of partnerships among governments, organizations and agencies is growing, especially at the local level. However, what may not be keeping pace is the amount of support that community groups receive to increase their human, physical and financial capacity to take full advantage of current and emerging opportunities.

Institutional questions are multidimensional and can be complex, as can the solutions required to address them. This chapter touches on recent developments and key issues in forestry education, decentralization of public forest administrations, benefit-sharing arrangements, prevention of illegal logging and cross-sectoral linkages. These are presented as some of the examples of the many components that are critical to the successful implementation of sustainable forest management.

FORESTRY EDUCATION: COPING WITH NEW DEMANDS

Education concerning forests and trees is crucial to achieving sustainable management and national sustainable development goals.

Fundamental changes in forest policies, in the role of foresters and, hence, in approaches to forestry education are needed as a result of trends such as increasing demands for forest goods and services; growing recognition of the contributions that trees outside forests make in rural and urban areas; the active participation of multiple stakeholders in forestry; the recent emphasis on food security and poverty alleviation; and the need to comply with legally binding commitments.

For the most part, however, education is not adequate to cope with today's needs. At all levels, curricula must be updated to include such topics as the role of trees outside forests, collaborative management, gender equity, access and benefit sharing, the potential impact of certification schemes on forest practices, and participatory learning. By the same token, if education is to respond to current social aspirations and challenges, foresters must be given the opportunity to move beyond the realm of forestry to learn about such fields as communication skills, business administration and management sciences. Equally important, efforts are needed to enable institutions to monitor and assess their efficiency in responding as demands evolve.

Meeting of experts proposes ways of strengthening institutional capacity

Ways of addressing these needs were discussed at a meeting of experts on forestry education organized by FAO in Rabat, Morocco in 2001 (FAO, 2001a). Participants affirmed that the capacity of institutions for all levels of forestry education and programmes needed strengthening and updating, especially in developing countries. They also noted that donor support to education was declining, partly because of the decrease in hiring by public services and non-governmental organizations (NGOs), and partly because increasing numbers of non-traditional foresters are managing lands that include forests as part of the mix of uses.

On the basis of their discussions, the experts identified some potential ways forward:

- regional networking to support forestry education institutions and more interinstitutional exchange of knowledge and experience;

- improved coordination among forestry education, research and extension so that needs become better known to all and knowledge becomes more accessible to the wider population;
- more use of innovative and interactive methods of teaching and learning, for example approaches that enable communities to use their own knowledge and to experiment with new management techniques;
- greater attention to distance learning and the use of new information technologies;
- raising awareness of the importance of trees and forests, for example by increasing access to knowledge about forests and forest-related issues for students at the primary and secondary levels.

Responding to changes in how forests and forestry are perceived is also one of the most important challenges for forestry education in developed countries. This was confirmed at the Meeting of International University Forest Education Leaders, held in Vancouver, Canada, in 2001, organized by the Faculty of Forestry, University of British Columbia and FAO (University of British Columbia and FAO, 2002). Among the various concerns raised, the declining number of forestry students and the dwindling support to forestry education in developed countries were stressed. One explanation was the lack of competitive employment opportunities.

Consortia could fill significant gaps in curricula

Many universities are unable to introduce specialized forestry programmes because of financial constraints, a shortage of staff with the required expertise, or potentially limited enrolment. At the moment, for example, little is being taught about how forest policy decisions made in the international arena influence actions at the national and local levels. To address such shortcomings and foster collaboration with international research organizations, intergovernmental organizations and others, groups of universities are taking steps to set up consortia to provide issue-driven programmes that build intellectual and professional capacity for sound forest management. The objective is to have a knowledgeable faculty from various institutions deliver courses, workshops, seminars and conferences economically throughout the world. The University of British Columbia, Canada, for example, is leading an effort to establish a consortium for international forestry education (University of British Columbia and FAO, 2002).

DECENTRALIZATION OF PUBLIC ADMINISTRATION OF FORESTS

National governments and international organizations are increasingly favouring the decentralization of authority and resources to local governments as a means of fostering development. While decentralization takes place regardless of the level of development, it is generally a more prominent issue in developing countries. A World Bank study in 1999 estimated that more than 80 percent of all developing countries and countries with economies in transition were experimenting with some form of decentralization (Manor, 1999). While this

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Education at all levels concerning forests and trees is crucial to achieving sustainable management and national sustainable development goals

trend is less marked in the forest sector, its importance is expected to grow considerably in the near future.

Local governance can provide a unique opportunity to combat poverty while fostering better management of the environment and the forest resource, because authorities living close to the many people who depend on forests are in a good position to address local needs. Successful efforts have enhanced participation, increased the regional share of income from forests, resulted in better delivery of services and improved the sustainability of forests (Hitchcock, 2001). However, there can also be drawbacks (see Box below).

To build on the positive aspects, international organizations are helping countries to improve decentralization policy and implementation and the conditions for success. Efforts include analysis of accountability processes, exploration of ways in which national forest programmes can make decentralization more effective and equitable, and development of methodologies to assess which institutional capacities are needed in the forest sector to put the concept into practice.

Decentralization brings risks and raises new issues

- Lack of accountability and institutional capacity on the part of local governments could result in breaches of authority.
- The critical need for financial resources could increase the rate of deforestation.
- The cost of externalities (with activities from one sector having a negative impact outside the sector) could fall on a particular region or group of communities rather than on society as a whole.
- New laws could interfere with customary rules and local models of resource management.
- Decision-making might not be passed effectively to the local level.
- The interests of some groups might not be adequately taken into consideration.

Decentralization is a long-term process and in many cases conclusions cannot be drawn from the results to date. However, successful implementation will likely require substantial building of local skills in organization, negotiation, management and accounting. It is also necessary to develop clear regulatory frameworks, to define responsibilities and competences, to transfer decision-making powers and to secure access to resources. The capacity to support an effective central monitoring and accountability system is also critical to ensuring that decentralized administrations are indeed providing the expected services.

Although progress is being made, gaps in information prevent an accurate global assessment of the changes taking place. Work is therefore under way by FAO and others to compile information on the number of countries that are decentralizing their forest sectors, the extent and type of resources transferred, the nature of responsibilities involved, the status of implementation and the relationship with decentralization models in other sectors. As a more complete picture becomes available, it will help shed light on the conditions that favour or hamper decentralization.

SHARING BENEFITS FROM FORESTS

In addition to supplying wood and non-wood products and services to individuals, forests provide common benefits to all or part of society. Over time, institutional and regulatory arrangements have resulted in a greater degree of shared utilization and have generally also fostered a wider and more equitable distribution of benefits. Where forest land is still predominantly State-owned in developing countries, such arrangements are less common.

While local communities often rely on forest goods and services for subsistence and income generation, ways of sharing the common benefits are not as well defined. For example, the collection and sale of unprocessed forest products may yield fewer benefits to local populations than to other parties. To improve such situations, monetary and non-monetary

Support to private and community forestry in Central and Eastern Europe

Since 1990, when privatization began in Central and Eastern Europe, new forest ownership patterns have called for:

- significant numbers of private owners to organize themselves;
- State forest services to respond to new demands;
- the institutional framework to adapt to current realities.

In response, FAO and the World Conservation Union (IUCN), in consultation with country partners, have developed two projects that share a vision of sustainable forestry in the region. The FAO initiative focuses on strengthening private and community forestry, while that of IUCN addresses biological diversity within the same context. Taking the collaborative approach one step further, FAO and IUCN are jointly developing a programme to strengthen State forest services, to support forest owners' associations, to assist with improving policy, legislative and institutional frameworks, and to enhance the role of civil society in policy formulation and in the political debate on sustainable forest management. The project will also benefit from the technical support of the European Confederation of Forest Owners, whose network is expanding in Central and Eastern Europe.

arrangements, covering the short, medium or long term, attempt to balance the interests of those involved and to promote fair and equitable sharing.

The sharing of profits from the sale of wood products can be partly addressed through collaborative approaches to forest management in which responsibilities are transferred to local communities, for example through community forestry, social forestry or joint forest management. However, such transfers do not automatically increase the benefits to local inhabitants. In the past, many revenue-sharing initiatives took place in forests where timber production was limited, so that the main benefits shared were from non-wood products. However, recent examples, such as those in Chattisgarh, India (Sharma, 2002), are demonstrating that returns from forests are being shared successfully, resulting in better management of the resource. New mechanisms based on enforced regulations and decentralized fiscal systems are also encouraging, in that local populations obtain a larger share of revenue from the sale of fuelwood and other activities.

Benefit-sharing arrangements also cover a wide range of non-wood forest products (NWFPs) used by the botanical medicine, personal care, cosmetic and food industries. Some trade initiatives strengthen local communities by focusing on a fair return, adequate benefits, tenure and customary rights, and healthy work environments.

Various benefit-sharing arrangements have also been negotiated between pharmaceutical companies and certain governments to cover the search for trade opportunities in commercially valuable natural biochemical and genetic resources (bioprospecting). Arrangements covering bioprospecting aim to ensure that the property rights of the providers of genetic resources and traditional knowledge are respected, and that the benefits are equitably distributed among members of the partnership, including local communities, governments and private companies. Other arrangements cover the increasing trade in environmental services, such as credits for carbon sinks, and in wildlife products, including photo safaris and trophy hunting.

These approaches have good potential for strengthening local communities and contributing to the socially equitable, environmentally friendly and economically viable use of forest products and services. However, implementation is still a challenge, and additional efforts are required to

strengthen political stability and establish appropriate legal and institutional frameworks. As a first step, more information is needed on how benefits are shared, as a basis on which to build political will – a prerequisite for implementation of the concept. Benefit sharing also needs to be linked to democratic decision-making at the national, regional and local levels.

THE FIGHT AGAINST ILLEGAL LOGGING AND ILLEGAL TRADE

Illegal activities in the forest sector were highlighted as a key issue in the *State of the World's Forests 2001* (FAO, 2001b). Attention to forest crime has grown in the past two years, and it is being discussed more openly than ever before. While there are still too few data on illegal forest activities, the World Bank estimates that illegal logging results in annual losses of between US$10 billion and $15 billion of forest resources from public lands. The international trade in illegally extracted timber is also a serious problem.

Governments and NGOs are continuing their efforts to curb forest crime, while international agencies and policy research institutions are stepping up their analyses of its extent and impact. Several meetings have recently taken place around the world and discussions are generating further interest and additional pressure to take action.

The following are some of the key events of the past two years.

- Ministers from countries in East Asia and the Pacific met in Bali, Indonesia at the Forest Law Enforcement and Governance (FLEG) East Asia Ministerial Conference and, for the first time, committed their governments to improving law enforcement and governance in the forest sector (September 2001).
- The International Tropical Timber Council (ITTC) proposed to undertake, in collaboration with others, a global study to assess the extent, nature and causes of the illegal trade in timber and timber products and to conduct studies to devise ways for countries to enhance forest law enforcement (November 2001).
- FAO organized a meeting with representatives from governments, the International Tropical Timber Organization (ITTO), the World Bank, NGOs and the forest industry to exchange ideas on compliance and policy options to reduce forest crime, and to identify themes for international action (January 2002). FAO is now examining ways of enhancing the contribution of forest corporations in the prevention, monitoring and suppression of illegal forest acts, and is also analysing options for establishing partnerships to improve governance in the sector.

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Some benefit-sharing arrangements enable local communities to obtain a fair return from the increasing trade in environmental services and wildlife products, such as photo safaris (United Republic of Tanzania)

- Ministers responsible for forests agreed on the need to act urgently and issued a declaration at the second session of the United Nations Forum on Forests (UNFF), asking the World Summit on Sustainable Development to call for "immediate action on domestic forest law enforcement and illegal international trade in forest products" (March 2002).
- A technical session was held in Cambodia to discuss ways of recording the custody of harvested wood so that ownership could be tracked and compliance determined (March 2002).
- The sixth Conference of the Parties to the Convention on Biological Diversity adopted an expanded Programme of Work on Forest Biological Diversity that includes activities to improve forest governance and law enforcement (April 2002).
- The European Commission organized an international workshop to identify several proposals for future action, including verification mechanisms, import controls for illegally extracted wood and ways of criminalizing related international trade (April 2002).
- As a follow-up to the East Asian ministerial meeting held in September 2001, a regional task force met to discuss implementation of the Ministerial Declaration (May 2002).
- ITTC decided to assist with efforts to improve knowledge about forest concessions and protected area management in the Central African Republic, the Democratic Republic of the Congo and the Congo (May 2002).
- The World Bank and the Government of the Congo co-hosted a meeting to plan a ministerial session on forest law enforcement and governance in Africa (June 2002).
- The G8, concerned with illegal logging since 1998, declared at its meeting in Kananaskis, Canada, that it will work to monitor and address the illegal exploitation and international transfer of natural resources from Africa which fuel armed conflicts, including timber (June 2002).

Many developing countries are making efforts to improve compliance with forest legislation. In addition, consumer and producing/exporting countries are undertaking joint initiatives to combat the illegal trade in forest products, which could serve as a basis for broader international arrangements. Private industry is showing its concern over the fact that illegal forest products place legally produced ones at a competitive disadvantage. For this and other reasons, the recently established International Council of Forest and Paper Associations issued a formal statement committing members to work with all interested groups to find solutions to the growing problem.

The fight against forest crime, once the exclusive domain of national governments, has expanded to include business concerns, international agencies and major NGOs. Indeed, international NGOs are at the cutting edge of the global campaign against illegal logging and trade, and their efforts are meeting with increasing success. Progress is also being made on several other fronts, including the establishment of regional and bilateral agreements in various parts of the world. The extent to which the situation improves over the next few years will be an indication of the commitment of governments and their partners to bringing about positive change in this area.

International Council of Forest and Paper Associations: a forum for global dialogue

The International Council of Forest and Paper Associations was formed in April 2002 to promote sustainable forest management and sustainably produced forest goods. Its members are national organizations committed to forest practices that meet sound environmental, social and economic objectives. As a forum for global dialogue, coordination and cooperation among forest and paper associations, the council facilitates discussion on matters of common concern, develops positions on issues of mutual interest and collaborates on the exchange of statistics. As the need arises, task forces are established to address specific issues and to provide advice to members.

Current trends are expected to continue as countries, institutions and organizations step up their collaborative efforts to curb illegal activities. In all probability, private corporations will adopt more stringent policies to differentiate between honest and dishonest operators, translating this into market advantages. These efforts, combined with pressure exerted by informed consumers, will make it increasingly difficult for illegally extracted forest products to find a place on the market.

IMPROVING CROSS-SECTORAL LINKAGES WITH REGARD TO FORESTS

Government policies and development objectives can have a profound impact on forest management, often in unexpected ways. While policies in the forest sector shape results on the ground, those outside the sector can have an even greater impact. In the face of globalization, these effects are no longer limited to national action. Policy-makers have shown growing interest in assessing the effects of external factors on the forest sector, and vice versa, based on the idea that a better understanding of the impact of changes across sectors can help reduce uncertainty, maximize synergies and minimize undesirable effects.

Currently, the debate on cross-sectoral linkages in forestry tends to focus on those influencing deforestation in the tropics. However, many other important linkages affect a variety of forest functions. At the same time, the positive effects of forest policies on other sectors are often treated as external benefits rather than as part of a cross-sectoral dialogue. The multiple functions of forests and the positive effects of non-commodity outputs must therefore be carefully considered, both nationally and internationally.

Cross-sectoral linkages

A recent evaluation by the World Bank (2000) of its forest project portfolio revealed that interventions in other sectors affected forests and trees to a greater degree than the World Bank's interventions in the forest sector itself. For example, this and other studies show that:

- structural adjustments to reduce government salary expenditure may have been desirable from a fiscal viewpoint but resulted in a reduced capacity to carry out regulatory functions;

New forest sector policy and strategy of the World Bank

In October 2002, the Board and Executive Directors of the World Bank approved a new strategy and operational policy for the forest sector. These recognize that forests are critical in alleviating poverty and developing sustainable economies and environments. They are thus built on three interdependent components.

- ***Harnessing the potential of forests to reduce poverty.*** Studies, field experience and consultations all confirm that forests are crucial for alleviating poverty in many of the World Bank's client countries – those with ample forest resources as well as those with few. Future World Bank involvement in this area and its broader economic engagement are delineated in the strategy.
- ***Inte grating forests into sustainable economic development.*** In client countries, forests are often mismanaged and suffer from poor governance and illegal activities, which reduce their value and potential contribution to sustainable economic development. The strategy proposes various approaches to address these issues.
- ***Protecting vital local and global forest services and values.*** The new strategy is closely linked to the World Bank's new environmental and rural development strategies. It acknowledges the importance of cross-sectoral impacts, the need to incorporate ecosystem protection issues into broader national programmes and the need to work more effectively with development partners.

- improved roads to stimulate economic growth have attracted land-poor migrants who then clear forests for agriculture;
- an increased demand for power has resulted in pressure to clear forest land to build more dams.

Conversely, forest policies have a direct impact on other sectors, particularly agriculture (in terms of soil and water conservation).

Sectors are also linked by issues of common concern, including poverty alleviation, food security, social equity, freedom of choice and access to resources. Problems in these areas cannot be resolved unilaterally, but forestry can provide an entry point, as a recent seminar on forestry and poverty alleviation concluded (see Box on p. 69). Collaboration to tackle common problems and to use the comparative advantages of each sector requires coordination. Recent international attempts in this direction include the decision of major donors to help to alleviate poverty through sectoral interventions and structural adjustments, and the improvement of linkages through regulatory and legislative measures, as reflected in efforts by global treaties and conventions to deal jointly with related issues. This trend is consistent with that towards globalization.

Decision-making processes for resource allocation

Most countries rely wholly or in part on market forces for the allocation of resources and the linking of economic activities among sectors

The forestry–poverty alleviation nexus

The interface among agriculture, forests, water and food security is central to achieving sustainable development, and both the positive and the negative aspects of these links should be taken into account. In the process of bringing agricultural and forestry policies closer through constructive discussion, two key points need to be considered.

First, agricultural and livestock expansion to feed growing populations is the main reason for deforestation. However, such expansion is often the result of food insecurity and poverty. This widespread problem justifies establishing stronger integrated policies, that will:

- improve control over resources, opportunities to earn a living and food security;
- remove perverse subsidies that encourage large-scale expansion of commercial ranching and agriculture;
- develop new technological and institutional packages that increase productivity within the context of sustainable agriculture and agroforestry to relieve pressure on forests.

Second, forests can help to reduce food insecurity, alleviate poverty, improve the sustainability of agricultural production and enhance the environment in which many impoverished rural people live. Evidence shows that rural people are aware of the opportunities to incorporate trees and forests into their livelihoods and farming systems, justifying stronger policies that will:

- increase support for agroforestry with a focus on research and extension of technology that promotes income generation and sustainable supplies of the food, fibre, fodder and fuel required by local rural populations and by those in cities who can purchase them;
- strengthen local participation in decision-making and sharing of the benefits of forest conservation, including benefits from forested watersheds, where the involvement of local people is often a key to success;
- strengthen the ability of poor farmers to obtain needed credit, to have access to markets, to use the most appropriate technology (including post-harvest technologies) and to participate in training and extension services to spread technologies that often sit on researchers' shelves;
- strengthen institutional, market and financial mechanisms that expand opportunities for off-farm employment, for example in forest- or tree-based enterprises.

through prices that reflect supply and demand, especially if the market is open and competitive. Indeed, the market is well placed to regulate commodities that have a market price. On the other hand, social and environmental public services related to such activities as carbon sequestration, biological diversity conservation, erosion control and watershed protection are not normally traded. There have been many studies on evaluating these services, which could be a basis for marketing, although little use has been made of them so far. Even if a value is calculated for public services, neither the public nor governments have demonstrated a willingness to pay or provide the full cost for environmental services, as they are doing for such other services as health and social welfare. There are, however, a few cases in Europe where public services are supplied to local markets, e.g. municipalities, at rates that beneficiaries are willing to pay.

The public services provided by forests are also maintained through regulations or incentives, such as laws on the use of riverine forests to ensure a stable source of clean water. State ownership and management of forests, especially in tropical countries, is another way of making services available to the public. This allows the government to decide on measures to control erosion and protect watersheds as well as to pay for such activities as tree planting in shelterbelts or along streams and maintaining forests that provide public services. Examples of efforts to provide environmental services at the global level include national implementation of the conventions on biological diversity and climate change.

When government interventions are used to provide public services in one sector, there may be undesirable impacts in other sectors if the effects have not been properly considered. In the past, consultation and coordination were carried out by intersectoral committees or specific sectoral agencies to avoid such situations. However, a new trend is emerging in which interested parties interact before decisions are taken. This is also a result of society's increased involvement in environment and equity issues and of the increased opportunities offered by new information technologies.

Sharing information and knowledge to foster links

In addition to deep-rooted institutional barriers, many problems associated with sectoral linkages stem from a lack of communication and transparency. Governments and organizations need to ensure that information and knowledge are neutral, objective and widely disseminated in a timely manner. Policy proposals and plans need to be made accessible before decisions are made, so that representatives from all sectors can contribute meaningfully to the dialogue and required interventions.

For those who have the resources to acces and use modern technology, it can be a powerful tool for sharing information and knowledge. However, as technology becomes increasingly sophisticated, there is a real risk that decision-makers may be provided with an overabundance of information. What is needed, therefore, is a method of screening data for relevance, accuracy and timeliness. Formal and informal networks or communities of specialists and practitioners can be of assistance here.

While useful, new technology is not always available to a large part of civil society, particularly rural communities in developing countries. Traditional forms of communication must therefore supplement the digital flow of information. Another important consideration is the need to tailor information to specific audiences and sectors. For example, unless they are articulated in monetary terms, the environmental and social services provided by forests will not receive the attention they warrant from ministries of finance or financial institutions.

Perhaps the most important contribution that the forest community can make to narrowing the communication gap is to provide information on the significance and benefits of forests to other sectors and to society as a whole, so that policy-makers and the public will understand the need to support sustainable forest management. Quantifying the benefits will make it easier to reach agreement on cost sharing. Furthermore, capacity building, efficient institutions and a transparent policy dialogue could increase the availability and use of information and

knowledge. These are key objectives of the National Forest Programme Facility (see p. 55).

The way ahead

The forest community can complement more conventional means of addressing cross-sectoral issues by alerting other sectors to the need for precautionary and remedial action when their interventions are likely to have undesirable effects on forests and trees. Capacity building is needed so that forest institutions can provide decision-makers with evidence of such potential effects. However, not only must forestry professionals be sufficiently prepared, but civil society at large must also be empowered to act, so that public intervention can address cross-sectoral effects adequately, in particular those that market forces alone cannot dictate.

A number of initiatives have recently been launched to raise awareness of the importance of identifying and addressing cross-sectoral issues in a comprehensive manner and of the need to improve knowledge and capacity in this regard. Experience to date confirms the need to share information in a transparent and timely way and to collaborate closely among sectors. The various sectors must:

- identify sectors and players that have common rather than specific interests and goals;
- exchange information and knowledge on policies, emerging issues and plans;
- monitor progress and respond proactively to policy and legislation initiatives in other sectors;
- propose revisions to policies and legislation to address concerns;
- support cross-sectoral scientific policy analysis (quantitative, so far as possible);
- strengthen institutions;
- promote the full involvement of forest sector stakeholders and civil society. ◆

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International forest policy dialogue

In the years following the United Nations Conference on Environment and Development (UNCED), ongoing and often intensive international debate on forest policy issues has taken place. However, the significant contribution that forests make to the health of the planet and its inhabitants is now undisputed, securing their place on the international agenda for some time to come. With the establishment of the United Nations Forum on Forests (UNFF), attention can now turn to putting words into practice, moving from negotiated text to action on the ground. This transition, however, is marked by challenges as the global community seeks to resolve difficult and complex problems in such areas as financing, trade, capacity building, the transfer of environmentally sound technology and future international arrangements.

The global forest policy dialogue can strengthen political will, catalyse action and mobilize financial resources, particularly if it takes full account of links with other sectors through integrated approaches and effective partnerships. Ultimately, however, success will be measured by the degree to which countries implement commitments they have made in international fora. While progress is encouraging, there is concern that forest issues are becoming increasingly politicized and that substantive discussions are being overtaken by procedural matters.

This chapter summarizes the results of the first and second sessions of UNFF, describes the Collaborative Partnership on Forests (CPF) and the CPF Network, explores the relationship between the global policy debate on sustainable forest management and forest biological diversity, and provides updates on international conventions and agreements concerning forests. The role of the new National Forest Programme Facility in bringing about positive change with regard to capacity building, information sharing and knowledge management is also underscored. In conclusion, the chapter highlights the outcomes of the World Summit on Sustainable Development (WSSD) – the Johannesburg Declaration and the Plan of Implementation – which affirm that sustainable forest management is essential to the achievement of sustainable development in developed and developing countries alike.

UNITED NATIONS FORUM ON FORESTS

In October 2000, the Economic and Social Council of the United Nations (ECOSOC) established UNFF to carry out functions related to the management, conservation and sustainable development of all types of forest, including elements contained in the UNCED Forest Principles and in the outputs of the Intergovernmental Panel on Forests (IPF) and the Intergovernmental Forum on Forests (IFF) (ECOSOC, 2000). In this regard, UNFF has the following tasks:

- facilitating and promoting the implementation of the IPF/IFF proposals for action;
- providing a forum for continued policy development and dialogue;
- enhancing cooperation as well as policy and programme coordination;
- fostering cooperation at the national, regional and global levels;
- monitoring and assessing progress and, on this basis, considering what future action is needed;
- strengthening political commitment.

In 2005, UNFF will consider the parameters of a mandate to develop a legal framework covering all types of forest. At the moment,

however, it is focusing on issues related to financial and technological support for implementing sustainable forest management.

First session: June 2001, New York
During the first session, governments emphasized the significance of UNFF as the central intergovernmental forum to deliberate international policy, and welcomed the establishment of CPF (see p. 44). After two weeks of intensive negotiations, it adopted a Multi-Year Programme of Work and a Plan of Action for implementing the IPF/IFF proposals for action (ECOSOC, 2001).

Second session: March 2002, New York
During the high-level segment at the second session, ministers responsible for forests underscored the role of UNFF as the primary forum for international forest policy deliberations. In their declaration, they invited WSSD to advance sustainable forest management in response to critical issues, such as the position of forests on national and international political agendas; the lack of financing; the need for collaboration with other sectors; and attention to enhancing the conservation, protection and use of forests. This first ministerial segment also included a dialogue with heads of CPF members on their role and commitment to implementing the IPF/IFF proposals for action, and a multistakeholder dialogue to discuss the contributions of non-governmental groups to implementation of these proposals (ECOSOC, 2002).

In accordance with UNFF's programme of work, the main outcomes focused on lessons learned and future steps with regard to:

- combating deforestation and forest degradation;
- conserving and protecting unique types of forest and fragile ecosystems;

Canadian Environmental Network identifies IPF/IFF priorities for implementation in Canada

The Forest Caucus of the Canadian Environmental Network consists of more than 100 environmental NGOs. As part of consultations for UNFF-2, Natural Resources Canada funded a workshop at which the Forest Caucus analysed and prioritized the IPF and IFF proposals for action for implementation in Canada. The group ranked those of greatest interest in terms of opportunities for new commitments and any additional effort required. On this basis, the group's priorities are:

- a national forest programme that incorporates the conservation and sustainable use of forest resources and values;
- policies and mechanisms to reform forest tenure, including access to and use of forest resources by local and indigenous communities;
- data collection on the value of all forest goods and services and on the environmental and social impact of changes in forest use;
- integrated national policies, economic instruments and mechanisms to support sustainable forest management and to address deforestation and forest degradation;
- the establishment of a network of representative protected areas;
- forest-related international development assistance to support bottom-up, participatory approaches to forest management;
- transparent international trade negotiations that are accountable to civil society;
- forest revenue collection systems and examination of the relationship of land tenure with deforestation and forest degradation.

The Canadian Environmental Network is now developing a work plan to present to the National Forest Strategy Coalition as it prepares Canada's National Forest Strategy for the period 2003 to 2008.

- rehabilitating and restoring degraded lands and promoting natural and planted forests;
- concepts, terms and definitions.

Agreement was also reached on criteria for reviewing the effectiveness of the international arrangement on forests at the fifth session of UNFF in 2005.

Despite its best efforts, however, UNFF-2 was unable to agree on terms of reference for ad hoc expert groups on three subjects: monitoring, assessment and reporting; the financing and transfer of environmentally sound technologies; and the parameters of a mandate to develop a legal framework covering all types of forest. Discussions will continue at UNFF-3, from 26 May to 6 June 2003, in Geneva, Switzerland.

Looking back and moving forward

Since UNCED, the international policy dialogue has brought forest issues to the forefront and raised awareness of the significant contributions that forests make to the health of the planet and its inhabitants. In addition to environmental services, their roles in sustaining livelihoods, contributing to food security and reducing poverty are increasingly being recognized.

IPF and IFF provided the forest community with an opportunity to build trust, confidence and consensus in the aftermath of the polarized debate of more than ten years ago. With a firm commitment to move from dialogue to action, UNFF is embarking on the next critical phase. While translating words into practice remains a constant challenge, current trends on the ground are encouraging. For example:

- more than 100 countries have revised national forest policies and developed national forest programmes, taking into account the need for wide participation and linkages with other sectors;
- 150 countries are involved in international initiatives concerning criteria and indicators for sustainable forest management;
- areas under official forest management plans have increased to 88 percent in developed countries and some 6 percent in developing countries (FAO, 2001);
- 10 percent of the world's forests now fall within protected forest areas (FAO, 2001);
- the involvement of local communities in forest planning and management is growing.

Now that UNFF has met twice, it should be in a better position to allow for rich exchanges of experience on implementing proposals for action so that countries can learn from one another. UNFF therefore has significant potential for developing solutions, generating strong political commitment and strengthening partnerships.

COLLABORATIVE PARTNERSHIP ON FORESTS

CPF was launched in April 2001 to support the work of UNFF and to enhance cooperation and coordination among CPF members on forest-related issues. It was created in response to an invitation from ECOSOC to the heads of relevant organizations, institutions and instruments at the time UNFF was established in October 2000. CPF is chaired by FAO and serviced by the Secretariat of UNFF.

Based on the high-level, informal Inter-Agency Task Force on Forests which supported IPF and IFF, CPF continues the tradition of teamwork through an informal and voluntary arrangement. Where the mandates of individual organizations are complementary, members collaborate on specific activities related to the work of UNFF.

CPF reports annually to UNFF on its progress and plans, with a document entitled *CPF framework to support the work of the UNFF*. While CPF takes into account the guidance it receives from UNFF, each member is accountable to its own governing body with regard to priority activities, work programmes and budget expenditure. If the partnership is to function effectively, it is therefore critical for national governments, through their various ministries, to send consistent messages to the governing bodies of all member organizations concerning their involvement in and contribution to CPF.

The notion of teamwork and comparative advantage is relatively new in the global arena, and the forest sector is leading the way in many respects. Major intergovernmental fora, including WSSD and the sixth Conference of the Parties

(COP-6) to the Convention on Biological Diversity (CBD) (see p. 49), are taking note of CPF's achievements and are making reference to it in some of their decisions. In addition to the CPF Framework, CPF produced a policy document outlining its objectives and operating modalities. It also supported a number of country-led initiatives and established a focal agency system to carry out joint responsibilities and activities, all within one year of its establishment.

CPF acts as a catalyst for national, regional and international action, provides expertise and information, strengthens political commitment, mobilizes financial resources and networks with a wide range of partners.

CPF Network

Membership of CPF is limited by design, to enable it to work effectively and flexibly. However, members clearly recognize the important contributions that a variety of groups make to sustainable forest management through their experience, resources and perspectives, which have enriched the intergovernmental forest policy dialogue to date. To capitalize on these, CPF has established the informal CPF Network, which seeks to involve a broad range of stakeholders in order to enhance CPF's work in supporting UNFF, in particular the implementation of the IPF/IFF proposals for action. Additional key functions include strengthening communication among stakeholders and further enhancing collaboration and cooperation among organizations, institutions, instruments and processes working on forest-related matters. The inaugural meeting was held in March 2002. Sessions are organized, as far as possible, on the margins of major international forest gatherings.

More information on CPF and the CPF Network is available on the Internet at www.un.org/esa/sustdev/unffcpf.htm.

INTERNATIONAL POLICY DEBATE ON FORESTS AND FOREST BIOLOGICAL DIVERSITY

Forest ecosystems are major reservoirs of biological diversity, supporting 50 to 70 percent of the world's terrestrial species, according to

CPF members

- Center for International Forestry Research (CIFOR)
- Food and Agriculture Organization of the United Nations (FAO)
- International Tropical Timber Organization (ITTO)
- Secretariat of the Convention on Biological Diversity (CBD)
- Secretariat of the Global Environment Facility (GEF)
- Secretariat of the United Nations Convention to Combat Desertification (UNCCD)
- Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC)
- United Nations Department of Economic and Social Affairs (DESA)
- United Nations Development Programme (UNDP)
- United Nations Environment Programme (UNEP)
- World Agroforestry Centre (ICRAF)
- World Bank
- World Conservation Union (IUCN)

Examples of areas in which CPF members are collaborating

- National forest programmes
- International criteria and indicators processes
- Activities to combat illegal logging
- Guidelines on reduced-impact logging
- Local communities' participation in fire management
- Capacity building and policy development
- Protection of unique types of forest and fragile ecosystems in more than 50 countries
- Assistance to low forest cover countries within the Tehran Process
- Data and information on forests
- Projections and outlook studies
- Guidelines for monitoring, assessing and reporting on forests
- Inputs to the reports of the UN Secretary-General to UNFF
- Secondment of senior professionals to the UNFF Secretariat

some estimates. Natural forests in the tropics are the richest in biological diversity, but are also the most threatened by deforestation and forest degradation. Increased awareness of potentially considerable losses of forest biological diversity has led to growing demands for international and national regulatory mechanisms, principles and guidelines to reverse this trend.

The forest community has long recognized the need to enhance forest resources and conserve biological diversity in forest ecosystems. This is shown, for example, by the work of some 150 countries within the nine international processes on criteria and indicators for sustainable forest management, which all consider the conservation of biological diversity an essential and integral element of sustainability.

CBD and UNFF are two separate but parallel processes dealing with forests and forest biological diversity. The former addresses the conservation and sustainable use of biological diversity and the fair and equitable sharing of benefits arising from the use of genetic resources, including those from forest ecosystems, while the latter looks at the management, conservation and sustainable development of forests on the basis of the outcomes of UNCED, IPF and IFF. Both consider their roles complementary and recognize the need to strengthen collaboration. Other international and regional bodies deal with various aspects of forest biological diversity as well, including FAO, the Global Environment Facility (GEF), the World Conservation Union (IUCN), the International Tropical Timber Organization (ITTO) and the Center for International Forestry Research (CIFOR), by supporting country activities and linking policy debate to implementation on the ground.

IPF/IFF/UNFF and forest biodiversity

The main purpose of IPF (1995–1997) and IFF (1997–2000) was to build consensus on the management, conservation and sustainable development of all types of forest, using the UNCED Forest Principles and Chapter 11 of Agenda 21 ("Combating deforestation") as a basis for deliberations. IPF recognized that sustainably managed forests play a valuable part in conserving biological diversity, as reflected in the large number of proposals for action that either directly or indirectly address this issue.

In 2000, after five years of ad hoc discussions, ECOSOC established UNFF to continue policy development, coordinate forest-related action, enhance international collaboration and facilitate implementation of the IPF/IFF proposals for action (see p. 42).

Development of the forest component in CBD

Although many articles of CBD apply to forest ecosystems, the convention itself does not make specific mention of forests. Discussions on the conservation of forest biological diversity within CBD first started at COP-2, in November 1995. A year later, COP-3 recommended that CBD develop a work programme in this regard. At the same time, it also discussed developing a protocol that could obviate the need for a global forest convention, a controversial issue debated by IPF and later by IFF, on which consensus could not be reached.

In 1998, COP-4 adopted the CBD Work Programme for Forest Biological Diversity, which focused on research, cooperation and technology development. It established an ad hoc technical expert group on forest biological diversity to make further progress on the issues.

COP-6, held in April 2002, significantly increased the scope of CBD forest-related activities by adopting an expanded Programme of Work on Forest Biological Diversity – described in the section on forest-related conventions (see p. 49).

Shift from conservation to management within CBD

Since COP-4 identified forest biological diversity as one of its five thematic areas, it has been a significant part of the agenda of CBD. Recently, other aspects of forests have been added, including the harvesting of wood and non-wood forest products (NWFPs), illegal logging and

forest fires. CBD thus appears to be focusing increasingly on the management and use of forest resources rather than on biological diversity in forest ecosystems *per se*.

In the course of this process, the debate has at times been confusing. For example, the use of such terms in COP-6 documents as "harvesting of forest biodiversity", "management of forest biological diversity" and "forest biodiversity products" leaves the impression that diversity is synonymous with resources. This is clearly not the case, inasmuch as resources are managed and harvested, and products are obtained from the resources. More important, CBD seems to be moving far away from its own definition of biological diversity as "the variability among living organisms".

Another shift is the increasing reliance of parties on international organizations to support implementation of decisions and to assist with national reporting. There are growing expectations that CPF assume a larger role in this regard, a trend that has also emerged in UNFF deliberations.

Role of CPF

As already noted, CPF was established to support the work of UNFF and to enhance collaboration among its members on forest-related issues. Consistent with this mandate, UNFF invited CPF to support its Multi-Year Programme of Work and Plan of Action, especially with regard to implementing the IPF/IFF proposals for action. Soon after, COP-6 to CBD invited CPF to support the expanded Programme of Work on Forest Biological Diversity.

While CPF is a voluntary partnership that receives guidance from UNFF, it is not an implementing agency, as CPF members operate individually under their own mandates, work programmes and budgets, which are approved by their respective governing bodies. Still CPF members can act as catalysts in countries to help implement sustainable forest management. They and other international and bilateral organizations can provide assistance and technical support, help raise awareness of needs, advise on strategies and help build capacity and partnerships. However, it is up to countries to conserve forest biological diversity at the national level, as no outside organization can undertake this, any more than it can halt deforestation.

The Secretariat of CBD is the focal agency within CPF for forest-related traditional knowledge. COP-6 called on the CBD Secretariat to facilitate the coordination and cooperation of CPF members in implementing the CBD expanded programme of work and the IPF/IFF proposals for action related to forest biological diversity. It also urged CPF to consider the CBD Secretariat as the focal point for forest biological diversity and CPF accepted this request.

The ecosystem approach and sustainable forest management

Amid growing confusion, calls are being made to clarify the relationship between an ecosystem approach on the one hand, and sustainable forest management on the other. In essence, while there are both differences and similarities, they are mutually supportive rather than contradictory concepts, with sustainable forest management encompassing the principles of the ecosystem approach.

Sustainable forest management refers to meeting present needs for forest goods and services, while ensuring their continued availability in the long term. The concept combines the production of wood and NWFPs with the conservation of soil, water and biological diversity, while the socio-economic, cultural and spiritual values of forests are maintained or enhanced. The conservation of biological diversity thus constitutes an essential and integral element of sustainable forest management, as recognized in all international criteria and indicators processes.

CBD defines the ecosystem approach as the integrated management of land, water and living resources, which promotes their conservation and sustainable use in an equitable way. Accordingly, forest ecosystems should be managed for their intrinsic values and for the tangible benefits they provide to humans.

Challenges of international debate on forests and forest biological diversity

Some concern has been expressed over the overlap and possible duplication in UNFF and CBD activities. One reason for these shortcomings may be that the forest community is not reaching out enough to other sectors – including the environment sector, which is the most closely involved in CBD – to facilitate a constructive policy dialogue. Industry and socio-economic groups, for example those representing labour, local communities and indigenous people, have also indicated that they do not feel sufficiently engaged. Another reason may be that some deem CBD to have a higher status than UNFF. However, while CBD is legally binding, its work programmes are not. In this regard, they have the same status as the IPF/IFF proposals for action and UNFF decisions.

CBD has generally acknowledged the work of IPF, IFF and UNFF, but it is worrying to note that in the CBD negotiations there seems to be a lack of knowledge of post-UNCED forest discussions and follow-up action at the international, regional and national levels. Awareness of work carried out by international organizations such as FAO, ITTO and CIFOR also appears to be lacking, even though efforts of these organizations in pursuit of sustainable forest management have entailed an ecosystem approach over the years.

All post-UNCED fora emphasize a move from dialogue to action. However, neither UNFF nor CBD has time-bound commitments or targets in its programme of work, and difficult negotiations are beginning to reflect a North/South divide again. Both fora spend considerable time on procedural matters – for example on debating whether to establish expert groups. CBD recently established another expert group on forest biological diversity, following the termination of the first, whereas UNFF must continue to discuss terms of reference for three groups on various aspects of sustainable forest management.

National reporting is yet another sensitive issue in both fora, because although it provides a means of evaluating progress, it also places a significant burden on countries. In this regard, UNFF recently invited CPF to propose ways of streamlining forest-related reporting to international organizations and bodies.

Lack of resources and insufficient capacity for implementing action proposals is a reality of CBD and UNFF (as for many other fora). Neither has the means to carry out action apart from supporting information exchange and further dialogue. Indirectly, CBD has access to funds from GEF, and in 2001, forests were the subject of 80 projects – worth more than US$500 million – in its biological diversity portfolio.

Action by countries in response to CBD and UNFF commitments needs to be coordinated and mutually supportive. Integration of the 130 activities in the CBD expanded Programme of Work on Forest Biological Diversity with the more than 270 IPF/IFF proposals for action constitutes a major challenge. Both CBD and UNFF encourage a cross-sectoral approach to national implementation through existing frameworks: UNFF through national forest programmes and CBD through national biological diversity strategies and action plans. Nevertheless, according to a study commissioned by the Global Forest Coalition (2002), by March 2002 virtually no integration had taken place.

While enhancing cooperation, coordination and synergy is among the main functions of UNFF, international discussions on forests seem to be increasingly fragmented. As CBD moves beyond its initial focus on conservation to issues related to resource management, there is considerable concern that other bodies, such as the United Nations Framework Convention on Climate Change (UNFCCC) and the World Trade Organization (WTO), may also wish to take a leading role on forest issues, notably those concerning reforestation and rehabilitation, trade and sustainable forest management. If they do so without considering activities that are being undertaken by mandated bodies, this will lead to confusion and wasteful duplication, and it could be counterproductive.

Ways forward

UNFF is relatively young, as is the CBD expanded Programme of Work on Forest Biological Diversity, and the effectiveness of both to guide action has still to be seen. What are required now are innovative approaches, effective support, and collaboration and coordination among partners. Governments need to stress this message when giving advice to governing bodies.

Recognizing that their work programmes are separate but complementary, the secretariats of UNFF and CBD are working together to identify common areas for action, with a view to avoiding duplication. Such efforts are consistent with the recommendations made by COP-6 to CBD and the Workshop on Forests and Biological Diversity held in Accra, Ghana in January 2002 (UNEP/CBD, 2002). CPF members are also collaborating to support both processes.

Perhaps countries should then agree on one joint programme of work that assembles these common elements, and they should ensure effective coordination and implementation at the national level, where responsibility for action lies. An example of this type of process is in place at the regional level in Europe, where the Ministerial Conference on the Protection of Forests in Europe and the pan-European ministerial process "Environment for Europe" jointly developed and adopted a work programme that defines shared objectives and actions in the field of biological diversity as essential elements of sustainable forest management. This could well serve as a model.

UPDATE ON FOREST-RELATED INTERNATIONAL CONVENTIONS AND AGREEMENTS

Convention on Biological Diversity

COP-6 was held in The Hague, the Netherlands from 7 to 19 April 2002. Among other decisions, it agreed on an expanded Programme of Work on Forest Biological Diversity composed of three elements: conservation, sustainable use and benefit sharing; an enabling institutional and socio-economic environment; and knowledge, assessment and monitoring. It also refers to the more specific issues of strategies on *in situ* and *ex situ* conservation, sustainable resource use, the

Ministerial Conference on the Protection of Forests in Europe

The Fourth Ministerial Conference on the Protection of Forests in Europe will be held in Vienna, Austria from 28 to 30 April 2003. At that time, 43 European countries, the European Community and 42 observer countries and organizations will reaffirm commitments made at previous ministerial conferences and report on their implementation. Reports will also be presented on the state of forests in Europe and on action taken at the national and pan-European levels. Participants will also discuss adoption of the Vienna Declaration, drafted as a strong and balanced political statement on the sustainable management of European forests. Additional agenda items include:

- pan-European priorities for forest biological diversity, taking into account the CBD expanded Programme of Work on Forest Biological Diversity and the UNFF Multi-Year Programme of Work and Plan of Action;
- topics related to economically viable sustainable forest management, such as enabling conditions for activities and investment, the promotion and marketing of forest products and services, and labour issues;
- climate change and sustainable forest management, including the role of bioenergy and the use of wood products as a substitute for non-renewable resources;
- cultural aspects as an integral component of sustainable forest management.

need to establish, evaluate and strengthen protected area networks, forest law enforcement, national coordination and the need to facilitate the participation of local and indigenous communities in the management of protected areas.

COP-6 stressed urgent action to safeguard forests that are threatened and/or that can contribute to conservation, sustainable use and benefit sharing. It highlighted the need to consider forest biological diversity in programmes concerning global forest resources assessments, forest fires, climate change and pollution abatement. It also noted the importance of linking forest biological diversity conservation with work on alien species.

During the high-level segment, ministers resolved to "strengthen efforts to put in place measures to halt biodiversity loss, which is taking place at an alarming rate, at the global, regional, subregional and national levels, by the year 2010" (CBD, 2002).

COP-6 recognized that implementation of the work programme should be based on national priorities and needs. In particular, it emphasized the need for the Secretariat of CBD and parties to it to cooperate with UNFF, CPF and their partners to ensure better implementation of common objectives contained in national forest programmes and national biological diversity strategies and action plans. It requested that FAO, in collaboration with international and national partners, continue its work on forest-related concepts, terms and definitions.

COP-6 requested the Executive Secretary of CBD to establish an ad hoc technical expert group to review progress on the work programme, and recognized that new and additional financial resources were necessary for its implementation.

Further information on the decisions and the Programme of Work on Forest Biological Diversity can be found on the Internet at www.biodiv.org/meetings/cop-06.asp.

Convention to Combat Desertification

In October 2001, 176 countries attended COP-5 to the Convention to Combat Desertification in Geneva, Switzerland. Building on previous sessions that focused on negotiating priorities and determining future action, this session turned its attention to issues of implementation.

One of the key decisions was the establishment of the Committee for the Review of the Implementation of the Convention to assist the Conference of the Parties in determining progress and proposing future action. Deliberations began at its first session in November 2002. Agreement was also reached to increase resources to the secretariat and to the Global Mechanism for 2002–2003.

With regard to addressing the devastating impact of land degradation in terms of lost income and lost productive land, participants welcomed the May 2001 decision of the council of GEF to pursue the designation of land degradation as a focal area. Such support then paved the way for the assembly to consider this focal area in October 2002. Consistent with the urgent need to raise awareness of this issue, COP-5 also gave the Committee on Science and Technology the priority task of examining how to address land degradation, vulnerability and rehabilitation in an integrated fashion.

Many governments have prepared National Action Programmes to reverse desertification.

A fifth regional annex to the Convention to Combat Desertification

Regional implementation annexes to the Convention to Combat Desertification provide details on how to prepare and carry out national, subregional and regional action programmes. A fifth regional annex for Central and Eastern Europe, adopted in 2000, entered into force in September 2001, complementing the four annexes for Africa, Latin America and the Caribbean, Asia and the Northern Mediterranean.

This is a significant step, enabling affected countries to inform partners about their efforts to combat land degradation and about their requirements for international support.

Further information on the Convention to Combat Desertification can be found on the Internet at www.unccd.int/main.php.

United Nations Framework Convention on Climate Change and the Kyoto Protocol

COP-8 to UNFCCC was held in New Delhi, India from 23 October to 1 November 2002. After three years of intense negotiations on the Kyoto Protocol, and with the signing of the Marrakech Accord in November 2001, discussions are moving from the establishment of rules for implementation to implementation itself. By 1 August 2002, 76 countries had ratified the Kyoto Protocol, 22 of which are from the industrialized world and responsible for 36 percent of that group's 1990 carbon dioxide emissions. When this figure increases to 55 percent, the protocol will enter into force.

An account of recent developments in the forest sector in the context of climate change is given on p. 25. Documents and decisions reached at COP-8 are on the Internet at www.unfccc.org.

Convention on International Trade in Endangered Species of Wild Fauna and Flora

COP-12 to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) took place in November 2002 in Santiago, Chile. One of the key items discussed was the CITES lists, or Appendices, which come up for review every two and a half years. Appendix I prohibits commercial trade in some 900 species threatened with extinction, while Appendix II regulates trade in 4 000 animal and more than 22 000 plant species through a system of permits. Member governments submitted more than 50 proposed amendments, including one to list bigleaf mahogany (*Swietenia macrophylla*) in Appendix II. The results of their deliberations can be found on the Internet at www.cites.org/eng/cop/index.shtml.

COP-12 also considered reports from two working groups that were established at COP-11: one on mahogany and one on bushmeat. Among other items, the former addressed the effectiveness of current and potential Appendix III listings, provided an analysis of legal and illegal trade and reported on the status of the species in tropical America. The working group on bushmeat, established to address the unsustainable hunting of wild animals for their meat, especially in Africa (see p. 24), reported on factors contributing to the bushmeat crisis and suggested ways in which the international community might deal with the problem. National legal reform and harmonization of laws among countries were viewed as important elements in the solution.

Ramsar Convention on Wetlands

Unlike most other environmental treaties, the Ramsar Convention on Wetlands is not part of the

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Bigleaf mahogany* (Swietenia macrophylla)*, shown here in Mexico, was included in Appendix II of CITES at COP-12 in November 2002

UN system. However, its bureau, housed at the headquarters of IUCN in Gland, Switzerland, has formally established collaborative agreements with a number of secretariats and with a wide range of partners. In fact, the Ramsar Convention has long paved the way for multistakeholder projects and activities around the world, and is recognized as a leader in this regard.

Six workshops were held in 2001 and 2002 in Africa, Asia, Europe, the Neotropics (Central and South America and the Caribbean), North America and Oceania to review progress and challenges in implementing the convention and to prepare for COP-8, which took place in November 2002 in Valencia, Spain. Discussions at these workshops helped to shape the agenda for technical sessions of COP-8, encompassing the following issues:

- major challenges and emerging opportunities for wetlands, water and sustainability;
- baselines for sustainable use – wetland inventory and assessment;
- global biological diversity and sustenance of human life – the Ramsar List of Wetlands of International Importance;
- management of wetlands for sustainable use and human well-being;
- cultural aspects of wetlands as a tool for their conservation and sustainable use.

Further information on the Ramsar Convention, including decisions taken at COP-8 can be found on the Internet at www.ramsar.org.

International Tropical Timber Agreement

The International Tropical Timber Agreement (ITTA) came into force on 1 January 1997 and expires on 31 December 2003, unless it is extended for a second of two possible three-year periods. ITTO is at present considering this option. In May 2002, membership of ITTO consisted of 31 producer countries and 25 consumer countries, in addition to the European Community.

The ITTO Objective 2000 continues to be an important focus, with all members working towards ensuring that their exports of tropical timber and timber products come from sustainably managed sources. ITTO has reaffirmed its full commitment in this regard and is assisting countries to move as fast as possible in this direction. Indeed, such efforts are central to ITTO's work, as reflected in the six major goals identified in its Action Plan 2002–2006:

TABLE 7
International criteria and indicators processes

Region	Countries		International/ecoregional processes or initiatives
	Total countries in the region	Countries participating in one or more processes	
Africa	56	46	Near East; Dry-Zone Africa; African Timber Organization; ITTO
Asia	49	36	Near East; Dry Forests Asia; ITTO; Pan-European
Europe	40	40	Pan-European; Montreal; ITTO
North and Central America	34	11	Lepaterique; Montreal; ITTO
Oceania	20	5	Montreal; ITTO
South America	14	11	Tarapoto; ITTO; Montreal
Total	**213**	**149**	

Source: FAO, 2001.

- improved transparency of the international timber market;
- promotion of tropical timber from sustainably managed sources;
- support to activities that secure the tropical forest estate;
- promotion of the sustainable management of tropical forests;
- promotion of increased processing of tropical timber from sustainable sources;
- improved processing and use by industry of tropical timber from sustainable sources.

Activities and issues receiving special attention include: training in applying ITTO Criteria and Indicators for Sustainable Management of Natural Tropical Forests; restoration, management and rehabilitation of degraded and secondary tropical forests; improved market access; means of assessing and combating illegal logging and illegal trade; encouragement of reduced-impact logging practices; forest certification; mangrove conservation and management; and the establishment and management of transboundary conservation areas. In addition, ITTO's first report on the state of tropical forest management will be published in 2003.

Criteria and indicators for sustainable forest management

Stakeholders at the international, regional, national and subnational levels increasingly acknowledge the importance of applying criteria and indicators for sustainable forest management as tools to monitor the effects of intervention and to assess progress over time. Intergovernmental organizations and agencies as well as numerous international and national non-governmental organizations (NGOs) are supporting the nine major international criteria and indicators processes, which involve nearly 150 countries and 85 percent of the world's forests (see Table 7). As might be expected with such extensive coverage, the degree of implementation varies considerably both among processes and among member countries within them. In this regard, it is encouraging to note that some processes, mainly the Pan-European, Montreal and ITTO processes, are in the midst of issuing reports on the status of sustainable forest management in member countries. Other processes are also working towards this end.

While action was originally directed to the national level, efforts to develop and implement criteria and indicators at the forest management unit level have recently been intensified, with governments continuing to involve a range of partners, including forest owners, NGOs and the private sector.

Over the years, countries participating in the various processes have been validating regional-level criteria and indicators, with the aim of selecting, adapting and implementing those considered most applicable and relevant to their particular situations. In connection with this work, the processes that have most recently produced guidelines for assessing, monitoring and reporting on progress towards sustainable forest management are the Dry-Zone Africa, Dry Forests in Asia and Near East Processes.

Challenges for the future include:

- strengthening political support for sustainable forest management;
- attracting more countries into the international criteria and indicators processes;
- improving the common understanding of concepts, terms and definitions;
- validating and adopting dynamic sets of relevant, measurable and affordable indicators;
- implementing field-tested and nationally adjusted regional guidelines for measurement and monitoring;
- improving country capacity to collect, store, analyse, use and disseminate information concerning sustainable forest management;
- developing cost-effective but comprehensive formats to improve and streamline reporting;
- incorporating criteria and indicators into national forest programmes;
- linking the monitoring of indicators for sustainable forest management to global forest resources assessments;
- helping countries and the international community to streamline efforts and to ensure that initiatives in related areas, such

as biological diversity, are complementary;
- supporting country efforts to secure adequate resources to carry out related work.

Along with others, FAO will continue to support international criteria and indicators processes, especially in developing countries as they move towards implementation. Assistance will be provided for validating criteria and indicators, particularly in countries with low forest cover, and for developing practical guidelines for assessment, monitoring and reporting. Efforts will also be made to encourage countries that are not yet members of any process to begin work in this area.

Following a recommendation from the Expert Consultation on Criteria and Indicators for Sustainable Forest Management, held in Rome in November 2000, an International Conference on Criteria and Indicators for Sustainable Forest Management will be held in 2003. The Government of Guatemala will host the event, with the support of FAO and ITTO, in collaboration with the Governments of the United States and Finland. The main objectives

National forest programmes

Following forest discussions at the intergovernmental level, agreement was reached on a holistic, comprehensive and multisectoral approach to sustainable forest management through national forest programmes. The importance of forests to a wide range of stakeholders, because of the diversity of the goods and services that they provide, means that partnerships are a key element in the process. Implementation therefore draws largely on close collaboration at the national and international levels, taking full advantage of synergies and the comparative advantages of the various players. Based on experience over the past two decades, national forest programmes are bringing about positive changes with regard to:

- broadening stakeholders' involvement in all aspects of sustainable forest management;
- refining current knowledge and broadening access to it;
- improving the capacity of technical staff and civil society;
- fostering cross-sectoral linkages;
- improving access to financing.

Although policy and legal frameworks to increase multistakeholder participation have improved in recent years, institutional arrangements to facilitate such partnerships need to be refined in both developing and developed countries. Moreover, as knowledge becomes the driving force of modern society, mechanisms for its generation, dissemination and application need to be strengthened. Precisely for this reason, national forest programmes give particular attention to:

- bridging the knowledge divide through better sharing of information among partners, taking full advantage of new technologies;
- incorporating traditional knowledge and encouraging local innovation;
- networking to strengthen the national capacity to gain access to, adapt and apply new knowledge.

A similar philosophy underlies efforts to mobilize investments in forestry. With improved enabling conditions for sustainable forest management, stronger institutions and more predictable institutional arrangements, financial resources may become more readily available. However, if this is to happen, initial public investment is needed in order to encourage future private sector involvement, given that many constraints to sustainable forest management can be removed through modest support from the public sector. In addition, the right conditions could significantly enhance investment, especially by farmers, community groups and private investors, while improved partnerships among donors would help to avoid conflicting efforts and results.

Agencies and partners have formed the National Forest Programme Facility, hosted by FAO, and are supporting the Programme on Forests, hosted by the World Bank (see Box on p. 55). Through collaborative efforts, these two initiatives are expanding access to both knowledge and financing for sustainable forest management.

are to improve development and implementation of criteria and indicators, to foster political commitment, to strengthen institutional capacity and stakeholder participation, and to contribute to the work of UNFF.

Additional information on international processes concerning criteria and indicators for sustainable forest management can be found on the Internet at www.fao.org/forestry/crit-ind.

NATIONAL FOREST PROGRAMME FACILITY

In many developing countries, the formulation and implementation of national forest programmes is hampered by a number of factors, including a lack of knowledge on how to address key obstacles to sustainable forest management, how to increase the forest sector's contribution to achieving broader development objectives, and how to create an enabling environment for forest sector development through effective forest policies. Weak national capacity for managing and implementing processes that are participatory, multisectoral and country-led is also problematic, as are issues related to governance, accountability and transparency of information.

The establishment of the National Forest Programme Facility is the result of intense collaboration among partner countries, FAO, the Programme on Forests (PROFOR), institutions from developing countries and NGOs in response to a call from the international forest community to consider national forest programmes as an important means of addressing key issues in a comprehensive and multisectoral manner.

The Facility focuses on information exchange, knowledge sharing and capacity building in order to ensure that the participation of the broad range of interest groups in national-level forest deliberations is meaningful. It differs from earlier project-funded assistance in that efforts are now geared to improving conditions that foster sustainable forest management. The Facility also seeks to link forest policy and planning with broader national objectives, strategies and programmes, particularly those concerning poverty alleviation. Critical to its success is the development of partnerships among governments, civil society, the private sector, donors and NGOs in recipient countries.

Over a period of five years and at an estimated cost of US$32 million, the Facility aims to support some 60 countries that are implementing national forest programmes.

Direct country-level support

The Facility will assist governments and civil society to enable them to manage and develop national forest programme processes. Support will vary from country to country, depending on the stage of development of each national forest programme, the extent to which the foundations for sustainable forest management have been laid, and the amount of support available from other sources. Country-level support is expected to improve:

- national capacity to manage the national forest programme process in a participatory

Programme on Forests

The Programme on Forests (PROFOR), recently transferred to the World Bank from UNDP as an element of its new forest policy and strategy, acts as a catalyst in developing new approaches and partnerships and in leveraging support for sustainable forest management initiatives. It analyses and generates knowledge on the implementation of national forest programmes and focuses on issues of common interest to particular countries, the World Bank and PROFOR donors.

The programme is divided into four areas:

- livelihoods;
- finance;
- governance;
- cross-sectoral analysis.

manner, including the participation of civil society, particularly so that forest-dependent people and other marginalized groups, such as the rural poor, can be heard;
- coherence and synergy with broader policy and planning processes, for example those concerning poverty alleviation, the environment and sustainable development in general;
- availability of and access to information and knowledge, for example on forest resources and their use, forest products, marketing and trade, the value of forest products and services, institutions, financing, forest-related agreements and other countries' experience concerning developments in other sectors;
- capacity for policy analysis, negotiation of policy goals and instruments, policy formulation, and implementation of policy instruments such as laws, institutional reforms, incentives and financing mechanisms;
- systemic use of local knowledge, experience and capabilities;
- sharing of knowledge on specific issues and themes through networks.

International forest information platform

The Facility is establishing an international forest information platform to enable users to identify and have access to the best possible sources of knowledge and information relevant to the national forest programme process, whether technical, political, process-related or financial. This platform is a collaborative effort among key providers of knowledge and information. It will make material available in several forms, including electronically, via the Internet, and in print, for those with either insufficient or no access to the Internet. Links are also being established with forest-related international conventions and processes and with providers of information in other sectors such as agriculture, transport, mining and tourism.

Contributions are received from national governments, research institutions, the private sector, NGOs and a multitude of sources that collect information on broad issues, including gender equity, conflict resolution, human rights, governance and corruption. More specifically, organizations and agencies involved in the initiative include the Tropical Agriculture Research and Higher Education Center (CATIE), CIFOR, FAO, the World Agroforestry Centre (ICRAF), the International Institute for Environment and Development (IIED), the International Institute for Sustainable Development (IISD), IUCN, the World Resources Institute (WRI), the World Wide Fund for Nature (WWF), the Global Forest Watch and the International Union of Forestry Research Organizations (IUFRO) Global Forest Information Service.

Further information on the National Forest Programme Facility is available on the Internet at www.fao.org/forestry/nfp.

WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT

WSSD, held in Johannesburg, South Africa from 26 August to 4 September 2002, conducted a ten-year review of UNCED commitments to sustainable development. Participation and interest in the event ran high, with more than 21 000 people joining 104 Heads of State and Government. The two main outcomes were the Johannesburg Declaration on Sustainable Development and the Plan of Implementation. In addition, more than 300 partnerships and other initiatives were submitted to the UN to advance sustainable development in various sectors.

Johannesburg Declaration on Sustainable Development

The Johannesburg Declaration on Sustainable Development affirmed the commitment of countries to continue to implement Agenda 21, endorsed the Plan of Implementation and pledged to achieve the Millennium Development Goals. Countries also resolved to increase access to basic requirements such as clean water, sanitation, adequate shelter, energy, health care and food security, and to protect biological diversity. The document reiterates that economic and social development and

International partnerships launched at the World Summit on Sustainable Development

CONGO BASIN FOREST PARTNERSHIP

At WSSD, the Governments of South Africa and the United States, along with Conservation International, WWF, the Wildlife Conservation Society and many others, announced the establishment of the Congo Basin Forest Partnership to promote economic development, alleviate poverty, improve governance and enhance conservation of natural resources in the region. These shared goals will be pursued through a network of national parks and protected areas, well-managed forestry concessions and assistance to communities that depend on forest and wildlife resources in 11 key landscapes in six Central African countries: Cameroon, the Central African Republic, the Congo, the Democratic Republic of the Congo, Equatorial Guinea and Gabon. Working together, governments, business and civil society are committed to investing time, energy and resources to bring about positive change in natural resource management and sustainable livelihoods in one of the world's largest blocks of intact and interconnected tropical forest.

ASIA FOREST PARTNERSHIP

The Government of Japan and its partners, including several other governments, intergovernmental organizations and NGOs, launched the Asia Forest Partnership to promote sustainable forest management in the region. The collaborative arrangement addresses issues related to good governance and law enforcement, capacity building, illegal logging, forest fires and degraded lands. Building on current international and regional activities, cooperation will extend to such areas as the development of forest policies, plans and programmes; the use of satellite data and mapping; participatory management; human and institutional development; and intersectoral co-ordination within governments. The partnership expects to enhance ongoing sustainable forest management initiatives by providing a framework for conducting research, exchanging information and experiences, and identifying and implementing new bilateral and multilateral programmes.

AMAZON REGION PROTECTED AREAS PROGRAMME

The Amazon Region Protected Areas Programme was presented by the Government of Brazil, GEF, the World Bank and WWF. It aims to expand and consolidate the protected areas system in the Amazon region of Brazil – a region that covers about 5 million square kilometres, encompasses the largest section of rain forest remaining on the planet, contains 23 ecoregions and is the repository of significant biological diversity. Over a ten-year period, the project is expected to create 18 million hectares of new protected areas; consolidate 7 million hectares of existing ones; establish and operate an endowment fund; and set up a system for monitoring and evaluating biological diversity at the protected area and regional levels.

environmental protection are the pillars of sustainable development and emphasizes the vital role of women, indigenous people and the private sector in achieving this goal.

Plan of Implementation

The Plan of Implementation emphasizes that sustainable development depends on the eradication of poverty, changes to unsustainable patterns of production and consumption, and the protection and management of natural resources. It notes that sound national policies, democratic institutions, good governance, ethics and international cooperation are critical factors in the integration of economic, social and environmental dimensions of sustainable development. In addition, the plan specifically calls for action to foster development in Africa and highlights the challenges that globalization poses to sustainable development. A number of global targets were agreed, for example:

- to halve, by 2015, the proportion of people whose income is less than US$1 a day, the

proportion of people who suffer from hunger and the proportion of people who are without access to safe drinking-water;
- to make progress in the formulation of national strategies for sustainable development and to begin their implementation by 2005;
- to reduce significantly the current rate of loss of biological diversity by 2010.

Furthermore, the Plan of Implementation calls for significant increases in financial resources, trade opportunities, access to and transfer of environmentally sound technologies, education and awareness raising, capacity building, scientific capabilities and information for decision-making, because all are important means to implement commitments. It lists detailed actions to take in each of these areas, mainly on the basis of the outcomes of major UN conferences such as the International Conference on Financing for Development, held in Monterrey, Mexico in 2002, and the fourth WTO Ministerial Conference, held in Doha, Qatar in 2001. The plan also calls for strengthened interagency collaboration among UN bodies, especially through partnerships, to bring about positive change on the ground.

WSSD and forests

The Plan of Implementation recognizes sustainable forest management as essential to achieving sustainable development and as a critical means for eradicating poverty, reducing deforestation, halting the loss of forest biological diversity, improving food security and increasing access to safe drinking-water and affordable energy. It calls for action to:
- support UNFF, with the assistance of CPF;
- accelerate implementation of the IPF/IFF proposals for action;
- improve domestic forest law enforcement and efforts to combat illegal international trade in forest products;
- promote sustainable timber harvesting;
- address the needs of the poorest regions, which suffer the highest rates of deforestation;
- support capacity building for sustainable forest management;
- support indigenous and community-based forest management systems;
- implement the CBD expanded Programme of Work on Forest Biological Diversity.

With a focus on development in Africa, the Plan calls for financial and technical support for afforestation and reforestation, for building capacity to combat deforestation and desertification and for improving national forest-related policy and legal frameworks on the continent.

Agreements reached at WSSD in other sectors, such as water, agriculture, energy and biological diversity, will also affect forests, particularly with regard to calls for integrated land management and water-use plans based on the sustainable use of renewable resources. The need for new and different partnerships has therefore never been greater, and WSSD has provided the impetus for all sectors to rise to the challenges ahead. ◆

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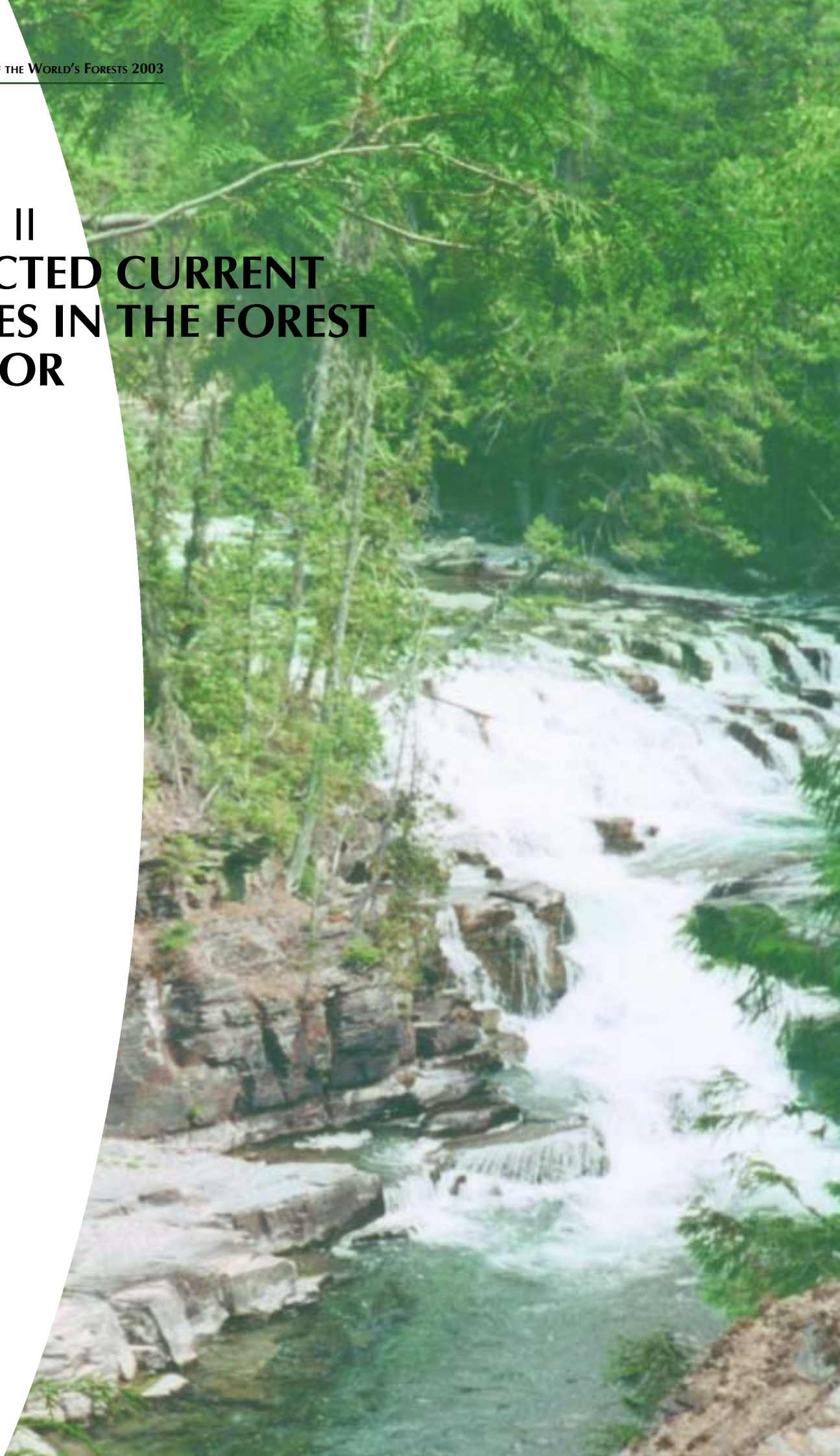
PART II
SELECTED CURRENT ISSUES IN THE FOREST SECTOR



Forests and poverty alleviation

This chapter focuses on the role of forests, particularly natural ones, in poverty alleviation in developing countries. While some attention is given to the potential of planted forests and agroforestry to alleviate poverty, space constraints allow only a passing reference to trees outside forests. Thus, while not attempting to provide an extensive analysis of the topic, the chapter defines forest-based poverty alleviation, examines the potential of forests in this regard, notes obstacles to progress, identifies conditions that may strengthen the role of forests in alleviating poverty, and proposes several strategies to improve the contributions of the forest sector.

Forests can be vital safety nets, helping rural people to avoid, mitigate or rise out of poverty. This function is unknown to many policy-makers and planners because it is not well understood or explained. One reason is that the contribution of forests to poor households is largely unrecorded in national statistics, as most of it is for subsistence or for trade on local markets. In addition, most wealth from timber goes to better-off segments of society, while some aspects of the access to and processing of timber resources actually inhibit their potential to assist marginalized people. Despite these obstacles, the contribution of forests to poverty alleviation can be increased, provided that decision-makers recognize and act on this potential.

DEFINITION OF TERMS

Poverty can be defined as a pronounced deprivation of well-being related to lack of material income or consumption, low levels of education and health, vulnerability and exposure to risk, no opportunity to be heard, and powerlessness (World Bank, 2001). Thus, poverty alleviation can be defined as the successful lessening of the deprivation of well-being. This chapter specifies two types of poverty alleviation associated with forest resources, as seen at the household level. These are:

- poverty avoidance or mitigation, in which forest resources serve as a safety net or fill gaps, for example by providing a source of petty cash;
- poverty elimination, in which forest resources help to lift the household out of poverty by functioning as a source of savings, investment, accumulation, asset building and permanent increases in income and welfare.

The term "forest-based poverty alleviation" thus covers situations in which forest resources are used either to avoid or to mitigate poverty, and situations in which they are used to eliminate poverty. Forest-based poverty alleviation cannot be carried out in isolation. It tends to be linked to other land uses, in particular agriculture, grazing and mixed systems of crop and tree growing.

There are three main ways of achieving forest-based poverty alleviation: preventing forest resources from shrinking if they are necessary for maintaining well-being ("protecting the pie"); making forests accessible and redistributing resources and rents ("dividing the pie differently"); and increasing the value of forest production ("enlarging the pie"). All are vital, but they are applied differently, depending on forest use and the strategies adopted.

It is also recognized that, in examining the forest-poverty relationship, there is a need to consider all types of disadvantaged people, irrespective of their level of poverty or of whether they are landless or have access to land. Even small differences in the level and type of household assets influence how forest people use their local resources (Barham, Coomes and Takasaki, 1999).

OPPORTUNITIES AND OBSTACLES IN FOREST-BASED POVERTY ALLEVIATION

Poverty often occurs in natural forests, although not all forested areas are poor and not all poverty is found in forested areas. Natural forests are home to human evolution, and human populations that have lived there for millennia are at a relatively low level of socio-economic development. Moreover, migrant rural populations that colonize forested areas and seek new agricultural land are often relatively poor. Forests often serve as a last-resort employer for economically marginalized people (owing, for example, to skewed land distribution in the lowlands). In the course of history, forests have often served as a refuge for less powerful people fleeing oppression, conflict and war.

Hundreds of millions of people depend on forests. It is hard to be specific about numbers because such an assessment depends on how dependence is defined (Byron and Arnold, 1999; Calibre Consultants and Statistical Services Centre, 2000). Byron and Arnold (1999) identified three categories: forest dwellers, including hunter-gatherers and swidden cultivators; farmers living adjacent to forests, including smallholders and the landless; and commercial users, including artisans, traders, small entrepreneurs and employees in forest industries. An additional category is consumers of forest products among the urban poor.

Forests serve as a vital safety net for millions of people around the world. Their role in eliminating poverty is not as well documented, but probably concerns a smaller number (Wunder, 2001). Little is known of the extent to which forests can alleviate poverty in developing countries in the future. Much research needs to be done in order to shed light on this question.

This section summarizes basic information on the opportunities and obstacles for forest-based poverty alleviation as regards five categories of forest use: conversion of natural forests to agriculture; wood products; non-wood forest products (NWFPs); payment for environmental services; and employment and indirect benefits. It also notes that the destruction and removal of forest cover, on the one hand, and its maintenance and sustained use, on the other, can both support poverty alleviation. A critical role for research is to clarify where forest conservation and poverty alleviation converge and where they diverge as policy goals.

Conversion of forests to agriculture

Between 1700 and 1980, the world's forest cover decreased by 19 percent, and the area of agricultural land increased four and a half times (Richards, 1990). The driving forces of this conversion were forest rent capture (use of unexploited economic opportunities), commercial interests behind the establishment of agricultural trade and the conversion of forest land to agriculture. Rural smallholders have also benefited from this process. The conversion of natural forests to agriculture – in other words, exploitation of the soil nutrient-building function of forests – is probably their main contribution to poverty alleviation in terms of numbers, in that hundreds of millions of people have probably benefited throughout history. Where smallholders are concerned, the conversion of natural forests can be either temporary, as with swidden systems, or permanent, as with sedentary agriculture.

Population increases in developing countries and the increasing demand for land are among the forces propelling forest conversion. According to FAO (1995), the area of agricultural land in developing countries, excluding China, will have to increase from 760 million to 850 million hectares by 2010 to meet the demand for food. Dyson (1996) and Evans (1998) claim that potentially cultivable land is abundant and that there is, in theory, no constraint in terms of supply. However, as Evans (1998) explains: "Much of the presently uncultivated area is already used for grazing livestock or is of poorer quality, too remote or subdivided to be economic, vulnerable to erosion, or cherished in its present state." The consequences of clearing all available cultivable land to meet demand are potentially disastrous. Most future increases in the demand for food will have to be met through more efficient use of existing agricultural land (Dyson, 1996; Rosegrant *et al.*, 2001). Some transitional land-use options, such as complex agroforests,

tree crop plantations and scattered trees on farmland, can potentially assist with poverty alleviation while conserving forests. However, win-win opportunities are few, and trade-offs must be made to prevent forests from disappearing (Tomich *et al.*, 2001; Lee, Ferraro and Barrett, 2001).

Local constraints on clearing large tracts of forest for agriculture are that some forest land has poor-quality soil or is in marginal, hilly or erosion-prone areas. In addition, permanent clearing means losing the safety net and income-generating functions of forests. At the global level, possible checks on further forest clearing include the consequences of a diminished capacity for carbon sequestration and the loss of habitat and biological diversity.

Wood products

Timber is by far the highest-value forest product in most forests. In 1998, the export of industrial roundwood, sawnwood and wood-based panels from developing countries accounted for US$10.4 billion (FAO, 2001a). (This figure excludes woodfuel, pulp for paper, and paper and paperboard. It also considerably understates the total value of timber, because most timber by volume is traded within countries and not internationally.) With so much wealth stored in developing country forests, the question arises as to why little has gone towards alleviating the poverty of people living in their midst. There are two reasons.

First, both timber extraction from natural forests and tree growing have certain features that

Community forestry in the United States: learning from developing countries

Community forestry is an emerging movement in the United States and is drawing heavily on lessons learned in many developing countries.

Tucked into forested mountains throughout the United States are numerous small towns where residents struggle daily to make a living. Poverty, unemployment, isolation and limited capital are among the features common to such forest communities. By the 1990s, their historical dependence on forest resources had been sharply reduced by resource depletion, increased environmental protection and globalization. Seeking economic activities to fill the gap, some communities began to explore how they could create sustainable rural livelihoods based on forest stewardship rather than resource extraction. They therefore cast about for models – and found them in community forestry efforts in developing countries.

Community forestry, in which local residents share in the decision-making, benefits, labour and expertise involved in managing local forests, has a history spanning decades in Asia, Africa and Latin America. Practitioners from developing countries have been influential sources of new ideas for rural forest communities in the United States. United States researchers, foundation representatives and ex-Peace Corps workers have applied their international experience to their work with communities in the United States. Most notable for local residents has been direct contact with community forestry practitioners from developing countries. Foresters, activists and government personnel from such countries as India, Mozambique and China have visited community forestry projects in the United States, offering insights and inspiration to local people. Community foresters in California have linked up with colleagues from the Philippines and Zimbabwe to share experiences. Several people from the United States attended the 2001 International Conference on Advancing Community Forestry, held in Thailand, in order to learn from the 300 participants of 28 other – mostly Asian – countries. The lessons they brought back to the United States emphasize the common challenges of capacity building, forest microenterprise development and effective collaborative agreements.

The United States community forestry movement is now growing and connecting with other efforts throughout the nation and across the world. Its strategies and successes owe much to lessons learned from developing countries.

do not favour the poor. Although some production and processing of timber is on a small scale and for local markets, much is capital-, technology- and skill-intensive, tends to require large economies of scale and is aimed at specialized consumer markets. Tree growing for timber requires secure land tenure, and the poor are often landless or have only informal control over the land that they use. High-value timber for extraction tends to be in inaccessible humid forests, whereas the poorest people are more numerous in dry forests. Tree growing requires a long-term, high-risk investment, while the poor require income in the short term and strive to minimize risks. Nevertheless, many poor rural families that own land in established agricultural areas do plant some trees.

Second, some poor people are excluded from access to timber wealth precisely because the value of timber is so high and because they lack power (see Peluso, 1992). In many countries, forest tenure, laws and regulations were designed on the one hand to ensure State control, with holders of timber concessions being granted privileged access, and on the other hand to avert interference and counter-appropriation by the rural poor. Only in recent years has this begun to change.

Two models of wood production – local management of natural forests and tree growing by smallholders – can possibly alleviate poverty, but significant obstacles are attached to both. Local management of natural forests is hampered by weak and slow-changing institutions, rent capture by local élites, inconsistent laws and regulations and cumbersome bureaucracy. In addition, communities lack control of downstream activities, and much of the forest rent is captured by those involved in processing and marketing. Although the use of trees for subsistence, for example for fuelwood, is an important function, overexploitation is common (e.g. Rathore, Singh and Singh, 1995; Schulte-Bisping, Bredemeier and Beese, 1999). While tree growing by smallholders can potentially produce substantial income, it requires access and land tenure security, which the poorest people tend not to have.

Non-wood forest products

NWFPs provide a wide range of goods for domestic use and for the market, among which are game, fruit, nuts, medicinal herbs, forage and thatch. In contrast to timber, NWFPs tend to require little or no capital and also to be available in open-access or semi-open-access circumstances. The poor generally use various types and are thus able to spread risk among different activities. There is strong evidence that the poorest people around the world are those most engaged in extracting NWFPs. This then raises the question of whether or not these products contribute positively to the livelihoods of the poor.

From a positive perspective, NWFPs can be viewed as a safety net. They are a source of emergency sustenance in times of hardship – when crops fail, when economic crises hit, in times of conflict or war, or when floods wash away homes. NWFPs tend to be seasonal or to fill gaps, and are sometimes a form of savings, but are rarely the primary source of household income (Byron and Arnold, 1999; FAO, 2001b), although there are important exceptions.

NWFPs can also be a poverty trap. Rural people rely on NWFPs because they are poor, but it is also possible that they are poor because they rely on NWFPs and economic activities for which remuneration is low. Some characteristics of the forest environment and the NWFP economy make it difficult or impossible for those who depend on them to rise out of poverty. Natural forests are often inferior production environments with little infrastructure, high transport costs because of remoteness, few buyers and exploitive marketing chains. The net benefits of NWFPs are often too low to justify articulating property rights, and as a result there is limited incentive to invest and increase yields. In the few cases where NWFPs have high value, the poor are often excluded from access (Dove, 1993). Furthermore, a sustained increase in the demand for NWFPs can lead to the collapse of the resource base, intensive production on plantations outside forests or the production of synthetics that are more competitive than NWFPs (Homma, 1992).

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Forests provide a safety net: a young farmer in Burkina Faso picks the leaves of a baobab tree (**Adansonia digitata**)*, for use as a food condiment*

The safety net and poverty-trap aspects of NWFPs are linked, inasmuch as the features that make them attractive to the poor also limit their potential for generating increased income. The key issue is how to preserve the role of forests as safety nets in locations where they are more than dead-end poverty traps and where other forms of social insurance cannot take their place.

Environmental services

The ecological services of forests are relevant to poverty alleviation in two ways. First, forests provide direct benefits to people living in or near them. Second, people living in or near forests that they own or manage can receive transfer payments for non-local services provided by them.

Forest dwellers can benefit directly from maintaining healthy forest ecosystems. For example, healthy forests can protect the quantity and quality of water supplies (WRI, 2000) and maintain or enhance agricultural production by restoring soil fertility in agroforestry systems (Sanchez, Buresh and Leakey, 1997). Forest biological diversity also provides various ecological benefits, including germplasm for crop improvement. The direct use of forest environmental services is related to the poverty avoidance/mitigation function of forests.

This section focuses on transfer payments, whereby off-site users pay forest dwellers to maintain the ecological services of particular forests. These payments could potentially improve the livelihoods of forest dwellers and help to eliminate poverty. However, while the potential benefits are immense, the challenges to implementing such schemes continue to be daunting.

Carbon storage and sequestration schemes seek to mitigate the contribution of forests to global warming, either by a reduction in forest degradation and deforestation or by reforestation, or by some combination of the two. Thirty forest-based carbon offset schemes have been developed to date, but sceptics point to high transaction costs and economies of scale that limit the involvement of the poor (Bass *et al.*, 2000; Smith *et al.*, 2000). The Clean Development Mechanism of the Kyoto Protocol must include safeguards to avert risks to local livelihoods and provide incentives for social benefits in forestry projects (Smith and Scherr, 2002).

Since the 1970s, integrated conservation and development projects have aimed at protecting forest habitats and biological diversity while improving livelihoods. Most have been unsuccessful, especially in terms of conservation objectives (Wells and Brandon, 1992; Gilmour, 1994). The main problem is that the employment provided through such projects does not necessarily reduce the incentives or the means for forest encroachment. In fact, such programmes may relax capital constraints and enable farmers to convert more forests to agriculture (Wunder, 2001). An alternative

approach is to pay people directly for the ecological services they protect, a tool that is under rapid development.

There have been payment schemes, mainly in Latin America, to compensate upstream forest owners for the protection of hydrological services. Examples include payments by hydroelectric plants, drinking-water consumers and users of irrigation systems in Colombia, Costa Rica and Ecuador (Pagiola, 2001) and tax benefits to forest-rich municipalities in Brazil (Grieg-Gran, 2000). The welfare implications of these schemes are not yet known. Landell-Mills and Porras (2002) state that the key hurdles facing the poor in watershed protection schemes are their lack of bargaining power and their lack of access to markets.

While tourism companies benefit disproportionately from forest-based tourism schemes, there is evidence that even small absolute cash transfers per tourist from nature-based tourism can benefit local people significantly. Examples are the CAMPFIRE project in Zimbabwe (Zimbabwe Trust, Department of National Parks and Wildlife Management, and CAMPFIRE Association, 1994), the Annapurna Conservation Area Project in Nepal (Gurung and Coursey, 1994), international ecotourism operations in Ecuador (Wunder, 1999) and nationally controlled tourism in forest areas in Brazil (Wunder, 2000).

Employment and indirect benefits

Very little is known about alleviating poverty through formal or informal forest sector employment and through indirect benefits, such as local multiplier effects or trickle-down effects. As limited empirical evidence is available, the present section lists only basic information about these aspects.

Employment. In the late 1990s, there were roughly 17.4 million employees in the formal forest sector worldwide, and roughly 47 million if informal employment was also included (ILO, 2001). Forest sector employment is understood here as encompassing forestry (including logging), wood industries (including furniture making) and pulp and paper production, but as excluding employees in government forest services and people involved in the transport, marketing and trade of forest products who are not employed by forest industry firms. A study of six developing countries found that forest-based enterprises accounted for 13 to 35 percent of all small-scale rural enterprise employment (FAO, 1987).

Local multiplier effects. It is possible that forestry activities alleviate poverty through local multiplier effects. For example, opening a forest concession and bringing in a logging workforce creates a demand for food, goods and services, as well as employment opportunities. Likewise, creation of a logging road not only enables the transport of logs, but also opens up access to markets for other goods, potentially increasing local incomes. It can also give local people access to outside health and schooling services. However, negative effects must also be considered, among which are reduced NWFP production from logged-over forests, conflicts with logging companies and disruptions resulting from the collapse of the economic boom after the logging has ended.

Trickle-down effects. Not enough is known about the extent to which forestry contributes to poverty reduction through its impact on overall economic growth, or about whether cheaper forest products from increased market supplies improve the economic status of urban consumers. The contribution of the forest sector to gross domestic product (GDP) tends to be a small fraction in most developing countries. It should be noted, however, that the value-added figure for the forest sector significantly underestimates the total, inasmuch as a large share of forest products are not registered because they are used for subsistence and trade on local markets. Moreover, low GDP contributions can also reflect the simple fact that in many cases forest products are not scarce and are therefore cheap (Simpson, 1999). Furthermore, although timber wealth often represents only a small share of GDP, it tends to be important for economic development, as the

capital from liquidated timber resources is used to establish economic activities outside the forest sector.

ENABLING CONDITIONS AND STRATEGIES

This section identifies recent developments and presents strategies that may improve the potential of forests to alleviate poverty.

Enabling conditions

The following changing socio-economic, political and environmental conditions present opportunities to enhance the role of forests in alleviating poverty. However, they do not guarantee a positive outcome. If forests are to serve effectively in this regard, conscious and dedicated efforts must be made.

Decentralization. Decentralization of authority and resource control is now occurring in many developing countries. This process increases – although by no means guarantees – the possibility of greater local access to forest rents. In some disappointing cases, mechanisms to exclude the poor have merely been reconfigured.

Forest tenure changes. As a result of extensive redistribution of forest resources in developing countries, 22 percent of the total forest area in these countries is now owned by or reserved for communities and indigenous groups (Scherr, White and Kaimowitz, 2002; White and Martin, 2002). Again, this does not guarantee that poverty will be alleviated, but may improve the chances.

Democratization. The trend towards democratization in many developing countries potentially increases the bargaining power of rural communities *vis-à-vis* the State and large enterprises. In Indonesia, for example, rural villagers are now freer to stake a claim to forest land and resources than they have been in the past 30 years.

Anticorruption campaigns. Corrupt practices in the forest sector tend to work against the interests of the poor (e.g. Hill, 2000). Together with democratization, anticorruption campaigns can boost opportunities for the rural poor to obtain a larger share of forest wealth.

Withdrawal of concession holders. In many countries, after concession holders have overharvested timber, they have not renewed their concessions. Their withdrawal presents an opportunity for forest communities to intercede and compete for access rights prior to the maturing of marketable timber stems.

Growing markets. Rapidly growing urban markets provide new opportunities for smallholders, especially those living in peri-urban areas, to market forest products. The increased scarcity of some forest products, such as fuelwood, makes it more profitable to grow them on-farm.

Market deregulation and liberalization. Market deregulation and liberalization can favour forest-based poverty alleviation in two ways. First, it can be a force behind the elimination of regulations that prevent tree growing on farms. (In the past, such tree growing has been more controlled than the growing of annual crops.) Second, it can lead to the reform of forestry marketing regulations that have tended to discriminate against small producers. However, trade liberalization does not always favour the interests of the poor, and government monopolies can easily be replaced by private ones. Government intervention is therefore needed to protect vulnerable people against negative effects (J. Mayers and S. Vermeulen, unpublished).

New technology. Small portable sawmills with lower capital requirements should favour a more decentralized production system for sawnwood, which should in principle make it easier to involve local entrepreneurs. Technological changes in the plywood industry allow the use of smaller-diameter trees and more species. This could increase the commercial value of the less valuable forests over which local communities have, at least in the past, had control. However, there is a risk that technologies that make new

areas and species commercially profitable for logging will speed up deforestation.

Growing global environmental threats. The growing threats of global warming and greater loss of biological diversity increase the likelihood that developed countries will be willing to compensate forest dwellers in developing countries for such environmental services as carbon sequestration and conservation concessions.

Strategies

The following six strategies are among those that hold the most promise of contributing to poverty alleviation.

People-centred forestry. Improved use of forest resources to alleviate poverty requires, above all, that forestry be people centred (FAO and DFID, 2001; Warner, 2000). Operationally, this means that the poor in forested areas must have a much greater say in determining their destinies and livelihoods. Local people should be the main stakeholders where forests continue to be central to livelihoods, and meeting their needs on a sustainable basis should be the main objective of forest management (Warner, 2000). As explained by Peluso (1999), "people's relations with others are as important to understanding their use of the forest as are their direct forest management activities". In view of the fact that conflicts tend to arise over access to forest resources, policies should formally recognize that intervention is needed to defend the interests of those who are powerless.

Removal of tenure and regulatory restrictions. A pro-poor forest use strategy requires the transfer (or return) of public forest land to local control so that local people can enter into long-term business contracts (Scherr, White and Kaimowitz, 2002). The elimination of excessive regulations, as well as regulations that discriminate against smallholder and artisan production of and trade in forest products, is equally important (Scherr, White and Kaimowitz, 2002; Arnold, 2001; FAO and DFID, 2001). In general, people should be allowed to decide whether to plant or harvest trees on their own land. If management plans really are required because of important external benefits, they should be kept simple. In some cases, regulations designed to exclude poor people are redundant, because large enterprises have overharvested and exhausted high-value timber rents. If local governments are inefficient or corrupt, or if local élites monopolize the benefits, the devolution of control over forest resources may not be advantageous to poor people. However, with good governance, devolution can work in their favour.

Improvement in marketing arrangements. Forest market policies that subsidize or provide privileged access to large-scale producers and processors must be eliminated, so as to move towards a "level playing field" for marginal producers (Scherr, White and Kaimowitz, 2002; FAO and DFID, 2001). Other measures to redress unfairness include: the elimination of tied credit deals and minimum volume or area requirements; the establishment of special sorting yards and services that provide information on prices and markets; and the active involvement of local producers in policy negotiations affecting forest markets (Scherr, White and Kaimowitz, 2002). Intervention strategies must distinguish between people who are involved in forest product activities because they lack other income sources and those who are responding to market opportunities (Arnold and Townson, 1998).

Partnerships. Closer partnerships between smallholders or communities and commercial companies, as in the case of outgrower schemes, would be an important step forward. An effective partnership between poor people and the private sector needs to be based on each group's comparative advantages. The poor can supply cheap labour and land, while companies have easier access to capital, knowledge, technology and markets. Mayers (2000) and Desmond and Race (2001) summarize lessons learned from such arrangements. Genuine

partnerships facilitate secure contractual obligations between communities and companies, in that communities receive an adequate economic return and companies are assured a supply of wood. The bargaining power of individuals and communities is often weak, and producer associations and alternative market outlets strengthen their power. NGOs have a crucial role to play in strengthening the negotiating power of farm foresters and producer associations by making the contract process transparent and by assisting the flow of information. Government is also an important player, since an enabling environment is required for effective partnerships to take root.

Redesign of transfer payments. The lack of secure land tenure and the high transaction costs of contracts with smallholders make it difficult to involve the poor in compensation agreements for the provision of environmental services. Moreover, many poor people are unaware of these income-earning possibilities and have no advocate to act on their behalf. Since poor people control an increasing share of tropical forest land, it is crucial to involve them if goals related to climate mitigation are to be achieved. One approach is to compensate governments for not logging certain areas (conservation concessions). Another is to pay local people for not deforesting and for safeguarding biologically diverse forest on their land (conservation easements). Under these arrangements, direct payments are made on the basis of the monitored quality of the forest resource. Setting aside of areas in this way is still in a pioneer

The Role of Forests and Trees in Poverty Alleviation
Cortevecchia, Italy, 4 to 7 September 2001

To explore further the ways in which forests and forestry can contribute to the United Nations' Millennium Development Goals and the targets of the World Food Summit, FAO, with support from the United Kingdom Department for International Development (DFID), convened an international forum that brought together some 60 policy-makers and practitioners to identify ways in which forest policy, legislation and programmes can alleviate poverty. Discussions resulted in an agenda for action that identifies four main areas.

STRENGTHENING RIGHTS, CAPABILITIES AND GOVERNANCE

- Support the decision-making power of the poor
- Strengthen the forest rights of the poor and the means to claim them
- Recognize the links between forestry and local governance

REDUCING VULNERABILITY

- Make safety nets, not poverty traps
- Support tree planting outside forests
- Cut the regulatory burden on the poor and make regulation affordable

CAPTURING EMERGING OPPORTUNITIES

- Remove the barriers to market entry
- Base land-use decisions on the true value of forests
- Ensure that markets for environmental services benefit the poor
- Support associations and financing for local forest businesses

WORKING IN PARTNERSHIP

- Simplify policies and support participatory processes
- Promote multisectoral learning and action
- Enhance interagency collaboration
- Make NGOs and the private sector partners to reduce poverty

Further details are available on the Internet at www.fao.org/forestry/fon/fonp/cfu/brochure/brochure.stm.

phase, but its application is rapidly expanding because of the growing demand for these services (Ferraro, 2000; Cutter Information Corporation, 2000). Improvements of transfer payment initiatives must be supported by policy research (Gutman, 2001).

Integration of forestry into rural development and poverty reduction strategies. The elimination of poverty in forested regions will involve not only the forest sector but also other sectors, such as agriculture, health and education. Forest-based poverty alleviation must be part of an overall rural development strategy and cannot be carried out in isolation. By the same token, efforts in other sectors must recognize the current role of forests in mitigating and avoiding poverty, and their potentially larger role in eliminating poverty. At the national and local levels, forests must be seen as an important asset to fight poverty (Gordon, Berry and Schmidt, 1999). A crucial first step is to review national poverty reduction strategies to ensure that, wherever appropriate, they recognize the importance of forests and include measures such as those proposed above.

SUMMARY AND CONCLUSION

At the beginning of the twenty-first century, poverty remains a problem of huge proportions, with 1.2 billion people, mostly in developing countries, living on less than US$1 a day (World Bank, 2001). In such circumstances, it is important to join forces to face the moral challenge, and the potential of the forest sector to contribute to poverty alleviation must be examined.

The present chapter makes a distinction between two forms of poverty alleviation in relation to forests. First, forest resources help marginal people to avoid poverty or mitigate the poverty that they are experiencing. NWFPs have a special but ambiguous role in this regard, because although their relative accessibility and low capital requirements make them valuable safety nets, these same qualities may make them poverty traps. Second, forests can help people lift themselves out of poverty. This potential is often unrealized because high-value timber tends to attract powerful competitors and because certain characteristics of timber make it relatively inaccessible to the poorest people.

Various forest uses provide both opportunities for and obstacles to poverty alleviation. Nine types of sociopolitical change may favour a greater role for forests in the future, although this is not assured. These changes are: decentralization; more secure forest tenure; democratization; better governance; overharvesting and withdrawal by concession holders; growing urban markets; market deregulation and liberalization; new technology; and a greater willingness to pay for environmental services.

Poverty alleviation is best pursued through policy reform. A forest-based poverty alleviation strategy should include the following elements: establishment of a people-centred agenda; removal of tenure and regulatory restrictions; improvement in marketing arrangements for marginalized people; creation of partnerships between poor people and forest enterprises; redesign of transfer payments; and integration of forest-based poverty alleviation efforts into rural development and poverty reduction strategies.

In closing, three points deserve emphasis. First, it is useful to note the recent attention to forests and poverty. In the 1960s, it was believed that forests could and would play a key role in alleviating poverty in developing countries. In the 1980s, disillusionment set in with the realization that the forecast of the 1960s had been overly optimistic (Westoby, 1987). At the dawn of the new millennium, there is renewed attention to this topic and a new call for people-centred forestry. While certain enabling conditions present a tentative basis for optimism, substantial benefits to poor people are unlikely unless they can achieve a degree of political power and influence that they currently lack.

Second, natural forests are under severe threat throughout the developing world, and the poor people who depend heavily on them are those who stand to suffer the most from their disappearance and degradation by outside agents. The practical implications of this situation are that equity and social justice must

be raised as additional reasons for natural forest conservation, and that the forest-dependent poor are a potentially important constituency in the mobilization to conserve forests. In some cases, giving poor people a greater voice assists not only the poverty alleviation goal, but also forest conservation.

Finally, it is important to recognize that much remains unknown about the relationship between forest resources and rural livelihoods. Developing such knowledge is crucial for designing forest-based poverty alleviation programmes that are effective, equitable and long-lasting. Greater understanding is particularly needed in three areas: how forests function as safety nets; ways of increasing forest income; and the significance of cross-cutting issues and political trends. ◆

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Sustainable use and management of freshwater resources: the role of forests

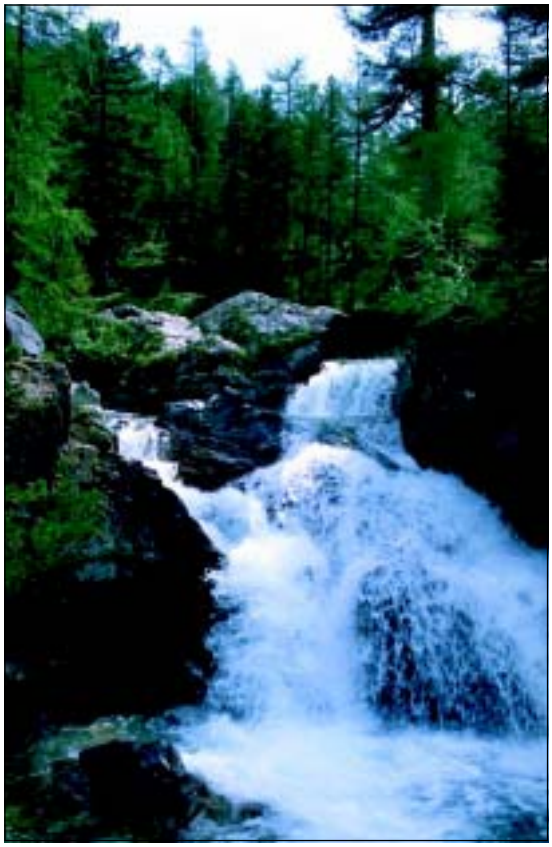
Dependable freshwater supplies and the ability to cope with the extremes of too little or too much water are requisites for sustainable human development. Warnings of freshwater scarcity issued at the end of the twentieth century (e.g. Falkenmark, 1989; Kundzewicz, 1997; Vorosmarty *et al.*, 2000) are proving to be accurate, to the point that lack of water now threatens food security, livelihoods and human health (see UN, 1992; IFPRI, 2001). Worldwide, freshwater supports about 40 percent of all food-crop production via irrigation, supports 12 percent of all fish consumed by humans and generates 20 percent of all electric power (Johnson, Revenga and Echeverria, 2001). In addition to the direct impact of water scarcity, impaired quality of water reduces its usability.

More than 3 billion people worldwide do not have access to clean water, and the problem is particularly acute in developing countries, where 90 percent of wastewater is discharged into streams without treatment (Johnson, Revenga and Echeverria, 2001). Of the more than 3 million deaths that are attributed to polluted water and poor sanitation annually, more than 2 million are children in developing countries (van Damme, 2001). Furthermore, extensive loss of life and economic productivity result each year from rain-induced landslides, floods and torrents in developed and developing countries alike. Water and its management are therefore strategically important to economies and the well-being of people, and water management has become one of the major challenges of this century. Conflicts over water use will arise as water becomes increasingly scarce, making action on many fronts imperative.

Technologies exist to deal with water scarcity, and to some extent with the effects of hydrometeorological extremes (Brooks *et al.*, 1997). If they are to be turned into solutions, several constraints must be overcome, including land scarcity and inadequate policies and institutions that hamper an effective response (Kundzewicz, 1997; Rosegrant, 1997; Scherr and Yadav, 1996). Although land use and freshwater are inextricably linked, they are rarely managed in concert. Upstream uses of land and water can affect downstream communities and their use of water. The converse is also true. Such linkages are readily seen with a watershed perspective, but are not always fully taken into account when responses are being developed at the local, national and international levels.

The International Year of Mountains – 2002 (Internet: www.mountains2002.org) focused worldwide attention on land and water use in mountainous watersheds. As the headwaters for all major rivers of the world, many of which are or were at one time forested, these watersheds are a key to freshwater management. The relationship between forests and freshwater, in both tropical and temperate regions, therefore needs to be understood if forests are to be better managed to sustain the productivity of uplands without affecting humans and the soil and water on which they depend. Enhancing the chances of achieving such objectives means taking a watershed management perspective in the planning, monitoring and implementation of forest, water resource, agricultural and urban development programmes.

Forested mountain watersheds are a key to dependable freshwater supplies (Switzerland)



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The loss of forest cover and conversion to other land uses can adversely affect freshwater supplies and compound human disasters resulting from hydrometeorological extremes. Watershed conditions can be improved and overall water resource management facilitated if forests are managed with hydrological objectives in mind. While not a panacea for resolving water issues, forests can provide tangible economic and environmental benefits. A watershed framework helps identify these benefits in both upstream and downstream areas.

Forests are found where there are large quantities of water, normally where precipitation is abundant or in riparian areas where soil moisture is high. Perception of the influence of forests on water led to the establishment of the national forest system in the United States, as forest cover was considered necessary to sustain river flow (Lee, 1980). Most forests were subsequently found to use great amounts of water, contrary to early thinking. The present chapter summarizes the impact of forests on freshwater and suggests how forests and forest management can help achieve water resource management objectives.

Forested watersheds are exceptionally stable hydrological systems. In contrast to other land uses, healthy forests:

- strongly influence the quantity of water yielded from watersheds;
- discharge the highest quality of water;
- discharge lower storm flow peaks and volumes for a given input of rainfall;
- moderate variation in stream flow between the high and low flows during a year;
- provide the greatest soil stability and the lowest levels of soil mass movement, gully erosion and surface erosion;
- export the lowest levels of sediment downstream.

FORESTS, ATMOSPHERIC WATER AND WATER YIELD

The relationship among forests, atmospheric moisture and water yield has long been controversial. Lee (1980) noted that the natural coincidence of forest cover and higher precipitation is at least partly responsible for the popular notion that forests increase or attract rain, which leads to the assumption that their removal would significantly diminish precipitation. Globally, this is not the case; the removal of all forest cover would only reduce global precipitation by 1 to 2 percent at most (Lee, 1980). Calder (1999a) further suggested that deforestation has little effect on regional precipitation, although exceptions could occur in basins where rainfall largely depends on internally driven circulation patterns, such as the

Amazon basin. Even then, it has been estimated that complete deforestation and replacement with non-forest vegetation would reduce basin rainfall by less than 20 percent (Brooks *et al.*, 1997).

There are circumstances, however, in which forests intercept fog or low clouds (cloud forests), adding moisture to the site that would otherwise remain in the atmosphere. The relationship between forests and the yield of freshwater differs between cloud forest and non-cloud forest conditions.

Cloud forests and freshwater yield

Cloud forests occur along coastal areas in temperate climates and also in tropical montane regions where fog or low cloud conditions are common. Forests intercept atmospheric moisture (horizontal precipitation), which condenses on and drips from foliage, adding moisture to the soil. Rainfall is not increased, but forests add moisture that low-growing vegetation would not. The following are examples of freshwater augmentation by cloud forests.

- Coastal forests in the fog belt of western Oregon, the United States, augment water yield (Harr, 1982; Ingwersen, 1985). The removal of old-growth conifer forests from the municipal watershed of Portland, Oregon, reduced summer stream flow, but the regrowth of vegetation caused stream flow levels to return to normal within five to six years.
- Water augmentation by tropical montane cloud forests varies with altitude, location and season (Bruijnzeel and Proctor, 1993). The ratio of horizontal precipitation to annual rainfall was shown to vary between 4 and 85 percent, with higher values corresponding to dry seasons, while average horizontal precipitation varied between 0.2 and 4 mm per day. Annual stream flow from tropical montane cloud forest for a given rainfall was higher than from other tropical forests. The stream flow response to conversion of tropical montane cloud forest to other land uses has not been widely documented, although research is under way in Central America (Calder, 1999b, as reported by Kaimowitz, 2000).

Non-cloud forests and freshwater yield

Outside fog or tropical montane cloud forest regions, forests generally consume large quantities of water. More than 100 watershed experiments around the world have shown that forest removal increases stream flow, which varies in magnitude with climate and forest type and diminishes as forests regenerate (e.g. Bari *et al.*, 1996; Bosch and Hewlett, 1982; Lesch and Scott, 1997; Verry, Hornbeck and Todd, 2000; Whitehead and Robinson, 1993). When other land uses replace forests, flow increases are sustained. With few exceptions, results show the following.

- Removal of forest cover increases annual water yield by 60 to 650 mm. The size of the increase is generally proportional to the amount of biomass removed and is greater in wetter areas. Little effect has been reported in dryland areas where annual precipitation is less than 400 mm.
- Flow during dry seasons generally increases after forests are thinned or removed.
- Forests with high interception rates (e.g. conifers) or high transpiration rates (e.g. eucalypts) yield less water than those with lower interception and transpiration rates. Water yield would therefore be expected to increase when conifer forests are replaced by broadleaf forests and to decrease when broadleaf forests, shrubs or grasses are replaced by conifers (see Box opposite).

FORESTS, FLOODS AND DEBRIS FLOWS

Forests produce low levels of storm flow and greater soil stability than any other vegetation type because of their high infiltration rates, protective ground cover, high consumption of soil water and high tensile strength of roots. These attributes are particularly beneficial in mountainous terrain that is subject to torrential rainfall. Forest removal and road construction are problematic in such areas because they

A lesson from Fiji

Afforestation reduced water yield to a water supply reservoir in Fiji (Drysdale, 1981).

On the leeward side of two of the largest Fiji islands, 60 000 ha of *Pinus caribaea*, planted to develop a wood-based industry, replaced shrub vegetation. Six years after the forest was planted, dry season flows to a downstream water supply reservoir had decreased by 50 to 60 percent. The areas afforested were not in a cloud-forest environment. Had freshwater resources been considered in the afforestation plan, species with lower interception and transpiration rates would have been preferred over conifers.

The experience in Fiji convinced the Beijing Water Conservancy Bureau to reverse its plans to replace Chinese locust and shrubs with pine in the catchment area of the Miyun Reservoir, a key municipal water source for Beijing. Planners had mistakenly thought that conversion to pine would increase water yield to the reservoir, whereas the result would have been the opposite.

Tree removal (above) and road construction (below) in mountain areas can cause serious soil erosion and landslides (Nepal)

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increase the frequency and magnitude of landslides and debris flows (Sidle, 2000). However, there is a limit to the protection that forest cover provides, as was found in Taiwan Province of China (see Box on next page), where nearly all mountainous watersheds are forested and managed for slope stabilization and torrent control (Lu, Cheng and Brooks, 2001). As the amount of rainfall becomes extreme, the extent to which forests can help to prevent landslides, debris flows and flooding diminishes.

A frequently asked question is the extent to which forest cover affects flooding. In northern Minnesota, the United States, rainfall-generated peak flows up to the 25- to 30-year recurrence interval (RI) increased when 70 percent of the forest cover on a small watershed was clear-cut (Lu, 1994; Verry, 2000). Larger floods (RI $>$ 100 years) were not affected by forest cover removal, supporting Hewlett's (1982) claim that changes

Typhoons, landslides and debris flows in Taiwan Province of China

Floods, landslides and debris flows, resulting from an average of three to four typhoons a year, cause extensive loss of life and property on the mountainous island of Taiwan Province of China. About 53 percent of the island has slopes steeper than 21°, and more than 100 peaks exceed 3 000 m above sea level (Lee, 1981). With shallow soils overlying weak, fractured and weathered geological formations, landslides load steep channels, which become primed for debris flows.

During the particularly destructive Typhoon Herb in 1996, rainfall at higher elevations exceeded 1 985 mm in 42 hours (Lu, Cheng and Brooks, 2001). Landslides and debris flows occurred throughout the island, many along roads and in drainage channels where native forest had been converted to grow tea, vegetable crops and betel nut palm, but many in forested areas as well. Given the amount and intensity of rainfall, debris flows and flooding occurred regardless of land use.

in forest cover have little effect on large floods in major streams. Importantly, the 1.5- to 2-year RI peak flows more than doubled when forest cover was removed.

Extreme hydrological events are the result of natural processes of erosion and sediment motion interacting with human systems (Davies, 1997). Where land scarcity concentrates people and their dwellings in hazardous areas, disasters will occur whether uplands are fully forested or not. This is the situation in Taiwan Province of China, with a population density approaching 600 inhabitants per square kilometre. People living on steep slopes, in the mouths of small drainage basins and in floodplains are bound to be vulnerable. A coordinated watershed management programme among government agencies has been suggested in order to address this threat for both upstream and downstream communities (Lu, Cheng and Brooks, 2001).

Hazardous areas must be identified, and policies and institutions established to provide incentives for people to avoid them. Terrain analysis based on Geographic Information Systems (GIS) offers the means to mark hazardous terrain in mountainous watersheds (Gupta and Joshi, 1990; Sidle, 2000), and methods to delineate floodplains and define zones according to the type and degree of risk are well known (Bedient and Huber, 1988). An example of an incentive to change people's behaviour is the Federal Flood Insurance Program in the United States, under which insurance rates in areas adjacent to rivers are linked to the degree of hazard.

FORESTS AND SEDIMENTATION

Because watersheds with healthy forests export the lowest levels of sediment of any cover type (Brooks *et al.*, 1997), it is not surprising that forests are often looked to as a means of reducing levels of downstream sediment in water supply reservoirs.

Larson and Albertin (1984) recommended reforestation to reverse a threefold increase in sedimentation in the Alhajuela Reservoir in Panama following the clearing of 18.2 percent of the watershed. Few such studies exist, and some people therefore suggest that the benefits from forest cover in reservoir protection have been overestimated (Kaimowitz, 2000). Reasons for such scepticism include:

- inadequate monitoring, and therefore limited empirical evidence linking forest changes to reservoir sedimentation levels;
- the fact that forest cover changes have occurred over such small areas of watersheds that little effect has been observed;
- the distance between upstream watershed projects and downstream reservoirs, which masks the effects;
- the recognition that other factors, such as non-forest land use, can increase stream flow peaks and affect sedimentation.

Downstream sediment delivery is affected both by changes in stream flow discharge from upland watersheds and by alterations in riparian areas along stream banks (Rosgen, 1994; Tabacchi *et al.*, 2000). Sediment levels of rivers are determined by both sediment availability

and stream flow discharge. The most effective discharge for transporting sediment over time is that associated with the bank-full stage (when the river channel is full but not overflowing), usually corresponding approximately to the average annual peak flow. When land use increases the size of these flows, the stream channel becomes unstable and sediment levels increase, regardless of whether erosion rates have been reduced. Healthy riparian forests can also reduce sediment levels by filtering out soil erosion inputs to channels and by maintaining stable stream banks. Degradation of both upland and riparian forests can therefore combine to increase sediment delivery to reservoirs.

FORESTS AND WATER QUALITY

Water pollution impairs water use by downstream users and seriously affects human health. The exceptionally high quality of water discharged from forested watersheds is the main reason that protected forests are preferred for municipal watersheds. Forests efficiently cycle nutrients and chemicals and decrease the sediment exported, thus reducing pollutants such as phosphorus and some heavy metals. The lower rate of rainfall runoff also reduces the load of all nutrients and pollutants entering water bodies.

In many developing countries, the food and resource needs of the rural poor, coupled with land scarcity and institutional limitations, constrain efforts to protect forested watersheds for municipal water supplies. However, the problems of polluted drinking-water and associated diseases significantly jeopardize the welfare of rural populations and urban communities alike. Water storage and transport facilities are sorely needed in many areas, along with improved sanitation and water treatment. Well-managed forested catchments above reservoirs can result in minimal requirements for water treatment. Echavarria and Lochman (1999) reported that US$1 billion spent on improved management of the New York City watersheds over ten years could save an outlay of US$4 billion to $6 billion for construction of new water treatment facilities.

Riparian forests

Forest buffers and agroforestry systems along water bodies further improve water quality. Long neglected and often exploited, riparian forests help to stabilize stream banks, reduce wastewater and chemical discharge into water bodies from upland areas and maintain cooler water temperatures, thus improving dissolved oxygen levels in water (Brooks *et al.*, 1997). The water quality can be enhanced for human consumption, leading to better health and productivity and greater diversity of aquatic ecosystems, including mangrove forests. As a result, healthy riparian forests increase fish production.

Riparian systems are heavily utilized because of their proximity to water and their high productivity for grazing and farming, and it is therefore unrealistic to protect them from all uses. With proper management, however, riparian forests and agroforestry systems along water bodies can mitigate the effects of nutrient, chemical and human waste discharge. At the same time, these systems can provide wood, forage and other products for the rural poor.

WATERSHEDS: RECOGNIZING UPSTREAM–DOWNSTREAM LINKAGES

Scale and cumulative effects

Freshwater benefits to downstream areas naturally accompany sound management of upland and riparian forests, but management can also be directed to specific freshwater objectives. In either case, benefits may be masked by spatial aspects, for example the location and diffuse nature of land-use practices and their effects; the scale of activities in proportion to watershed size; and the time needed for benefits to be realized. Changes on the land can have incremental effects that may not be individually apparent but can be considerable over the whole watershed and over time. This complexity has clouded the view of decision-makers in many parts of the world and weakened their commitment to watershed management. However, these cumulative effects must be recognized in environmental and economic assessments.

Cumulative effects of land use on downstream water flow, sediment loads and pollutants can best be observed on islands, over a few kilometres rather than hundreds. For example, deforestation and cropping practices on islands in the Caribbean and the Pacific have been linked to the degradation of estuaries, coral reefs and their dependent fisheries. In eastern Jamaica, the replacement of forests with upland coffee farming has increased soil erosion and the export of chemicals, which have contributed to the degradation of coral reefs (K. Eckman, personal communication, 2002). Such linkages are clear in river basins, but in larger systems the impact may take decades or longer to become evident, and may be masked by other land-use practices. An example of such an impact is the depletion of oxygen in the Gulf of Mexico, which has been traced in part to agricultural non-point pollution of the Mississippi River basin in the United States. Midwestern states in the United States are focusing on restoring riparian forests and wetlands and improving agricultural land use to reduce total maximum daily loads to the Mississippi River, in accordance with federal legislation calling on all states to improve impaired bodies of water. Urban and peri-urban forest and tree programmes are being developed and promoted to address poverty and food insecurity as well as to support protection and sustainable use of land resources.

Economic considerations

Forest management and other watershed improvements to protect and manage freshwater require economic justification. A watershed perspective provides clarity in determining the economic value of forests for these purposes. Johnson, White and Perrot-Maître (2001) have emphasized the economic importance of the water-related ecosystem services provided by forests. However, no comprehensive economic analyses that consider the full range of these benefits have so far been made, because of a number of difficulties. These include inadequate monitoring and evaluation of watershed services from forestry projects; difficulties in placing an accurate value on many services, particularly those that are not traded in the marketplace; and water subsidies. In many parts of the world, water is heavily subsidized and often considered a free good. Its scarcity is now causing people to determine the value of freshwater more realistically. In contrast, the economic benefits of well-managed or protected forests have not been fully considered in terms of avoided losses from soil erosion, debris flows, sedimentation and floods, for example.

Improved watershed economics may thus be forthcoming as a result of water scarcity. What some are calling a new global water economy is emerging, in which freshwater is viewed more as an economic commodity than as a publicly managed resource (Anderson, 2002). For example, in southern California, the United States, farmers pay US$8.11 per 1 000 m^3 of water in comparison with US$1 622 paid by the city of Santa Barbara. Water there is more valuable than the crops being irrigated, with the result that some farmers sell their supplies to municipalities. In such instances, there may be sound economic justification for managing forested watersheds for water supplies.

The new water economy faces hurdles in developing countries, where water has often been treated as a free good because of longstanding practices and religious beliefs (Rosegrant and Cline, 2002). More efficient water allocation and innovative pricing policies can provide incentives to support forest management for water supply purposes. Policies that continue to treat water as a free good or that heavily subsidize it will continue to promote waste in developing and developed countries alike. Johnson, White and Perrot-Maître (2001) have suggested financial mechanisms that can enhance the restoration, maintenance and improvement of water-related services from forested watersheds.

In most cases, the methodology to perform the needed financial and economic analysis exists. Upstream and downstream data, sometimes sorely lacking, are transformed into benefits and costs that can be contrasted under "with" and "without" conditions (FAO, 1987). This approach has been used to assess watershed projects in

Morocco and China, encompassing, but not limited to, changes in forest cover and management (Brooks *et al.*, 1981; Shuhuai *et al.*, 2001). In both cases, watershed improvements, including forests and agroforestry, were found to be economically viable (with economic rates of return of 10 to 16 percent) when production and water resource benefits were combined.

Hydrological computer models can be used to examine human-induced effects on watersheds. Changes in water yield, flooding and sediment transport, for example, can be simulated and related to specific sites where economic benefits and costs are of interest. The cumulative effects of agricultural development, the loss of riparian forests in floodplains and wetland drainage were simulated for a watershed of the Minnesota River basin in the United States, using the Hydrocomp Simulation Program – Fortran (HSPF) model (Miller, 1999). These land-use changes increased annual stream flow and peak flow discharges, which can be related to "lost storage" in the basin. Hey (2001) determined that the downstream damage associated with a major recent flood could have been significantly reduced by restoring sufficient areas of riparian forest cover, floodplains and wetlands in the basin. He concluded that farmers could justifiably be compensated for such land conversion on the basis of reduced economic losses from future flooding. Such innovative approaches need to be expanded and considered for tropical watersheds and developing countries, with emphasis on developing computer simulation models.

Institutional and policy considerations

Better management of forests and water resources to improve human welfare requires more than just technical knowledge. While technical information provides a foundation for assessing upstream–downstream linkages and carrying out economic analyses, transforming such information into management practices requires the effective participation of stakeholders in order to develop a consensus and provide incentives for implementation (Eckman, Gregersen and Lundgren, 2000). A policy environment must be created that supports, rather than hinders, the integration of land and water management.

Since watershed and political boundaries rarely coincide, the coordination of land and water management depends on organizations to resolve transboundary issues and water-use disputes. In the United States during the 1990s the absence of effective watershed- or basin-level organizations led to the formation of more than 1 500 watershed districts to deal with upstream–downstream issues (Lant, 1999). Nile-basin countries established a partnership of nine riparian countries to resolve transboundary issues and to move towards more sustainable development (Baecher *et al.*, 2000). The inequities of water distribution in this region are amplified because more than 80 percent of the flow to the lower Nile, on which the Sudan and Egypt depend, originates in mountainous Ethiopia. Without cooperation and coordination, disputes over water use and development could clearly arise.

A better understanding of the processes and approaches required in large river basins is needed, and the International Year of Freshwater in 2003 is an opportunity for stakeholders to share experiences in order to identify possible paths for the future.

CONCLUSIONS AND RECOMMENDATIONS

The scarcity of freshwater is a global problem calling for more effective and efficient water management, from local watersheds to major river basins. The International Year of Freshwater in 2003 can help to focus global attention on issues and solutions and on the need for a comprehensive approach to cope with scarcity, on the one hand, and excess, on the other. Forests can have an important role in supplying freshwater, but their management must complement water management. Technology exists for the most part, but implementation requires policies and institutions to promote intersectoral dialogue and cooperation. The following are some

potential ways in which the management of forests and water can be mutually supportive.

First, mountainous forested watersheds require special attention as the highest freshwater-yielding areas in the world, but also as the source areas for landslides, torrents and floods. People inhabiting the headwater regions and those living in the downstream lowlands depend on freshwater from the uplands, and also feel the effects of hydrometeorological extremes. Action to prevent or mitigate disasters in mountainous terrain should include:

- maintenance of healthy forest cover on mountainous watersheds that are subject to torrential rainfall;
- development of programmes that combine forest protection with zoning, floodplain management and engineering structures to protect people from landslides, debris flows and floods.

Second, forests can be managed to enhance freshwater supplies, but as a component of comprehensive and multifaceted water management programmes. The economic value of water and its source areas must be recognized. By reducing water subsidies and treating water as a commodity rather than a free good, economic incentives can support better management in the following ways.

- The water yield of municipal watersheds in non-cloud forest conditions can be augmented when tree species with low consumptive use replace those with high consumptive use or when forest stands are periodically thinned and harvested.
- In cloud-forest conditions, mature and old-growth forests should be protected and managed to sustain stream flow during dry periods.
- Riparian forests should be managed to protect water quality, which can in turn enhance the productive capacity of aquatic ecosystems and improve the health and welfare of local human populations. In addition, full use should be made of agroforestry buffer systems that can achieve these goals and also provide food, fodder and wood products.
- Agroforestry systems need to be developed for upland watersheds in order to capture the hydrological benefits of forests, while enhancing food and natural resource production for the rural poor.

Third, the potential exists to mitigate the economic damage caused by floods and sediment delivery through forest management in uplands, riparian areas and floodplains. Although the largest and most damaging floods in major rivers are not affected by the extent of forest cover, moderate and localized floods can increase when forests are removed. Forest degradation brings with it many undesirable effects on water flow and quality. Healthy upland and riparian forests can maintain low levels of sediment delivery to rivers, lakes and reservoirs.

Fourth, a watershed perspective should be incorporated into the planning and management of forests, water, and urban and agricultural land use. This perspective is needed at the local level as well as the highest government levels in order to promote sustainable solutions.

Fifth, incentives and the means to achieve freshwater objectives must be provided through forest and other land-use management policies and institutions, from the local watershed level to the river basin level. Intersectoral dialogue and cooperation are necessary to achieve management objectives and to resolve inequities in terms of who pays for and who benefits from changes in upstream and downstream resource use. Expanded economic analysis is needed to understand these inequities better and to resolve them. The emerging water economy will facilitate the justification of land-use changes to enhance water supplies. Consideration should be given to compensating inhabitants who improve forests and other land uses that reduce downstream losses. The policy environment and institutional support may be enhanced through:

- improved understanding of the processes and required approaches for upstream–downstream management systems in the context of better water resource management and sustainable development;

- expanded educational and training programmes that are directed to local watershed inhabitants up to the highest-level policy-makers;
- better understanding and reconciliation of the role of forests in freshwater management, with emphasis on demonstration and extension programmes aimed at local users of land and water;
- expanded monitoring and evaluation of projects, as well as improved research on tropical forested watersheds in developing countries, given that many of the questions asked in the 1970s and 1980s about the hydrological role of tropical forests are still largely unanswered, or at least not well documented.

Socio-economic aspects as well as technical components need to be stressed so that the resulting information can provide the foundation for developing new technology and policies to enhance people's welfare through improved forest and freshwater management. ◆

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How sustainable use of forests can contribute to conserving biological diversity

The term "biological diversity" entered the public vocabulary only about 15 years ago, but its arrival signalled a new and more comprehensive approach to conservation, bringing together information, knowledge, awareness, ethics, forestry, protected areas, agricultural practices, economics, intellectual property rights (IPRs), land tenure, trade and other elements for the holistic management of ecosystems. The concept has encouraged land-use planners to revise outdated approaches, such as excluding people from their traditional lands in the name of conservation or focusing on one forest benefit to the exclusion of others. It also led to the adoption of the Convention on Biological Diversity (CBD), which has now been ratified by more than 180 countries.

CBD captures the essence of the modern approach to the management of living resources. Its three objectives, all contained within the same sentence (thereby showing their fundamental unity) are "the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" (Article 1). The convention thus recognizes that sustainable use is an essential part of conservation, and vice versa, and that an equitable distribution of benefits is essential to achieving both. It follows that the conservation of biological diversity is an integral component of sustainable forest management.

The present chapter explores some of the issues involved in conservation of biological diversity and sustainable forest management, showing how they are related and suggesting how criteria and indicators for conservation can be developed as part of the broader set of criteria and indicators for sustainable forest management.

Conserving biological diversity is an ethical imperative because all life has a right to exist, and humans should not knowingly cause any loss of this diversity. From a more practical angle, biological diversity provides many benefits to humans, supporting the systems that store and cycle nutrients essential for life, absorbing and breaking down pollutants, recharging groundwater, producing soil and protecting it from excessive erosion, providing the basis for all improvements to domesticated plants and animals, and providing numerous raw materials for industry and medicine. In more general terms, the variation in life provides the basis for adapting to changing conditions.

SOME KEY CONCEPTS IN BIOLOGICAL DIVERSITY CONSERVATION IN RELATION TO FORESTS

CBD defines biological diversity as the variability among living organisms, including diversity within species, between species and of ecosystems. It is thus an attribute of life and a property of assemblages of organisms. Strictly speaking, what is used, misused, conserved or destroyed is not biological diversity itself but biological resources, which CBD defines as "genetic resources, organisms or parts thereof, populations or any other biotic component of ecosystems with actual or potential use or value for humanity".

For the first time in a binding international instrument, the intrinsic value of biological diversity has been recognized, along with its

ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic value. However, the main focus is on benefits to people from the sustainable use of biological resources.

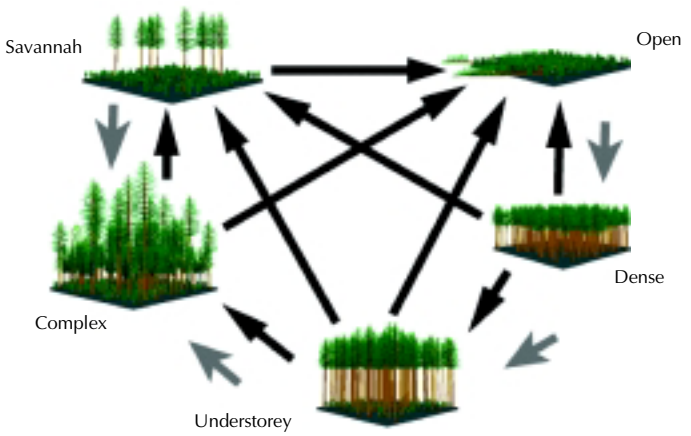
The people who use these biological resources have many different needs, interests, cultures and goals. The global industrial society that characterizes the modern world consumes vast amounts of such forest resources as timber, fibre, food and fodder. Thus, macroeconomic decisions taken far away from forests often determine the fate of forest biological diversity and the way land is used. The forested areas where species diversity is richest are often remote from the centres of power, but the people who live in these areas are strongly affected by economic decisions taken in distant capitals. Although forest residents also make decisions about resources that may result in the conversion of a forest into another form of land use or the local extinction of a species, evidence indicates that people who have lived for a long time on the land seldom cause such extinctions.

New research on forest ecosystems is being applied to the conservation of biological diversity. Findings indicate that forests are loose, temporary assemblages of species, each of which behaves according to its own needs, depending on specific physiology, morphology, demography, behaviour and dispersal capacity. "Because of a continual turnover of ecological conditions, local communities show a continual turnover of species, at one time gaining species because the scale of processes allows a certain type of trait, and at others losing them again because the same trait happens to have resulted in too great a risk of extinction. Biological diversity is both the result and expression of all sorts of adaptations of life to the environmental turmoil; it can only be maintained as long as this turmoil exists" (Hengeveld, 1994). These new insights are the basis of managing dynamic ecosystems as a whole, recognizing the many different forest structures found in nature (Oliver and Larson, 1996) (Figure 6).

Conserving this natural dynamism in the face of unnatural pressures, such as fragmentation, invasive alien species and climate change, is a major challenge for forest managers, requiring judgements about the scale on which benefits are to be delivered to people. As Daily *et al*. (1997) point out: "The continued existence of coniferous tree species somewhere in the world would not help the inhabitants of a town inundated by flooding because of the clearing of a pine forest upstream. Generally, the flow of ecosystem goods and services in a region is determined by the type, spatial layout, extent, and proximity of the ecosystems supplying them." Because forests are dynamic, highly complex and unique to the site in which they are located, it is not sufficient to conserve one minimum viable population of a species or one example of an ecosystem. Instead, conservation approaches must recognize the dynamism of systems, the dependence of local people on forest resources and the need to build redundancy into systems of protecting biological diversity.

Approaches being developed under many forest-related international agreements and programmes call for forests to be managed to meet multiple national objectives, including: supplying timber, fibre and energy; keeping options open for

FIGURE 6
Complexity and dynamism of forests: a diversity of structures is needed to protect all species



Constant changes in forest structure and species composition result from plant growth, disturbances, species migration, climate changes and other processes.

Source: Oliver and Larson, 1996.

future economic use; fulfilling an aesthetic function; and providing the nation's share of global benefits. If these sometimes conflicting objectives are to be achieved at a time of rising expectations and shrinking government budgets, new approaches are required. The development of appropriate policies for managing forests in the twenty-first century warrants consideration of some of the critical issues facing the conservation of forest biological diversity.

CRITICAL ISSUES IN CONSERVING FOREST BIOLOGICAL DIVERSITY

Fragmentation

Although deforestation is widely recognized as a major conservation issue, the related issue of habitat fragmentation receives insufficient attention. As human pressure increases in both temperate and tropical forests, areas that were once continuously forested have become more fragmented. In the Brazilian Amazon alone, the area of forest that is now fragmented (with forests less than 10 000 ha in area) or prone to edge effects (less than 1 km from clearings) is more than 150 percent greater than the area that has actually been deforested. Recent research indicates that small fragments have very different ecosystem characteristics from larger areas of forest, containing more light-loving species, more trees with wind- or water-dispersed seeds or fruits, and relatively few understorey species. The smaller fragments also have a greater density of tree falls, a more irregular canopy, more weedy species and unusually abundant vines, lianas and bamboos. Thus, they preserve only a highly biased subset of the original flora and fauna, which is adapted to these conditions (Laurance, 1999; Laurance *et al*., 2000).

A study comparing the density of lowland birds in unlogged and recently logged forests in Seram, Indonesia found that few bird species were excluded from logged forest and several were common in both habitats. Species that were rare in unlogged forests were no more likely to decline after logging than were the common ones. However, while birds with restricted global ranges fared no worse than widespread species, several endemic forms were seriously affected. Because so many of the birds of Indonesia are restricted to single islands, logging concessions need to be examined at an individual island level to ensure that endemic forms are not threatened (Marsden, 1998).

For some species of forest bird, fragmentation reduces nesting success, and hence the number of offspring that they can produce. In some temperate forests, fragmentation exposes some species to greater rates of nest predation by mammals and nest parasitism (in which birds lay eggs in the nests of other species, which then raise these offspring at the expense of their own). Reproduction rates are sometimes so low for some species in the most fragmented landscapes that their populations depend on immigration of other populations from areas with more extensive forest cover (Robinson *et al*., 1995; Askins, 1995). Conservation strategies therefore need to ensure the preservation and restoration of large, continuous forest habitats in each region.

Research on the impact of natural forest fragmentation on the distribution of mammals in Lope Reserve in central Gabon found that total mammal biomass was highest in the forest fragments, at 6 010 kg per square kilometre. Of eight species of primate, four were more common, two occurred with similar densities, and two were much less common in the fragmented habitat. Most mammal species moved between continuous forest and forest fragments, but a few resided permanently in some fragments. The diversity and high biomass of large mammals found within the forest fragments suggests that fragmentation *per se* will not be catastrophic for most of these species. However, since logging typically results in greatly increased hunting – sometimes only to feed the logging crews, but more often to sell meat and other animal products on lucrative international markets – the remaining structurally intact forest may be emptied of primates and other large mammals and birds (Tutin, White and MacKanga-Missandzou, 1997).

Surveys conducted over 28 years in Kibale National Park, Uganda quantified the long-term effects of both low- and high-intensity selective logging on the density of five common primates. The results suggest that, in this region at least,

low-intensity selective logging could be one component of plans to conserve primates. On the other hand, high-intensity logging, typical of most logging operations in the tropics, is incompatible with primate conservation (Chapman *et al.*, 2000).

Invasive alien species

As the global movement of people and products expands, so does the movement of plant and animal species from one part of the world to another. When a species is introduced into a new habitat – for example, oil palm from Africa into Indonesia, *Eucalyptus* species from Australia into California, and rubber from Brazil into Malaysia – the alien species typically requires human intervention to survive and reproduce. Indeed, many of the most popular species of tree used for agroforestry are alien or non-native and prosper in their new environments partly because they no longer face the same competitors, predators and pests as in their native environment. Such alien species are economically very important and enhance the production of various forest commodities in many parts of the world.

In some cases, however, species introduced intentionally become established in the wild and spread at the expense of native species, affecting entire ecosystems. Notorious examples of such invasion by alien woody species include the introduction of kudzu (*Pueraria lobata*) from Japan and China into the United States, where it now infests over 2 million hectares; the ecological takeover of the Polynesian island of Tahiti by *Miconia calvescens*; the spread of various species of Northern Hemisphere pine and Australian acacia in southern Africa; and the invasion of Florida's Everglades National Park by *Melaleuca* species from South America. Of the 2 000 or so species that are used in agroforestry, perhaps as many as 10 percent are invasive. Although only about 1 percent are highly invasive, they include popular species such as *Casuarina glauca*, *Leucaena leucocephala* and *Pinus radiata* (Richardson, 1999). Great care is required to ensure that such species serve the economic purposes for which they were introduced and do not escape to cause unanticipated negative effects on native ecosystems.

Perhaps even worse are invasive alien species that are introduced unintentionally, such as disease organisms that can devastate an entire tree species (e.g. Dutch elm disease and chestnut blight in North America) or pests that can have a major effect on native forests or plantations (e.g. gypsy moths and long-horned beetles). The economic impact of such species amounts to several hundred billion dollars per year (Perrings, Williamson and Dalmazzone, 2000), much of it in forested ecosystems, even within well-protected national parks. The 1951 International Plant Protection Convention was established to address some of these issues, and new international programmes are now addressing the most serious problems. The World Conservation Union (IUCN) has developed a global strategy (McNeely *et al.*, 2001), and best practices for prevention and management have been identified (Wittenberg and Cock, 2001). However, as global trade grows, so does the threat from devastating invasive species of insect and pathogen. They could fundamentally alter natural forests and wipe out tree plantations, the latter being especially vulnerable because of their lower species diversity. Efforts related to both conservation of biological diversity and sustainable forest management need to recognize clearly and address the issue of invasive alien species.

Climate change

Forests are often highly sensitive to climate, judging by the past distribution of forest types during periods with different climates and by the vegetation bands on mountains. While the Intergovernmental Panel on Climate Change (IPCC) and associated national research programmes are generating valuable new information, forecasts of the potential impact of climate change on forests remain somewhat speculative. Some contend that the most significant threats are drying trends, changes in rainfall patterns, changes in fire regimes and changes in seasonality, which would in turn lead to changes in species distribution and composition. Others suggest that forests may be equally affected by the indirect effects of climate on soil properties or on reproduction. In the final analysis, the most important factor may well be the impact of climate

change on human populations, affecting settlement and consumption patterns, which will then influence how forests are used. Nonetheless, the capacity of tree species to shift their ranges in response to climate change also depends on ecological factors, such as dispersal mechanisms. Trees propagated by seeds that are scattered by the wind or carried by animals may disperse more easily than others (Peters and Lovejoy, 1992). In addition, the changing ranges of animal species may affect those tree species that depend on them for propagation.

A growing body of research has examined the possible effects of climate change on individual species and biotic communities. Findings suggest that biological communities will shift in intricate and unexpected ways as the geographical distribution of species is altered individually rather than in community units (FAUNMAP, 1996). Furthermore, because species are interrelated, any advantage falling to a given species in an ecosystem will affect other species in ways that are not always predictable. As climates change, the rates of species invasion and extinction are likely to accelerate, bringing about complex changes in species composition and interaction (Mooney and Hobbs, 2000). Thus, rather than causing a simple northward or uphill shifting of ecosystems with all inhabitants intact, climate changes will reorganize forest biological communities and force evolutionary changes. Populations located near the edge of a species' range, narrowly endemic species and endangered species that exist only in protected areas or other limited habitats are especially vulnerable to regional vegetation shifts. Species already threatened by direct exploitation, habitat loss and habitat degradation are likely to be particularly susceptible to new threats (Peters and Lovejoy, 1992; Schneider and Root, 2002).

INTERFACE BETWEEN BIOLOGICAL DIVERSITY AND SUSTAINABLE FOREST MANAGEMENT

While timber production often dominated the way in which forests were managed in the twentieth century, new pressures in the twenty-first century demand a more nuanced approach, calling for the delivery of multiple goods and services. The public expects forestry plans to provide adequately for the protection of watersheds, indigenous people to be able to occupy their traditional homelands (even if they are in economically valuable forests), a system of protected areas to cover all major ecosystem types in the country, and any exploitation of timber and other forest products to be sustainable. Sustainable forest management based on ecosystem principles – such as maintaining healthy breeding populations, conserving soils, avoiding erosion, allowing natural fire regimes and carefully planning roads to minimize impact – is therefore entirely consistent with what is required to conserve biological diversity.

Managing natural forests for sustainability requires moving beyond the outdated concept of maximum sustainable yield. In many parts of the world, the focus on this aspect has simplified the forest structure, replacing natural mixed forest with single-species and even-aged monocultures. While the area of planted forests is still very small (less than 5 percent of total forest area), the selection and breeding of planting stock – and in some cases intensive management – tend to narrow genetic diversity and reduce the number of associated species. Intensifying the management of natural and planted forests has often involved eliminating competing species, draining wetlands, suppressing natural fires and accelerating rotation cycles. At least in the short term, these activities have led to an increase in productivity, often at the expense of forest quality because of threats to forest-dwelling fauna and increased vulnerability to various pests. Sustained-yield forestry, designed to provide a steady stream of timber, is therefore not synonymous with sustainable forest management, which gives greater attention to various ecological processes and the range of related goods and services.

Sustainably produced timber

Since timber is the most valuable forest product in many forest ecosystems, a critical question is how it can be produced sustainably without depleting biological diversity. Natural forest management is widely advocated as the best hope of making

forest land more profitable while maintaining biological diversity. Post-harvest surveys of a spectrum of tropical forests indicate a range of logging effects, from local extirpation to substantial increases in the local density of some species (Bawa and Seidler, 1998). This suggests that there are no easy answers.

A review of research on the impact of logging practices on tropical forest ecosystems and biological diversity concluded that the logging of mature forests commonly leads to a local increase in species diversity as structural and associated microclimatic changes create patches of habitat and food resources that are attractive to species typically residing in secondary forest and forest edges (Johns, 1997). However, populations of many taxa typically resident in forest understoreys markedly decline and remain locally scarce or absent for many years. Thus the most appropriate compromise between logging and the conservation of biological diversity in tropical forests is to have small undisturbed forest areas preserved within a larger matrix of production forest, a prescription that is being attempted in peninsular Malaysia and elsewhere (Poore *et al.*, 1989).

Several studies indicate that sustained timber-yield management of tropical moist forest can be technically and economically feasible (Rietbergen, 1993; Dykstra and Heinrich, 1992; Poore *et al.*, 1989), although little such technology is as yet being applied. However, it is possible, especially with low-intensity selective felling, to design harvesting operations that satisfy requirements for environmental, social and economic sustainability while reducing costs by a substantial margin. Recent developments in certifying environment-friendly timber indicate that progress is being made on the timber production side of sustainable forest management (Donovan, 2001), especially in temperate forests.

Non-wood forest products

While timber is economically the most important forest product, many other products are valued both on world markets and by local people. One study found that nearly 6 000 species of rain forest plants in Southeast Asia have economic uses (Jansen *et al.*, 1991; see Table 8). Moreover, many of these non-wood forest products (NWFPs) are of particular value to the local people, providing a ready store of products to meet their everyday needs for health, food and aesthetic pleasure. Animal species are also highly valued at the local and global levels, with the trade in skins, meat and live animals accounting for hundreds of millions of dollars per year (Reynolds *et al.*, 2001).

Although people in rural areas depend on hunting as a source of food or income and have been sustainably harvesting wild products for thousands of years, today's increasing population, more sophisticated technology and changing social, economic and political structures have removed most traditional controls over how such resources are harvested. Serious problems concerning hunting seem particularly difficult to address where governance is weak. Moreover, with greater access to remote forest areas and high prices on the international market, wildlife management agencies are too stretched to deal with increased incidences of overharvesting.

If benefits are to be provided on a sustainable basis to local communities and to countries at large, more effective controls may be required to

TABLE 8
Selected economic uses of Southeast Asian tropical rain forest plants

Product/commodity group	Species *(number)*
Timber trees	1 462
Medicinal plants	1 135
Ornamental plants	520
Edible fruits and nuts	389
Fibres	227
Rattans	170
Poisonous and insecticidal plants	147
Spices and condiments	110
Others	1 790
Total	**5 950**

Source: Jansen *et al.*, 1991.

maintain populations of harvested plants and animals at productive levels. The means to accomplish this will vary, but they must be built on sound economic and ecological principles, and often on traditional institutions. Establishing additional well-managed protected areas may at least partly restore the balance between hunter and prey that has enabled populations to survive and thrive in rural areas.

Benefits for people and society: a systems approach

An essential component of any effort for sustainable forest management is the economic viability of the various enterprises involved. While timber extraction is the most obvious money-earner, many other economic activities are possible. Furthermore, if local people can benefit financially from enterprises that depend on the biological diversity of the forest, they might reasonably be expected to support the conservation and sustainable use of forest ecosystems. Salafsky *et al*. (2001) tested this idea extensively across 39 sites in Asia and the Pacific through such activities as ecotourism, distilling essential oils from wild plant roots, producing jams and jellies from forest fruits, collecting other forest products and sustainably harvesting timber. The study concluded that a community-based enterprise strategy can indeed lead to conservation, but only under conditions that depend on external factors, such as market access. Moreover, any such enterprise can be sustainable only if it can adapt to changing circumstances. Because many forested areas are subject to political or economic turmoil, fire, drought and other external factors, this adaptability is essential to long-term sustainability. The complexity of factors affecting forests also calls for multiple levels (local, national and international) of biological diversity protection, providing the redundancy that ensures that all genes, species and ecosystems are conserved.

If the potential benefits of conserving forest biological diversity are to be converted into real and perceived goods and services for society at large, and especially for local people, a systems approach is needed. Its elements would include:

- at the national level, an integrated set of protected areas encompassing various levels of management and administration, including national, provincial and local governments, non-governmental organizations (NGOs), local communities, indigenous people, the private sector and other stakeholders (McNeely, 1999);
- within the framework of market-based economic systems, greater participation by civil society in economic development, extending to the management of both production forests and protected areas, especially for tourism and the sustainable use of certain natural resources (Szaro and Johnston, 1996);
- a large geographical scale (sometimes called a bioregion) for resource management programmes, within which protected areas are considered components in a varied landscape, including farms, production forests, fishing grounds, human settlements and infrastructures (Miller, 1996);
- cooperation among private landowners, indigenous people, other local communities, industry and resource users;

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If local people benefit financially from enterprises that depend on the biological diversity of the forest – as does this seller of oils, creams, ointments and traditional medicines derived from forest plants in Brazil – they might reasonably be expected to support the conservation and sustainable use of forest ecosystems

- the use of economic incentives, tax arrangements, land exchange and other mechanisms to promote conservation of biological diversity;
- the development of administrative and technical capacities which will encourage local stakeholders, universities, research institutions and public agencies to harmonize efforts.

A programme for sustainable forest management that encompasses conservation of biological diversity needs to include both firm government action and alliances with stakeholders. Inasmuch as national governments cannot delegate their role as guarantors of the conservation of their countries' natural heritage, authorities need to build the capacity to fulfil their regulatory and management duties and responsibilities. However, civil society can share certain rights and responsibilities regarding the management of living natural resources, as long as the ground is carefully prepared and the rights and responsibilities are adequately defined. Given the interests of NGOs, industry, indigenous people and local communities who live within or close to protected areas and other forested regions, alliances should be created that enable each stakeholder to have a role according to clear government policies and laws.

CRITERIA AND INDICATORS FOR CONSERVATION OF BIOLOGICAL DIVERSITY

In view of the great variability of natural systems and the lack of any single measure of biological diversity, developing appropriate criteria and indicators to guide management interventions is a challenging task. This variability also makes it hard to determine the specific impact of any management measure on biological diversity. Any forest management action is likely to have a range of effects on the various components of biological diversity, benefiting some while damaging others. In addition, it is often difficult to show a correlation between changes in different components, even in those rare cases in which changes can be detected within relatively short time frames. Even where it is possible to demonstrate specific changes in biological diversity within a reasonable length of time, obtaining the necessary data may require substantial investment in monitoring programmes. In addition, many of the greatest threats to biological diversity are caused by policy measures that may be instituted from a distance, so that the effects are hard to measure.

Despite such challenges, several organizations have developed criteria and indicators that generally fit within a pressure–state–response framework, where pressure is the cause of biological diversity loss, state is the current status of biological diversity and response is the set of measures taken to address the pressure. These criteria and indicators are designed to be applied by resource managers at the forest management unit level, where the responsibility lies for their implementation. Each indicator needs to be:

- relevant, relating to an explicit objective;
- representative, covering the most important aspects of sustainability;
- accurate, correctly reflecting the extent to which the objective is met;
- feasible in terms of data availability and collection costs;
- credible, analytically sound and replicable using standardized measurements;
- sensitive, showing trends over time;
- responsive, reflecting changes in conditions and differences among places and groups of people (Prescott-Allen, 1998).

Indicators appropriate for assessing conservation of biological diversity as part of sustainable forest management might include:

- the area of forest under sustainable management regimes;
- the percentage of the human population in and around the forest that is involved in sustainable production activities;
- population trends for certain designated species of plant or animal;
- the extent to which fragmentation remains within the limits of natural variation;
- the influence of invasive alien species.

One comprehensive set of criteria and indicators has been prepared by the Center for International Forestry Research (CIFOR, 1999).

CONCLUSIONS

The values that different sectors of society attach to various forest goods and services have changed more rapidly and deeply in the past few decades than ever before, and will continue to do so. The impact of climate change, forest fragmentation and invasive alien species on forest biological diversity has also increased considerably. These changes cannot reasonably be expected to slow down – and, indeed, many experts expect them to accelerate. The challenges facing forest communities, scientists, conservationists and foresters in the future are therefore likely to be very different from those facing them today. Society needs a range of approaches to forest management in order to provide multiple benefits to a wide variety of stakeholders with a legitimate interest in conserving forest biological diversity and using forests sustainably.

Within the context of sustainable forest management and in the face of global change, the following measures can help to conserve forest biological diversity:

- protection of large areas of forest, where this is still possible;
- rebuilding of connectivity between small adjacent protected areas by promoting reforestation of the landscape and restoring habitats;
- protection of forest edges against structural damage, damage by fire and colonization by invasive alien species, by leaving a natural buffer zone of forest that could be managed to resemble a natural ecotone (a transitional zone between vegetation types);
- softening the edges between matrices by diversifying and promoting less intensive types of land use, managing the use of fire, minimizing the application of toxic chemicals and controlling the introduction of plant species from outside the region (Gascon, Williamson and da Fonseca, 2000);
- allocation of the whole forest landscape to specified land uses, including:
  - protected areas for conservation, tourism and non-consumptive uses;
  - protection forests, for example to control erosion or protect watersheds;
  - production forests managed under sustained-yield principles for timber and other forest products;
  - planted forests for intensive production of specific commodities;
- inclusion of ecological reserves within commercial forests to protect seed sources, watercourses and critical habitats;
- forest management decisions based on the legitimate needs of local people for access to the range of forest resources upon which their livelihoods depend.

Sustainable forest management requires the development and implementation of sustainable production systems that are adapted to the different forest ecosystems. These should include scientific, technological, economic, social, financial and educational components to ensure sustainability. The exact combination of goods and services to be provided from any particular forested region should be based on dialogue among industry, government, academics, local communities and NGOs, thereby bringing democracy to forests and enhancing the likelihood of sustainability. ◆

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Science and technology in the forest sector: widening gaps and narrowing options

Improvements in science and technology are critical to the sustainable management of forests, woodlands and trees, and to their capacity to meet growing demand for the range of goods and services that they provide, including environmental and social benefits. A significant shift in research and development is needed to address multiple-use management, with more attention given to ecosystem processes and their interaction with social and economic systems. Yet the resources invested in forest research are alarmingly inadequate and significant imbalances exist between developed and developing countries, government and industry, and different segments of the forest sector. It is in this context that the present chapter examines issues relating to scientific and technological capacity in the forest sector, focusing on the widening gaps and narrowing options.

CHANGING FOREST SECTOR PRIORITIES

The relative importance of the different functions of forests varies depending on the culture, the state of social and economic development and the specific demands and aspirations of a given society. Investment in research and development reflects the changing priorities, although the improvement of wood-production and wood-processing technologies has traditionally attracted the most public and private resources, while research related to other ecosystem functions and social dimensions, such as poverty alleviation, has largely been neglected. However, pressure from local communities, environmental groups, the private sector and civil society, coupled with international efforts that began with the United Nations Conference on Environment and Development (UNCED), has led to better recognition of the broader values of forests, with implications for forest research and development as noted in the following.

Environmental concerns

Environmental concerns are receiving greater attention as many former assumptions are coming into question. For example, a substantial body of knowledge has accumulated on the conservation of biological diversity, climate change, hydrological cycles and land degradation, all of which have a bearing on land use, particularly forests.

Biological diversity. Concern over the conservation of the totality of life, including the entire system of natural processes, has significant implications for forestry, forest management practices and forest research (see the preceding chapter). Replacing commercially less valuable vegetation with monoculture plantations has become less acceptable and now requires consideration of biological diversity issues. Improved methods of assessing current and changing values of biological diversity will therefore help to fine-tune required interventions.

Climate change. Concern about the impact of human activity on climate change has drawn attention to the role of forests in storing and

sequestering carbon, given that they account for an estimated 80 percent of annual exchanges of carbon between terrestrial ecosystems and the atmosphere (see p. 25). This calls for substantial work on carbon budgets, the costs and benefits of various interventions, and the use of market and non-market mechanisms to mitigate climate change.

Forests and water. Access to freshwater has already become a critical limiting factor in the economic development of several countries and a cause of conflict in many parts of the world. However, considerable uncertainty exists regarding the link between forests and water (see chapter on freshwater resources, p. 74). Additional multidisciplinary research is required in order to reach a better understanding of the consequences of various land uses, including forestry, for water yield, and to develop systems for equitably sharing the costs and benefits of protecting watersheds.

Socio-economic issues: alleviating poverty and enhancing food security

Despite unprecedented economic progress, the gap in wealth and income is widening, and poverty and deprivation are persisting. An estimated 815 million people suffer from malnourishment (FAO, 2002), and progress towards the United Nations' Millennium Development Goals is too slow (UNDP and UNICEF, 2002). Approximately half the world's population of 6 billion survives on less than US$2 per day. Although most live in rural areas and depend on natural resources, the lack of skills, of access to appropriate technology and of secure tenure, as well as a host of other problems, means that they are unable to manage and use resources sustainably. The fact that developments in science and technology have bypassed large segments of society also contributes to the unsustainable use of resources and environmental degradation. It also aggravates poverty, and not only in developing countries, for there are pockets of deprivation everywhere, even in the midst of plenty.

Implications for forest research

In terms of research, both alleviation of poverty and environmental protection will require:

- better understanding of the interaction between ecosystem processes and social and economic systems, and development of tools and techniques based on more comprehensive knowledge;
- an increase in the production of goods and services required by the poor, and enhancement of employment- and income-generating opportunities;
- modification of technology to comply with environmental requirements, especially the protection of biological diversity and the maintenance of key ecosystem processes.

The fundamental question is whether science and technology, as a whole, and forest research, in particular, are moving in that direction, or whether the gaps in knowledge and capacities are widening and long-term options narrowing.

WIDENING GAPS

Precisely when science must focus on social and environmental concerns in the forest sector, it seems that gaps in capacity among countries are widening and that, despite the need to undertake more broad-based research, current shifts in priorities and institutional arrangements

Power and impotence

"A profound paradox of power and impotence, crying out for a solution, now faces concerned people in every society. On the one hand, there is the unmatched power of basic scientific and technological research, reporting one remarkable advance after another at dizzying speed. On the other hand, individuals and whole societies are plagued by ominous problems that yield all-too-slowly, in part because of persistent ignorance at the fundamental level."

Branscomb, Holton and Sonnert, 2001.

could result in reduced attention to public goods research in these areas.

The technology divide

Almost all science and technology efforts and their results point to a wide gap between developed and developing countries. Table 9 classifies 87 countries on the basis of per capita investment in technology efforts and patents. The high-technology group consists entirely of industrialized countries, while all those in the low and negligible groups are developing countries. The moderate group includes some industrialized countries and some in transition.

On a per capita basis, countries in the high-technology group invest about 20 times more than those in the group immediately below. This is consistent with other parameters, such as the number of patents per 1 000 inhabitants and the average number of patents per country group in 1997–1998. As can be seen, the bulk of the world's population lives in countries with low and negligible investment in research and development. This disparity is manifest in the level of output.

The involvement of developing regions in science and technology efforts is clearly very low. Although not a perfect indicator, the differences

CANADIAN FOREST SERVICE/K. KLIMASZEWSKA

Technology divide, narrowing options: white spruce **(Picea glauca)** *seedlings developed through somatic embryogenesis – a sophisticated but expensive biotechnology for large-scale production of trees*

TABLE 9

Average technology effort per country divided into technology groups, 1997–1998

Technology group	Number of countries	Total population *(millions)*	Research and development per capita *(US$)*	Patents per 1 000 inhabitants	Number of patents per country
High	23	855.1	293.25	0.99	6 803
Moderate	20	756.0	14.01	0.02	50
Low	23	2 536.4	0.24	0.00	11
Negligible	21	655.6	0.00	0.00	0

Source: Based on Lall, 2001.

in the number of scientific articles published by region hint at disproportionate efforts and the marginalization of developing countries in knowledge advances. In 1999, North America and Western Europe accounted for about 70 percent of scientific articles published, while sub-Saharan Africa accounted for about 0.6 percent (Table 10). Furthermore, the broad groupings conceal disparities within regions. For example, Australia, China, India and Japan accounted for 94 percent of the publications in the Asia and the Pacific region. In sub-Saharan Africa, 56 percent of scientific articles were published in South Africa. What is more disturbing, however, is the significant decline in sub-Saharan African output between 1986 and 1999.

Although data comparing research and development efforts in the forest sector in different countries are limited, they appear to mirror the overall situation described in the previous paragraphs. For example, almost 70 percent of the member institutions of the

TABLE 10
Number of scientific articles published in different regions

Region	Number of publications in 1986	Number of publications in 1999
North America	199 138	183 211
Western Europe	143 496	188 548
Asia and the Pacific	59 931	101 369
Eastern Europe and Central Asia	42 299	30 763
Near East and North Africa	7 659	9 086
Latin America	5 583	12 034
Sub-Saharan Africa	4 639	3 632
World	**462 745**	**528 643**

Source: NSF, 2002.

An overview of science and technology investment

- Research and development investment in the 28 OECD countries in 1998 was estimated at US$502 billion; seven countries accounted for 85 percent, and the United States alone accounted for 44 percent of the total (NSF, 2002).
- In 1997–1998, the United States registered an average of 3.3 patents per 1 000 people. South Africa, industrially the most developed country in sub-Saharan Africa, had only 0.03 patents per 1 000 people, while India had just 0.001 (Lall, 2001).
- Per capita productive enterprise research and development for Japan in 1997–1998 was US$858.4, while for Brazil, South Africa and China it was US$13.7, $12.8 and $0.9, respectively (Lall, 2001).
- United States Federal Government support for academic agricultural research and development in 2000 was US$16 345 million (NSF, 2002), while the total budget of the 16 CGIAR centres in that year was US$331 million (CGIAR, 2000).
- Government research and development support for agriculture, forestry and fisheries in the United States in 1999 was estimated at US$15 528 million (NSF, 2002), while government investment in agricultural research in India, a country with a relatively well-developed national research system, was US$348 million in 1995 (Pray and Fuglie, 2001).
- An increasing proportion of research investment in OECD countries comes from the private sector. In 1981, industry accounted for 51 percent of the total OECD research and development outlay of US$251 billion. By 1998, this had increased to 62.5 percent, while the total outlay had almost doubled (Pray and Fuglie, 2001).

Marginalization of developing country research

"The gap between developed and developing countries in forestry research capacity and the delivery of usable results remains unacceptably wide. Developing countries, with 80 percent of the world's population, account for only 2 percent of the global expenditures on scientific research and for an even smaller share of the research output, which is the quantity of direct importance. They continue to face difficulties participating in the globalization process and many risk being marginalized and effectively excluded from global dialogue."

Szaro *et al.*, 1999.

International Union of Forestry Research Organizations (IUFRO) come from the 30 countries of the Organisation for Economic Co-operation and Development (OECD). IUFRO has launched a special programme to address the low level of involvement of developing countries in its networks (IUFRO, 2002).

Despite efforts in recent years, there are no indications that developing country research is increasing or that gaps in science and technology are narrowing, except in a small number of countries in Asia and Latin America. In many countries, especially those in sub-Saharan Africa, where forests could play a critical part in sustainable development and the enhancement of livelihoods, there is little research capacity in terms of institutions and human resources. The few institutions that do exist are underfunded and often lack adequate systems to make effective use of the limited resources that are available. Moreover, they are unable to plan and implement research or to encourage the adoption of appropriate technology.

Declining international support

Until the early 1990s, there were many programmes and projects to build research capacity, and the forest sector also benefited from such initiatives. However, with the decline in development assistance, support for research and development also shrank. This has particularly affected sub-Saharan Africa, where donor funding has been critical in sustaining efforts in several national research institutions. The declining trend in agricultural research and development most probably applies to the forest sector as well.

Private sector involvement

In many countries, structural adjustment programmes have led to public-sector downsizing and significant reductions in research capacity. Economic liberalization policies were thought to provide incentives for growth in the private sector and to more than compensate for the drop in public-sector investment, including research investment. It was also claimed that privatization of forest research would strengthen the links between research and its application, increasing its efficiency by focusing on outputs and products. Proponents of neo-liberal economic policies maintain that increased domestic private sector investment will replace public sector investment and that increased foreign direct investment will fill the gaps left as a result of declining development assistance. These assumptions seem unrealistic, especially in many developing countries where the private sector is weak and has neither the interest nor the capacity to invest in research. The few private initiatives that do exist are limited to adaptive research in areas that provide immediate competitive advantages, such as enhancing the productivity of plantations and wood processing. Even in Europe, where the private sector has a major role in growing and processing wood, the wisdom of privatizing and commercializing forest research is being questioned (Hellström, Palo and Solberg, 1998). This is also the case in New Zealand, where forest research was drastically restructured a decade ago (Richardson, 2002).

Increased flows of foreign direct investment have not been sufficient to compensate for declining development assistance, especially in

Forest research in New Zealand

"At first glance, everything seems rosy in research labs. After nearly ten years of operating under a boldly experimental commercial model, scientists are focusing on industry needs like never before and success stories abound. Last year Crown Research Institutes, including Forest Research, boasted record profits. But look behind the upbeat annual reports and you'll see a different picture."

Richardson, 2002.

Some trends in international development assistance for agriculture and agricultural research and development

- Although the European Community has increased overall development assistance, agriculture's share and support to agricultural research and development have declined. In the 1980s, agriculture accounted for 12 percent of European Community support, but this figure declined to 4 percent between 1996 and 1998.
- World Bank support for the rural sector has been erratic during the past two decades. However, after adjustment for inflation, the trend has been downward. The share of agriculture in total lending has declined from an average of 26 percent in the first half of the 1980s to 10 percent in 2000.
- The amount of funding that the United States Agency for International Development (USAID) directed towards agricultural research in the least-developed countries declined by 75 percent between the mid-1980s and 1996.

Source: Pardey and Beintema, 2001.

forest research. Foreign investment is concentrated in relatively well-off developing countries and newly industrialized countries. In addition, most of it flows to activities that have short pay-back periods and high returns. Although foreign investment results in some technology transfer in forestry, this is mostly related to logging, forest plantations and wood processing. Seldom does it increase indigenous capacity in science and technology, particularly in areas relevant to the needs of local communities.

NARROWING OPTIONS

Imbalances in ongoing research lessen options, thus increasing vulnerability to economic and environmental change. Low investment, coupled with changes in institutional arrangements, is bringing about a significant shift in research priorities, at a time when a broader framework is required to address the complexities of sustainable forest management.

Integrating approaches to science and technology

While the importance of integrated research is recognized, it is seldom reflected in the

Privatization of forest research in Europe: some findings

"Both economic theory and our empirical findings give strong support for the continuing dominating role of public funding in most forestry research. We have not found support from theory or practice that decreased public funding of most forestry research would be compensated by increased private funding in the respective fields of research. In addition, if public funding of forestry research is cut, it means that research orientation is to an increasing degree controlled by the markets, which for forestry research are very narrow. Inevitably such privatization would shift research priorities towards the interests of the private bodies capable of funding forestry research."

Hellström, Palo and Solberg, 1998.

International Union of Forestry Research Organizations: the leading international forest research network

IUFRO is 110 years old and has grown into the largest international non-governmental forest research network, encompassing virtually all aspects of forest research. Membership consists of 15 000 scientists from 700 institutions in 112 countries. Much of IUFRO's work is carried out by divisions and working groups that are organized according to the various disciplines. However, task forces are also established to examine such cross-disciplinary issues as:

- environmental change;
- forests in sustainable mountain development;
- management and conservation of forest genetic resources;
- water and forests;
- global forest information services;
- the science–policy interface;
- public relations in forest science;
- the role of forests in carbon cycles, sequestration and storage;
- information technology and the forest sector.

Research needs to be selective

"Research will need to avoid the perennial temptation to glorify all small-scale enterprises. In fact, many such activities are mere disguises for open unemployment; refuges for the desperate deprived of options; are poverty traps with no potential to bring real well-being in the long term; or offer little room for helping those dependent upon them to achieve technological and institutional upgrading. It will be essential to be selective and to favour activities with some improvement potential."

Kowero, Spilsbury and Chipeta, 2002.

formulation and implementation of science policy. Many developing countries have established science and technology departments, and their policies acknowledge the need to increase research capacity. However, substantial efforts are still required to integrate forest research so that it is not undertaken as an isolated activity with limited links to research in other sectors. Moreover, within wider policies concerning economic and social development, most countries, especially developing ones, have yet to link priorities and strategies for forest research to outcomes and impacts on society and the environment.

Continued focus on traditional areas

A major thrust of forest research has been the improvement of timber production, largely in plantations through enhanced technology. Neither research institutions nor those concerned with science policy formulation have been able to adapt adequately to the need for more comprehensive approaches to address the basic purpose of research. Many are finding it hard to make changes in their portfolios and are therefore making only cosmetic changes. Most projects and programmes still focus on products or disciplines. Only recently has IUFRO, for example, started paying more attention to cross-disciplinary issues.

Emergence of large corporate players

In the context of globalization, forest industries are restructuring through mergers, acquisitions and diversification (ILO, 2001). Some of the larger players are investing in developing countries and positioning themselves to take advantage of low labour costs and economies of scale, especially in technology development. Producing for a global market means standardizing products and processes, which to some extent limits the pursuit of a diversified and broad-based research agenda. Experience in most sectors, including agriculture,

demonstrates that the corporate research agenda is narrowly focused on technology that increases productivity, especially breeding, pest management and processing. Even large concession holders operating in tropical forests for decades have not invested sufficiently in research on sustainable forest management, and the situation is compounded by the preoccupation of many companies with short-term profits.

Neglect of the informal sector

In many developing countries, the forest sector is characterized by small-scale enterprises, of which a significant proportion operates in informal markets. A study by the International Labour Organization (ILO) indicated that 63 percent of total global employment in the forest and wood industries is in the "invisible forest sector", comprising informal sector small enterprises (34 percent) and fuelwood collection (29 percent) (ILO, 2001). Despite a number of deficiencies, rural enterprises based on the collection, processing and trade of forest products are a major source of employment and cash income in some places (Kowero, Spilsbury and Chipeta, 2002). Many of these enterprises are small, consisting of little more than one family working on a part-time basis. Investment is low, most technology is simple, and the failure rate is high. Notwithstanding the importance of the informal sector, few efforts have been made to improve its technological capacity, and there is a real need to gain a clear understanding of its potential and to develop technology that is relevant to small-scale producers.

Although attention is now paid to indigenous technology and local technical knowledge, efforts to improve these through modern science have been limited. Two trends seem to be emerging: total acceptance of traditional or local knowledge, based on the assumption that it is the best available; or its outright rejection as unscientific and inappropriate. Neither stance has helped to improve capacity at the community level. While there is an urgent need to give greater consideration to traditional knowledge, out-of-hand replacement of what is considered "modern" often results in systemic rejection and unsustainability.

Impact of developments in science and technology in other sectors

A substantial proportion of developments in science and technology is generic, and has been adapted to forestry as appropriate. For example, advances in the following areas have had impacts in the forest sector:

- molecular biology and biotechnology;
- chemical and process engineering, including new materials technology;
- transport technology;
- space technology, including remote sensing techniques;
- information and communications technology.

Transport technology, for instance, has revolutionized forestry, permitting greater access to distant markets and increased flexibility to shift the production site. Techniques such as helicopter logging have opened up areas previously considered inaccessible, while tree improvement techniques have led to substantial increases in the productivity of plantations, and more precise remote sensing could make it possible to assess and monitor resources on a real-time basis. However, the inadequacy of technological capacities poses certain constraints and raises two key issues: access to generic technology and the adaptation of such technology to the specific needs of a place or sector.

Patent regimes are increasingly acting as barriers, because some countries are not in a position to pay royalties for access to knowledge. Where the potential exists for technology transfer, large enterprises with well-developed research and development capacity capture a significant proportion of benefits. Countries that fail to develop indigenous science and technology capacity thus become markets for capital and consumer goods or, at best, producers of goods for global markets largely using cheap labour and natural resources. In most cases, even the capacity to assess the appropriateness of technology in the global marketplace is lacking.

Effectiveness of partnerships

Partnerships between the private and public sectors. Partnerships between the private and public sectors can strengthen research efforts by making them more demand-driven, with a focus on well-defined outputs. They are also a way of generating funds in times of declining resources. However, pitfalls do exist. Public institutions, under pressure to mobilize resources, are often compelled to enter into partnerships with the private sector on terms that compromise the purpose of their research. Most partnerships of this type increase the competitive advantage of the private sector, and a substantial proportion of research tends to be product- and productivity-focused. Other limitations include:

- a decrease in resources for more fundamental public goods research, which in due course negatively affects applied and adaptive research;
- increased vulnerability to unforeseen problems, such as pest infestation and disease resulting from a narrow focus on a limited number of species and clones;
- restricted access to outputs, limiting the generation and wider application of knowledge.

Public sector partnerships with communities and non-governmental organizations (NGOs). Traditionally, most public sector forest research has responded to the needs of government forest agencies and has been related to large-scale forestry, especially plantations. The narrow technical specialization this entails has limited the ability to build up strong links between public sector institutions and local communities. Although the recent focus on agroforestry by the World Agroforestry Centre (ICRAF) and some NGOs, for example, has helped to improve the scientific basis of traditional practices, there are nevertheless serious gaps. The fragmented nature of conventional research, coupled with limited capacity in social science research, often undermines the potential for a strong partnership between the public sector and local communities.

Partnerships between the private sector and the community. In several countries, private industries are increasing support to local communities and farmers for tree growing. Industries provide seeds, seedlings and technical expertise, and invest substantially in efforts to identify appropriate species and

Center for International Forestry Research: adaptive responses to emerging concerns

CIFOR, established a decade ago to strengthen forest policy research at the global level, is helping to redefine the focus of such research. Through four research programmes and one programme for research support, CIFOR is responding to evolving demand and emerging issues, for example in the following areas:

- the underlying causes of deforestation, forest degradation and poverty in forest margins;
- forest ecosystem management;
- multiple resource management of natural forests;
- assessing the sustainability of forest management – testing criteria and indicators;
- plantation forestry on degraded or low-potential sites;
- conservation of biological diversity and genetic resources;
- livelihoods, community forests and devolution;
- sustainable use and development of non-wood forest products (NWFPs);
- research impact, information and capacity building;
- policies, technologies and global change.

provenances and standardize management practices. They also provide market access. Such partnerships concentrate mainly on the production of industrial roundwood, often from fast-growing species, and industry undertakes most of the applied and adaptive research. With other aspects receiving little attention, these partnerships can be vulnerable to economic and environmental changes.

International initiatives

Collaboration through networking is an important mechanism to add value to ongoing science and technology efforts, and there are some excellent examples. IUFRO has been operating for more than a century and is seen as a pioneer. Recently established regional networks of forest research institutions, such as the Asia-Pacific Association of Forestry Research Institutions (APAFRI) and the Forestry Research Network for Sub-Saharan Africa (FORNESSA), are attempting to improve the prioritizing of research and the exchange of methodologies, experience and results. With limited numbers of researchers in many countries, building up strong collaborative networks at the subregional, regional and global levels becomes imperative. During the past decade, the Consultative Group on International Agricultural Research (CGIAR) has established the Center for International Forestry Research (CIFOR) and incorporated ICRAF into its system. In the context of evolving priorities, these institutions have adapted and reoriented their research agendas to tackle issues related to environmental services, sustainable livelihoods and governance.

While international research institutions provide frameworks and concepts that can be applied more widely, such application largely depends on capacity at the country level. As previously noted, most traditional forest research institutions lack the resources, capacity and orientation to design and implement the new agenda required for sustainable forest management, and alternatives are yet to emerge. Meanwhile, research remains narrowly focused,

Global Forum on Agricultural Research

GFAR was founded in 1996 by representatives of national agricultural research systems in developing countries, advanced research institutions, regional and subregional organizations, universities, NGOs, farmers' organizations, the private sector, international research centres and the donor community. It became fully operational in 1998. Its mission is to mobilize the scientific community and all those with a stake in agricultural research for development, to alleviate poverty, increase food security and promote the sustainable use of natural resources.

The objectives of GFAR are to:

- facilitate the exchange of information and knowledge in crop and animal production, fisheries, forestry and natural resource management;
- promote the integration of national agricultural research systems and increase their capacity to produce and transfer technology in response to users' needs;
- foster cost-effective partnerships among those with a stake in agricultural research and sustainable development;
- facilitate the participation of all stakeholders in formulating a global framework for development-oriented agricultural research;
- increase awareness among policy-makers and donors of the need for long-term commitment to, and investment in, agricultural research.

Natural resource management and agro-ecology is one of the five priority areas of GFAR. It will therefore need to develop a forestry dimension in its work at the national, regional and global levels.

largely driven by the short-term priorities of an imperfect market. The Global Forum on Agricultural Research (GFAR), established in 1996, has the potential to fill the gaps, although its effectiveness remains to be seen.

CONCLUDING OBSERVATIONS

If current weaknesses in forest science and technology efforts persist, the following circumstances could prevail in coming years.

- The technology gap between advanced countries and those at the lower end of the ladder may widen, with many countries remaining excluded from the generation and application of knowledge.
- It will be hard to adopt sustainable forest management on a wider scale and to address the growing number of social and environmental issues in forest resource use.
- Limited application of scientific advances to a few élite segments of the forest sector will contrast sharply with the lag in the rest of the sector resulting from insufficient research and development efforts, especially in the management of indigenous forests and those catering to local needs.
- The narrow pursuit of commercial profits could increase society's vulnerability to unforeseen environmental and economic changes, and declining public sector investment will impair its capacity to address such situations.

There is therefore an urgent need to strengthen scientific capacity, especially in countries where it remains poor. Innovative approaches are required to ensure that limited resources are effectively utilized and that results have wider relevance and application. ◆

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Recent trends in fiscal policies in the forest sector in Africa

As interest in sustainable forest management has grown, so has the importance of finding ways to finance it. Indeed, one of the main points of agreement at various international meetings on forestry has been the need for support for it (UN, 2000). Little progress has been observed, however, and considerable differences of opinion remain as to how funding for forestry can be obtained.

The present chapter is based on 32 country reports on forest finance produced by African national experts between 2000 and 2002, with the assistance of a joint European Commission/FAO project on sustainable forest management in Africa (FAO, 2001, 2002a) (see Box for list of countries covered). It presents recent trends in public expenditure on forestry and revenue collection from the sector, and then describes some recent innovations in related fiscal policies. It concludes by suggesting how fiscal policies in the sector might be improved and offers comments on the broader debate on financing sustainable forest management.

PUBLIC EXPENDITURE ON FORESTRY

Public expenditure on forestry is likely to be the driving force for implementing sustainable forest management in Africa. Although public funding supports the management of protected areas and a few small production forests, most public expenditure is used to monitor and control private sector operations. It is in this latter regard that an increase is particularly needed if forest management is to improve on the continent.

Public expenditure on forestry usually comes from two main sources: domestic financing, including government revenue from taxes and

Countries covered in the FAO study on forest finance in Africa

Benin
Burkina Faso
Burundi
Central African Republic
Chad
Comoros
Côte d'Ivoire
Democratic Republic of the Congo
Ethiopia
Gambia
Ghana
Guinea
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritius
Namibia
Niger
Nigeria
Senegal
Seychelles
Sierra Leone
South Africa
Sudan
Togo
Uganda
United Republic of Tanzania
Zambia
Zimbabwe

duties, as well as government borrowing; and, in the case of developing countries, international financing through grants and loans. In addition, an important component of domestic financing in some countries is revenue collected in the form of charges, fees and levies.

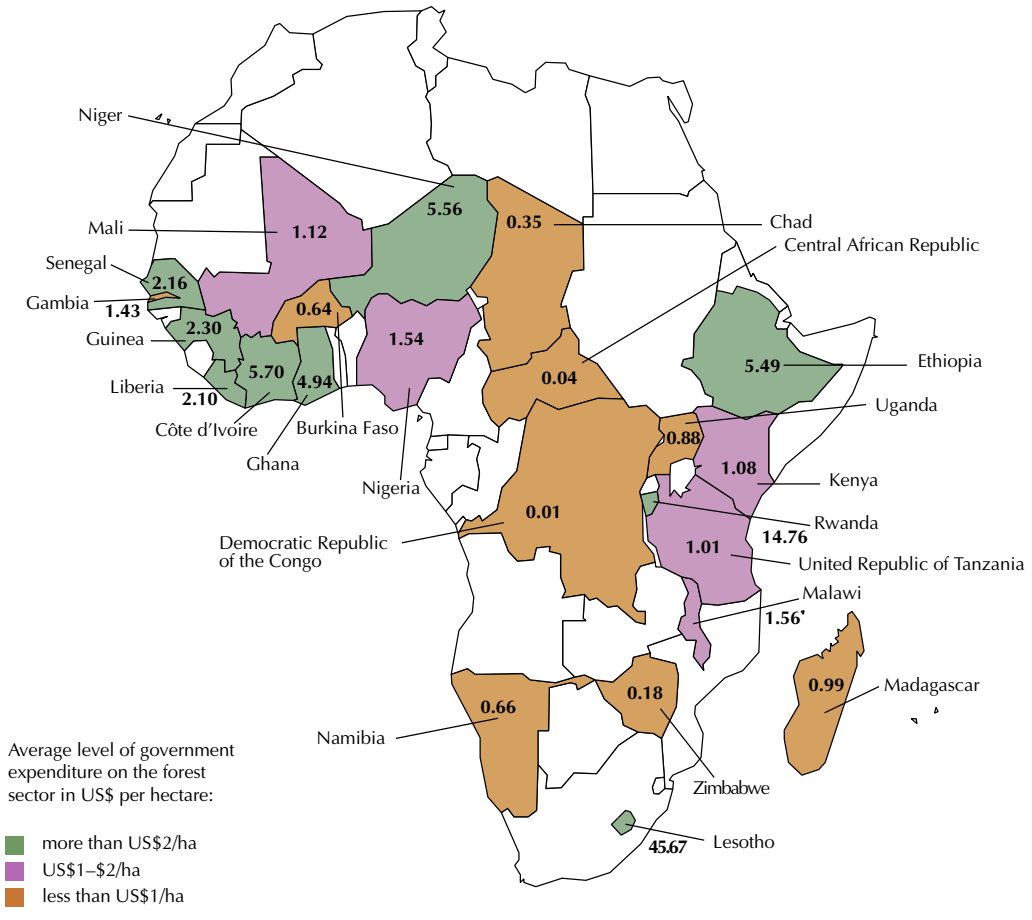
Trends in total public expenditure on forestry

Faced with many demands for public services, most governments assign a low priority to financing of forestry. In fact, several country reports noted that public expenditure on forestry accounted for less than 1 percent of the total, and it seems likely that this is the case throughout Africa. On the basis of 24 country reports, the average total public expenditure on forestry in 1999 was US$0.82 per hectare (FAO, 2002a). However, international financing accounted for about 45 percent, making the average level of domestic financing only US$0.45 per hectare.

Figure 7 shows total public expenditure on forestry per hectare in countries where information was available. The countries with the highest levels of public expenditure on forestry per hectare were those with relatively small forested areas (Lesotho and Burundi). Others with high levels of public expenditure included the Niger, Ethiopia, Côte d'Ivoire and Ghana. In the Niger, the high expenditure is

FIGURE 7

Public expenditure on forestry per hectare in African countries, 1999



explained by high levels of international financing, but this is not the case in Ethiopia and Côte d'Ivoire. In general, there is little correlation between total public expenditure on forestry and the level of international financing.

About half the countries in the study also presented information about recent trends in total public expenditure on forestry. As Table 11 shows, it has increased in all countries except two. However, increases in most countries failed to keep up with inflation, so that in real terms total public expenditure on forestry grew in only five countries.

TABLE 11
Trends in total public expenditure on forestry in selected African countries

Country	Time period	Average annual increase in total public expenditure on forestry over the specified time period (%)	
		At current prices	At constant prices
Burkina Faso	1996–1999	- 6	- 11
Burundi	1990–2000	+ 4	- 5
Central African Republic	1996–2000	+ 8	- 11
Chad	1991–2000	+ 10	+ 1
Côte d'Ivoire	1990–1999	+ 5	- 4
Ethiopia	1997–1999	+ 3	- 5
Gambia	1995–2000	+ 1	- 3
Ghana	1990–1999	+ 37	+ 8
Kenya	1995–2000	- 7	- 18
Malawi	1990–1999	+ 26	- 4
Mali	1992–1999	+ 16	+ 6
Mauritius	1996–2000	+ 6	- 3
Niger	1991–1999	+ 8	+ 1
Nigeria	1993–1999	+ 16	- 18
Senegal	1990–1999	+ 6	0
Zimbabwe	1996–2000	+ 59	+ 25

Source: FAO, 2001, 2002a.
Notes: The figures for Ethiopia are an underestimate because the most recent expenditure figures do not include all the states. The figures for the Central African Republic, Ghana and Malawi exclude expenditure supported by international financing. The figures for Nigeria include estimates of spending on forestry by State forest administrations, based on the country report plus information about State budgets in Nigeria (IMF, 2000).

Trends in international financing

Further details about the sources of financing for public expenditure on forestry in Africa are given in Table 12. Although this table shows a wide variation in international financing among countries, countries tend to fall into three categories.

- A few countries with relatively large and well-developed forest sectors have high levels of public expenditure on forestry and relatively low levels of international financing (e.g. Côte d'Ivoire and Ethiopia).
- A few more countries have quite high levels of public expenditure on forestry but have much higher levels of international financing as well (e.g. Madagascar, Mali and the United Republic of Tanzania).
- Most countries have generally low levels of public expenditure on forestry with proportionately high levels of international financing. In most, the forest sector is not a major part of the market economy, although forests have enormous value for subsistence and for social and environmental benefits. These priorities are generally reflected in the types of project and programme that international agencies tend to finance.

The average contribution of international financing to total public expenditure on forestry in 1999 was 41 percent. On the basis of limited information about trends in international financing since 1990, it appears that this figure has varied by an average of 35 to 40 percent over the past decade and that it declined from a peak of US$132 million in 1995 to US$110 million in 1999, a fall consistent with broader global trends, as reported by Madhvani (1999) and the Organisation for Economic Co-operation and Development (OECD, 2000).

Activities supported by public expenditure on forestry

An important aspect of public expenditure, in addition to its total amount, is the contribution

it makes to sustainable forest management. Based on information provided by 17 countries, the following general observations can be made.

- Most public expenditure from domestic financing goes to current expenditure rather than to investment (86 percent in 1999).
- Most current expenditure covers staff costs. About half the countries reported that these costs accounted for more than 70 percent of the total.

TABLE 12
Sources of public expenditure in the forest sector in selected African countries, 1999

Country	Forest revenue	Total public expenditure ($US'000)[a]			Sources of funds (%)		
		Domestic financing	External financing	Total	Forest revenue	Government (net)	External
Burkina Faso	780	2 201	2 328	4 530	17	31	51
Burundi	50	193	1 198	1 391	4	10	86
Central African Republic	5 566	1 030	n.a.	1 030	541	n.a.	n.a.
Chad	60	471	3 960	4 431	1	9	89
Côte d'Ivoire	41 561	32 971	7 566	40 538	103	-21	19
Democratic Republic of the Congo	803	1 277	0	1 277	63	37	0
Ethiopia	2 283	21 345	3 865	25 209	9	76	15
Gambia	225	242	445	686	33	2	65
Ghana	12 559	31 294	n.a.	31 294	< 40	n.a.	n.a.
Guinea	902	7 362	8 551	15 913	6	41	54
Kenya	1 845	17 407	1 054	18 461	10	84	6
Lesotho	44	521	119	639	7	75	19
Liberia	3 100	7 317	0	7 317	42	58	0
Madagascar	2 734	4 385	7 255	11 641	23	14	62
Malawi	110	3 992	n.a.	3 992	< 3	n.a.	n.a.
Mali	321	4 830	9 896	14 726	2	31	67
Mauritius	770	5 603	0	5 603	14	86	0
Namibia	68	2 548	2 787	5 335	1	46	52
Niger	351	773	6 612	7 385	5	6	90
Nigeria	2 572	12 580	8 241	20 821	12	48	40
Senegal	1 579	2 835	10 578	13 413	12	9	79
Uganda	763	1 282	2 386	3 668	21	14	65
United Republic of Tanzania	2 763	7 567	31 773	39 340	7	12	81
Zimbabwe	908	2 132	1 254	3 386	27	36	37

Source: FAO, 2001, 2002a.
n.a. = not available.
[a] At 1999 exchange rates.
Notes: Although figures were not available, it should be noted that both Ghana and Malawi receive significant levels of external financing for the forest sector. It should also be noted that international financing might be higher than shown because these figures may not include support to forestry under more general rural development and environmental projects in some countries.

- In contrast, nearly all expenditure supported by international financing was spent on investment (73 percent in 1999), mostly on relatively small and specific areas.
- Only five countries reported investment programmes supported by domestic financing of more than US$1 million per year in the forest sector.

Given that public expenditure covers a wide range of activities in forestry, most countries could not easily identify how much was devoted to sustainable forest management. Only community forestry and protected area management were distinguished. The most commonly reported areas for investment were projects related to infrastructure and to reforestation for community forestry, commercial forestry and desertification control.

Revenue collection

Where forests are owned by the State, it has been suggested that one way to increase public expenditure is to increase forest charges and revenue collection. However, a number of studies have shown that the forest revenue collected is low in many countries (FAO, 1983; Repetto and Gillis, 1988; Grut, Gray and Egli, 1991). Low forest revenue not only has a negative impact on total government revenue and expenditure, but also sends incorrect price signals to the market about the value of forests and wood. Such messages are damaging to sustainable forest management in that low prices can result in overharvesting and undervaluing of the resource, both of which contribute to deforestation and forest degradation.

Analysis of the data from Africa reveals the following.

- Forest charges are complicated and duplicated in many countries. If general taxes and levies are included, it is quite common for producers to pay more than ten different taxes and charges.
- Most countries levy charges on several types of forest output from among, for example, woodfuel, industrial roundwood, processed products, non-wood forest products (NWFPs) and forest services.
- Forest charges are reviewed every three to four years on average, but four countries had not reviewed their charges since 1990. Since 1990, charges had increased by more than the rate of inflation in only four of the countries studied.
- Governments set most forest charges by using market-based formulae or by consulting with interested parties. When market-based methods have been used, forest charges have tended to increase. Consultation, often with the forest industry, has tended to restrict increases.
- Of the 22 countries that provided adequate data on the total revenue collected, 17 had increased it since 1990, although only 13 had done so by more than the rate of inflation. Given that forest charges generally fell over the period, most countries have become more efficient in revenue collection (O.I. Ajewole, in preparation).

The average revenue collected per cubic metre was calculated by dividing total revenue collected by total production. Using total roundwood production, the average revenue collected in Africa in 1999 was US$0.19 per cubic metre. However, excluding woodfuel production, the figure is US$2.42 per cubic metre.

These results show little improvement in this area. Forest charges remain low, complicated and difficult to collect. Countries suggested a number of reasons for this, including staff shortages, poorly motivated staff, infrequent revision of charges and poor governance. However, in some cases, low revenue collection is a deliberate policy of governments that want to subsidize wood consumption – in the form of woodfuel, for example – for social reasons.

NEW FISCAL ARRANGEMENTS

Given the limitations of public finances, many African countries are attempting new and innovative ways of drawing or retaining finance. The most notable of these are a move towards greater decentralization and financial

autonomy for forest administrations, experiments with cost and benefit sharing with stakeholders, increased use of forest funds and privatization of forest resources.

Fiscal decentralization and financial autonomy

In terms of fiscal decentralization, most African countries have followed one of three models.

- ***Complete decentralization.*** In a few countries, notably Ethiopia and Nigeria, forestry has been almost entirely decentralized to the state government level. Both countries report some disadvantages, such as wide variations among states in forest charges and revenue collection. However, some states in these countries have implemented effective models of forest financing.
- ***Decentralization within a common national framework.*** Many of the Sahelian countries (e.g. Mali and the Niger) have partly decentralized fiscal policy in the forest sector. Thus, for example, local communes are involved in the development of areas for forest harvesting and revenue collection and keep a share of the revenue collected. At the national level, the government determines the rules and regulations for forest harvesting and sets the level of forest charges to be applied across the country.
- ***Centralized administration with revenue sharing.*** The central administration maintains control over forest management and revenue collection but shares some of the revenue with local authorities. This model has been applied in Uganda and Zambia, and to a lesser extent in Ghana. It seems to have few benefits, except that it might create a stronger link between forest protection and the collection and use of revenue for local services and facilities.

At a recent workshop on forest finance in Abuja, Nigeria (FAO, 2002a), countries reported that the current trend towards decentralization was generating some concern about the future for forest financing. In brief, it was felt that if local and regional governments collected revenue and had authority for spending it, even less attention would be paid to the need for public expenditure on forestry.

Most African countries levy charges on several types of forest output including woodfuel, although low revenue collection is sometimes a deliberate policy to subsidize fuelwood consumption for social reasons

FAO/19344

Another innovation that is becoming more common is the granting of greater financial autonomy to forest administrations. More independent and, in some cases, self-financing forest administrations have been launched or are under consideration in several countries, including Ghana, Uganda and Zambia. A number of countries have also experimented with having regional or state forestry offices retain a proportion of the revenue they collect, for use in implementing local forestry projects and programmes.

Many countries reported problems with access to agreed budget allocations from State treasuries, so greater autonomy in collection and retention of revenue may improve the administration of public finances in the sector. However, it is too early to tell whether these schemes will be successful.

Cost and benefit sharing

Thirteen countries reported that they had developed or implemented various mechanisms to increase the involvement of local communities in the management of forests, including sharing some of the costs and benefits from forest harvesting.

A few countries have given communities complete control over forest resources, including responsibility for collecting revenue (e.g. the Gambia). In return, they must return a share to the forest administration and, in some cases, must spend some of the money on forest management. However, most countries have introduced simpler systems, under which the

Forestry Outlook Study for Africa

The recently completed Forestry Outlook Study for Africa (FOSA) provides a 20-year perspective and long-term planning framework for development of the sector. The main outputs are an overview and five subregional reports that address issues pertaining to Central, East, North, Southern and West Africa. These reports identify driving forces, describe policies and institutional scenarios, assess implications for the future of forestry and present possible ways of increasing its contribution to sustainable development. Key findings and conclusions are summarized in the following.

FACTORS AFFECTING FORESTRY

Factors expected to have an impact on the forest sector over the next 20 years include:

- the varying pace of political and institutional changes, especially democratization, decentralization and the involvement of stakeholders;
- persistent conflict and war;
- demographic changes, including an estimated population increase of around 400 million or 50 percent by 2020, as well as such factors as urbanization, population movements and HIV/AIDS;
- the low growth in income, exacerbated by its very unequal distribution, accentuating poverty and therefore dependence on natural resources such as forests;
- the high debt burden, declining development assistance, low levels of foreign direct investment and declining terms of trade;
- emerging opportunities and constraints arising from globalization;
- insufficient diversification of economies and the predominance of the informal sector;
- inadequate investment in human resources and technology.

The overall institutional environment is marked by inadequate and rapidly declining capacity in public sector institutions, a poorly developed market mechanism that is unable to provide a level playing field, and a growing informal sector which, although critical for livelihoods, is unable to manage resources sustainably. In addition, most people are not empowered and hence lack the freedom to bring about positive change.

IMPLICATIONS

In the absence of any fundamental change, the forestry situation in Africa will be marked by:

Many African countries have implemented mechanisms to increase the involvement of local communities in the management of forests and the harvesting of their products; these women in Burkino Faso process the nuts of **Butyrospermum parkii** *to obtain shea butter*

FAO COMMUNITY FORESTRY UNIT/CFU000183/R. FAIDUTTI

- continued land-use conflicts and loss of forest cover at roughly the current rate;
- slow progress in applying sustainable forest management;
- deterioration in the state of the environment, particularly exacerbation of the water crisis, increasing land degradation and desertification, and loss of biological diversity;
- continued dependence on wood as a source of energy, increasing woodfuel consumption from about 635 million cubic metres in 2000 to about 850 million cubic metres in 2020;
- depletion of NWFPs, most importantly medicinal plants;
- increased conflicts in wildlife management, undermining the potential of wildlife as a source of bushmeat and protein for rural diets and impeding the expansion of wildlife-based tourism;
- a significant decline in productivity and in purchasing capacity on national and local markets as a result of HIV/AIDS.

PRIORITIES AND STRATEGIES

Fundamental changes in priorities and strategies are needed over the next two decades if current trends are to be reversed, especially with a view to:

- alleviating poverty, by emphasizing the production of basic goods and services and by generating income to meet basic needs;
- protecting the environment, by conserving and rehabilitating watersheds, arresting land degradation and desertification and conserving biological diversity.

This involves empowering key actors and enhancing positive action by:

- redefining the responsibilities of the public sector and enabling it to play a leading role in creating conditions for all stakeholders to function effectively;
- supporting the development of an effective and transparent market mechanism;
- improving the efficiency of the informal sector by providing legal, institutional and other support mechanisms.

The FOSA reports outline how these priorities and strategies could be adapted to each subregion. Follow-up will focus on incorporating the findings into national forest programmes. Specific attention will be paid to improving strategic planning capacities at the national and subregional levels.

The full texts are available on the Internet at www.fao.org/forestry/outlook.

Impact of HIV/AIDS on forestry

With an estimated 40 million people infected globally and 3 million deaths in 2001 (UNAIDS and WHO, 2001), HIV/AIDS has become a major development problem in all sectors, including forestry. Sub-Saharan Africa has been particularly hard hit, accounting for 70 percent of the world's total infected. In countries where more than 20 percent of adults are infected, life expectancy has declined considerably (UN, 2001). To date, AIDS has killed about 7 million agricultural workers in the 25 most-affected African countries. Another 16 million could be lost by 2020 (FAO, 2002b).

Although the overall effects of HIV/AIDS have been well documented (ILO, 2000), no comprehensive study has been undertaken on the direct and indirect effects of HIV/AIDS on forests and forestry. As increasing numbers of people succumb to the disease, however, the severity of the problem is becoming more evident. Implications include:

- a drastic decline in the human and financial resources of households, undermining labour- and capital-intensive land uses and leading to increased dependence on forests;
- the loss of traditional knowledge and skills, with devastating consequences for the social, economic and cultural stability of communities;
- the loss of qualified professionals and technicians, severely limiting the capacity of governments and communities to implement sustainable resource management;
- high absenteeism and declining productivity of the workforce, undermining the economic viability of forest industries;
- reduced public sector investment in sustainable forest management as a result of additional resource requirements for combating HIV/AIDS.

A shortage of labour stemming from AIDS-related deaths has already increased the use of forests and tree systems. Instances of people reverting to the use of wild, uncultivated resources in sub-Saharan Africa have been documented (Barany *et al.*, 2001). In Malawi, a survey of microenterprises and small enterprises, including those in the forest sector, indicated a decline in the number of enterprises as a consequence of HIV/AIDS (National Statistical Office, Malawi, 2000).

The forest sector is developing comprehensive strategies to address the problem of HIV/AIDS, and opportunities for collaborating with other sectors have been identified. Little can be done to address short-term agricultural production and nutrition issues, but secure land tenure, labour-extensive production systems and emphasis on certain medicinal plants and tree species can make significant contributions in the longer term. Forestry training and education, including youth and continuing education, also have a part to play in raising HIV/AIDS awareness, promoting safety measures and enhancing income opportunities for junior workers, women and children.

> "There has not been any specific study on the impact of HIV/AIDS in the forestry sector but we lose staff almost every week in the department alone. Workers suffer different degrees of the illness, thereby reducing their availability to work. Since HIV-related illnesses tend to be long term, measured in years most of the time, the impact is quite significant. The other dimension is the amount of resources used for treatment or for facilitating funerals. Our tradition is that one is buried in the home village. A lot of money is spent to buy coffins and transport the dead home. Even without a systematic assessment, we know the impacts in terms of human loss, lost hours due to illness, and funeral costs are high."
>
> Sam Kainja, Deputy Director of the Forestry Department, Malawi

forest administration retains control and gives a share of the revenue it collects to communities or the local government.

Most of these schemes have been introduced recently, driven by specific pilot projects that were donor-funded and -managed. Thus, the institutional capacity to sustain them is often lacking. Other problems noted in the reports include: identifying who should benefit from revenue sharing; the lack of capacity in communities to manage funds; obtaining funds held at the central level; the lack of public awareness; and reporting, monitoring and accountability. As with decentralization, it is still perhaps too early to tell whether cost- and benefit-sharing arrangements will do much to improve the financing of sustainable forest management.

Forest funds

The third way in which countries have recently tried to improve the financing of sustainable forest management is through forest funds. These can be organized in many ways (Rosenbaum and Lindsay, 2001) but they are generally raised through contributions from specific sources and are to be used only for specific purposes.

Forest funds are often derived from special fees or levies in the forest sector, although in some cases these are supplemented from other sources. Forest funds in Africa are used for various purposes, including: forest industry development; monitoring of forest operations; research, training and education; conservation; purchase of equipment; and wildlife management. More general funds have also been established to support revenue sharing and self-financing forest administrations, as already noted.

Fifteen countries reported that they had at least one forest fund. However, most also indicated that these funds had done little to improve access to timely and adequate amounts of public finance to support operations. This finding was confirmed by a statistical analysis of trends in revenue collection and public expenditure on forestry, which showed that in countries without forest funds, roughly 52 percent of past increases in the revenue collected were returned to the forest administration in the form of higher

Forest funds in Africa are used for various purposes, including forest industry development

FAO/17996/P. JENKIN

domestic public financing. In countries with forest funds, this figure was only slightly higher, at 56 percent, suggesting that forest funds have done little to strengthen the link between revenue collection and public expenditure in the sector (O.I. Ajewole, in preparation).

Privatization of forest resources

A number of countries in Africa are examining options for privatizing parts of their public forest estate, mostly consisting of forest plantations rather than natural forests. A move in this direction is being considered particularly in Southern Africa, by Malawi, South Africa and Zambia. Many countries are promoting new and innovative forms of private sector management in their natural forests as well.

The driving force for privatization is likely to be the inefficiency of the public sector in managing many of these areas. Several countries reported that they could not afford to manage and replant their forest plantations with the revenue that they were obtaining from the sale of forest products. As a result, encroachment and selective cutting of the most valuable trees is degrading these resources. If current attempts at privatization are successful, other African countries may follow suit. Alternatively, if the circumstances are right, countries may clear their forest plantations and then rent or lease the land to private tree growers, as has happened in Uganda (see Box below).

It is also important to note that the area of privately owned forest land in Africa is extremely small, with only Uganda, South Africa and a few other countries recognizing significant areas of privately owned forest. A few countries maintain that all forests belong to the State. In most, however, ownership and control remain unclear and uncertain.

Renting forest land to promote private tree planting in Uganda

The system of renting out cleared forest land was introduced in peri-urban areas of Uganda, where the government allocated plots for individuals, institutions and organizations to plant trees to supply poles and fuelwood for urban areas. This was initially done because the Uganda Forest Department lacked the resources to replant these areas, but later it was seen as an opportunity to involve private farmers in tree planting.

Under the scheme, farmers are each allocated a 5-ha plot, on which they usually plant *Eucalyptus* species. The Forest Department provides technical guidance for planting and tending operations, but the farmer covers the costs of labour and materials and pays an annual land rent of USh1 500 (US$0.85) per hectare. When the trees are harvested, the farmer retains all the profit from the sale of the poles and fuelwood.

The demand for these products in urban areas is such that large areas of privately managed *Eucalyptus* plantations are found in many peri-urban areas today. The same scheme is now being examined for industrial softwood, and some investors have already shown interest.

RECOMMENDATIONS FOR IMPROVING FISCAL POLICIES

Public expenditure on forestry in Africa is low compared with that of other regions, and a lack of available financial resources suggests that sustainable forest management will not be achieved on the continent in the foreseeable future. The following suggestions are made with a view to improving this situation.

- ***Public expenditure.*** An analysis of public expenditure on forestry (O.I. Ajewole, in preparation) has shown that population has the greatest impact on total spending, which suggests that forests are valued largely for their subsistence, social and environmental benefits rather than purely for their financial benefits. Countries should therefore stress the socio-economic benefits of forests, including poverty alleviation, to attract more public spending.
- ***Efficiency of expenditure.*** The huge proportion of public expenditure allocated to wages leaves little for investment or operations. Fewer employees, with adequate funding to carry out tasks, might be more effective. In addition, more attention should

be paid to supporting the vast number of small-scale producers in the region.

- ***International financing.*** The declining trend in international financing for forestry might be reversed if donors made their applications for assistance more transparent and user-friendly, and if forest agencies took a more proactive approach to obtaining international financing. In addition, greater coordination of international assistance to the forest sector could avoid duplication and repetition.
- ***Forest charges.*** Forest charges should probably be increased in most countries, and this analysis suggests that market-based mechanisms rather than consultation should be used in setting them. Any increases in charges should be accompanied by measures to avoid such problems as corruption.
- ***Efficiency of revenue collection.*** Countries should move towards simpler and more efficient charges, in light of experiences showing that area-based charges often collect more revenue. With a large number of producers, transaction costs are high and countries should consider contracting the collection of charges and fees through such arrangements as cost and benefit sharing.
- ***Decentralization.*** Experience from various countries suggests that the decentralization of revenue collection and expenditure functions can be effective, but that this should be done within the framework of a national fiscal policy.
- ***Cost and benefit sharing.*** Local populations should be involved in revenue collection through cost- and benefit-sharing arrangements, inasmuch as these increase efficiency. Although existing local government structures may be used, it is sometimes necessary to create new structures, and this can be difficult.
- ***Forest funds.*** Although forest funds have been successful in other regions, this has not been the case so far in Africa, except in one or two countries that have made considerable investment in capacity building (e.g. the Niger). Greater attempts should be made to address cumbersome bureaucracy, inefficiency and corruption if forest funds are to be more successful. They must also be managed more independently from the rest of public finances.
- ***Privatization.*** Given the current performance of the public sector in forestry, it may be desirable to transfer more control and ownership of forest resources to the private sector, including local communities. This will reduce transaction costs and increase the likelihood that private forest owners will be more successful at setting prices that the market can bear and at collecting revenue. In many countries, this may do more to achieve sustainable forest management than current underfunded and inefficient public systems.

First and second Conference of Ministers in Charge of Forests in Central Africa

As a follow-up to the 1999 Summit of Central African Heads of State on the Conservation and Sustainable Management of Forests and the adoption of the Yaoundé Declaration, ministers responsible for forests met in Yaoundé, Cameroon, in December 2000 and again in June 2002. They signed statutes establishing the Conference of Ministers in Charge of Forests in Central Africa (COMIFAC) as the body to provide guidance and make decisions on forest-related initiatives in the region. The ministers also adopted resolutions on medium- and long-term financing, an action plan for implementing the Yaoundé Declaration, a common position to take to the World Summit on Sustainable Development, and a resolution requesting development partners to help finance protected areas and promote alternative livelihoods for people affected by their establishment. The ministers also approved the Executive Secretariat of COMIFAC and clarified links with the Conference on Humid High Forests of Central Africa.

The next COMIFAC meeting is scheduled for June 2004 in Libreville, Gabon.

BROADER IMPLICATIONS FOR FINANCING OF SUSTAINABLE FOREST MANAGEMENT

In the global debate about financing sustainable forest management, emphasis is being placed on increasing domestic and private, rather than international and public, financing (UN, 2000). The results of the analysis presented in this chapter suggest that there is little chance that either of these objectives will be met in Africa in the near future, given that the region is one of the least equipped to address such challenges.

There is a great difference between developed and developing countries with regard to the practice of sustainable forest management, largely because of the disparity in income, which in turn affects the levels of available public and private financing. Although forestry's share of total public expenditure is probably very similar in both categories, in absolute terms it is negligible in developing countries because of much lower public spending. If there is a genuine desire to implement sustainable forest management on a large scale across many developing countries, then international financing for the public sector will have to increase.

The extent to which sustainable forest management can be financed from private sources depends very much on the profitability of the sector. In the few countries in Africa with significant and well-developed private operations (e.g. in West African countries and South Africa), it may be possible to encourage the private sector to finance a significant proportion of the investment needed for this purpose. However, in most countries, production comes mainly from small-scale and informal producers or from people harvesting forest products for their own use, so it is unrealistic to expect them to finance sustainable forest management to any great extent. It therefore seems likely that the public sector will continue to have an important role in implementing sustainable forest management and will remain its most important source of financing. ◆

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ANNEX 1
ACRONYMS

ACRONYMS

AFWC
African Forestry and Wildlife Commission

AIDS
acquired immunodeficiency syndrome

APAFRI
Asia-Pacific Association of Forestry Research Institutions

ASEAN
Association of Southeast Asian Nations

CATIE
Tropical Agriculture Research and Higher Education Center

CBD
Convention on Biological Diversity

CDR
Centre for Development Research (Denmark)

CGIAR
Consultative Group on International Agricultural Research

CICERO
Center for International Climate and Environmental Research

CIFOR
Center for International Forestry Research

CITES
Convention on International Trade in Endangered Species of Wild Fauna and Flora

COMIFAC
Conference of Ministers in Charge of Forests in Central Africa

COP
Conference of the Parties

CPF
Collaborative Partnership on Forests

DESA
United Nations Department of Economic and Social Affairs

DFID
Department for International Development (UK)

EC
European Community

ECOSOC
Economic and Social Council of the United Nations

EFC
European Forestry Commission

EOMF
European Observatory of Mountain Forest

FLEG
Forest Law Enforcement and Governance

FORNESSA
Forestry Research Network for Sub-Saharan Africa

FOSA
Forestry Outlook Study for Africa

FRA 2000
Global Forest Resources Assessment 2000

GDP
gross domestic product

GEF
Global Environment Facility

GFAR
Global Forum on Agricultural Research

GIS
Geographic Information System

HIV
human immunodeficiency virus

HSPF
Hydrocomp Simulation Program – Fortran

IAMF
International Association for Mediterranean Forests

IBRD
International Bank for Reconstruction and Development

ICRAF
World Agroforestry Centre (formerly International Centre for Research in Agroforestry)

ICTSD
International Centre for Trade and Sustainable Development

IEA
International Energy Agency

IFAD
International Fund for Agricultural Development

IFF
Intergovernmental Forum on Forests

IFPRI
International Food Policy Research Institute

IIASA
International Institute for Applied Systems Analysis

IIED
International Institute for Environment and Development (UK)

IISD
International Institute for Sustainable Development

ILO
International Labour Organization

IMF
International Monetary Fund

IPCC
Intergovernmental Panel on Climate Change

IPF
Intergovernmental Panel on Forests

IPRs
intellectual property rights

ISME
International Society for Mangrove Ecosystems

ITTA
International Tropical Timber Agreement

ITTC
International Tropical Timber Council

ITTO
International Tropical Timber Organization

IUCN
World Conservation Union

IUFRO
International Union of Forestry Research Organizations

JIAM
Japan International Association for Mangroves

LFCCs
low forest cover countries

LUCC
Land-Use and Land-Cover Change

NEFC
Near East Forestry Commission

NGO
non-governmental organization

NSF
National Science Foundation of the United States

NWFPs
non-wood forest products

OECD
Organisation for Economic Co-operation and Development

PROFOR
Programme on Forests (World Bank)

RI
recurrence interval

TREES
Trans-agency Resources for Environmental and Economic Sustainability

UN
United Nations

UNAIDS
Joint United Nations Programme on HIV/AIDS

UNCCD
United Nations Convention to Combat Desertification

UNCED
United Nations Conference on Environment and Development

UNCTAD
United Nations Conference on Trade and Development

UNDP
United Nations Development Programme

UNEP
United Nations Environment Programme

UNEP-WCMC
UNEP World Conservation Monitoring Centre

UNFCCC
United Nations Framework Convention on Climate Change

UNFF
United Nations Forum on Forests

UNICEF
United Nations Children's Fund

USAID
United States Agency for International Development

USDA
United States Department of Agriculture

WFP
World Food Programme

WHO
World Health Organization

WRI
World Resources Institute

WSSD
World Summit on Sustainable Development

WTO
World Trade Organization

WWF
World Wide Fund for Nature

ANNEX 2
DATA TABLES

EXPLANATORY NOTES

GENERAL

Country/area nomenclature and regional groups used in the data tables

The country/area names and order used in these tables follow standard UN practice regarding nomenclature and alphabetical listing. Data for "China" incorporate values for China (including Hong Kong Special Administrative Region and Macao Special Administrative Region) and for Taiwan Province of China. The regional groups used in these tables represent FAO's standardized regional breakdown of the world according to geographic – not economic or political – criteria.

Totals

Regional and global totals may not tally because of rounding or territories not included in the tables.

Abbreviations

n.s. = not significant, indicating a very small value

- = not available

TABLE 1

"Land area" refers to the total area of a country, excluding areas under inland water bodies. The source of these data is FAO (2001); they may differ slightly from those in the *State of the World's Forests 2001*, which used a different source. The forest cover figure for each country has been calibrated to the country's land area. Statistics on total population, population density and annual rate of population change are taken from UN (1999). Rural population data are from UN (1997).

Economic data are from World Bank (2000). The gross domestic product (GDP) per capita figure represents the GDP divided by the mid-year population. The data are in constant 1995 US dollars. The annual percentage growth rate of GDP is based on constant local currency.

TABLES 2 AND 3

These figures for 2000 represent the most current global data set available for forest area and forest area change. The source of the data is FAO (2001). In Table 2, "total forest" is the sum of natural forest plus forest plantations. Forest area change is the net change in forests and includes expansion of forest plantations and losses and gains in the area of natural forests.

In Table 3, "volume" refers to total volume over bark of living trees above 10 cm diameter at breast height. "Biomass" refers to above-ground mass of the woody part (stem, bark, branches, twigs) of trees (alive or dead), shrubs and bushes. For Europe, the countries of the Commonwealth of Independent States, Australia, Canada, Japan, New Zealand and the United States, the stem volume for all living trees has been used for the volume figure. Some variation as to the minimum diameter applied is reported in ECE/FAO (2000).

TABLE 4

The source of the data is the FAOSTAT release of 7 August 2002 (apps.fao.org).

"0" indicates either a true zero or an insignificant value (less than half a unit).

TABLE 5

The source of information is the Web sites of the listed conventions and agreements:

- CBD: www.biodiv.org/world/parties.asp.
- UNFCCC: unfccc.int/resource/conv/ratlist.pdf
- Kyoto Protocol: unfccc.int/resource/kpstats.pdf
- CCD: www.unccd.int/convention/ratif/doeif.php?sortby=name
- CITES: www.cites.org/eng/parties/alphabet.shtml
- Ramsar Convention: www.ramsar.org/key_cp_e.htm
- World Heritage Convention: whc.unesco.org/nwhc/pages/doc/main.htm

In addition to the countries indicated in the table, the European Community has ratified CBD, UNFCCC, the Kyoto Protocol and CCD.

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TABLE 1

BASIC DATA ON COUNTRIES AND AREAS

Country/area	Land area ('000 ha)	Population				Economic indicators	
		Total, 1999 ('000)	Density, 1999 (population/km²)	Annual rate of change, 1995–2000 (%)	Rural, 1999 (%)	GDP per capita, 1997 (US$)	Annual growth rate of GDP, 1997 (%)
Africa	**2 978 394**	**766 627**	**25.9**	**2.4**	**63.0**	**...**	**...**
Algeria	238 174	30 774	12.9	2.3	41.5	1 409	1.3
Angola	124 670	12 479	10.0	3.3	66.5	159	7.6
Benin	11 063	5 937	53.3	2.7	58.5	381	5.6
Botswana	56 673	1 597	2.8	1.9	29.4	3 307	6.9
Burkina Faso	27 360	11 616	42.5	2.8	82.1	250	5.5
Burundi	2 568	6 565	255.6	1.7	91.3	141	0.4
Cameroon	46 540	14 693	31.6	2.7	51.9	587	5.1
Cape Verde	403	418	103.7	2.4	39.5	1 108	3.0
Central African Republic	62 297	3 550	5.7	1.9	59.2	341	5.1
Chad	125 920	7 458	5.9	2.7	76.5	218	6.5
Comoros	186	676	303.1	2.8	67.3	413	0.0
Congo	34 150	2 864	8.4	2.8	38.3	633	-1.9
Cote d'Ivoire	31 800	14 526	45.7	1.8	54.1	727	6.0
Dem. Rep. of the Congo	226 705	50 335	22.2	2.6	70.0	114	-5.7
Djibouti	2 317	629	27.1	1.2	17.0	-	0.5
Egypt	99 545	67 226	67.5	1.9	54.3	1 097	5.5
Equatorial Guinea	2 805	442	15.8	2.5	52.9	892	76.1
Eritrea	11 759	3 719	36.8	3.9	81.6	222	7.9
Ethiopia	110 430	61 095	61.1	2.5	82.8	112	5.6
Gabon	25 767	1 197	4.6	2.6	45.9	3 985	4.1
Gambia	1 000	1 268	126.8	3.3	68.2	342	5.4
Ghana	22 754	19 678	86.5	2.7	62.2	384	4.2
Guinea	24 572	7 360	30.0	0.8	68.0	552	4.8
Guinea-Bissau	3 612	1 187	42.2	2.2	76.7	232	5.0
Kenya	56 915	29 549	51.9	2.0	67.9	330	2.1
Lesotho	3 035	2 108	69.5	2.2	72.9	734	8.0
Liberia	11 137	2 930	30.4	8.6	52.7	-	-
Libyan Arab Jamahiriya	175 954	5 471	3.1	2.4	12.8	-	-
Madagascar	58 154	15 497	26.6	3.0	71.1	229	3.6
Malawi	9 409	10 640	113.1	2.5	85.1	163	5.1
Mali	122 019	10 960	9.0	2.5	70.6	259	6.7
Mauritania	102 522	2 598	2.5	2.8	43.6	452	4.5
Mauritius	202	1 150	566.5	0.8	58.9	3 796	5.0
Morocco	44 630	27 867	62.4	1.8	45.4	1 281	-2.0
Mozambique	78 409	19 286	24.6	2.5	61.1	131	12.4
Namibia	82 329	1 695	2.1	2.3	60.2	2 196	1.8
Niger	126 670	10 400	8.2	3.2	79.9	202	3.4
Nigeria	91 077	108 945	119.6	2.4	56.9	239	3.9
Réunion	250	691	276.4	1.3	29.8	-	-
Rwanda	2 466	7 235	293.3	8.0	93.9	207	10.9
Saint Helena	31	6	19.4	0.8	33.3	-	-
Sao Tome and Principe	95	144	150.0	2.1	54.2	297	1.0
Senegal	19 252	9 240	48.0	2.6	53.7	554	5.2
Seychelles	45	77	171.1	1.1	41.6	7 031	4.3
Sierra Leone	7 162	4 717	65.9	3.0	64.1	150	-20.2
Somalia	62 734	9 672	15.4	4.2	72.9	-	-
South Africa	121 758	39 900	32.7	1.5	49.9	3 377	1.7
Sudan	237 600	28 883	12.2	2.1	64.9	255	4.6
Swaziland	1 721	980	57.0	2.9	65.3	1 555	3.7
Togo	5 439	4 512	83.0	2.7	67.3	337	4.7
Tunisia	16 362	9 460	60.9	1.4	35.2	2 092	5.4
Uganda	19 964	21 143	105.9	2.8	86.2	326	5.4
United Republic of Tanzania	88 359	32 793	37.1	2.3	72.9	183	4.1
Western Sahara	26 600	284	1.1	3.4	4.9	-	-
Zambia	74 339	8 976	12.1	2.3	55.8	387	3.5
Zimbabwe	38 685	11 529	29.8	1.4	65.4	656	3.2

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/area	Land area ('000 ha)	Population				Economic indicators	
		Total, 1999 ('000)	Density, 1999 (population/km²)	Annual rate of change, 1995–2000 (%)	Rural, 1999 (%)	GDP per capita, 1997 (US$)	Annual growth rate of GDP, 1997 (%)
Asia	**3 084 746**	**3 634 278**	**117.8**	**1.4**	**63.0**	**...**	**...**
Afghanistan	64 958	21 923	33.6	2.9	78.5	-	-
Armenia	2 820	3 525	125.0	-0.3	30.3	896	3.1
Azerbaijan	8 359	7 697	88.9	0.4	43.1	472	3.2
Bahrain	69	606	878.3	2.1	8.1	-	-
Bangladesh	13 017	126 947	975.2	1.7	79.4	352	5.9
Bhutan	4 701	2 064	43.9	2.8	93.1	406	-
Brunei Darussalam	527	322	61.1	2.2	28.6	-	4.0
Cambodia	17 652	10 945	62.0	2.3	77.2	303	1.0
China	932 743	1 274 106	136.6	0.9	66.2	668	8.8
Cyprus	925	778	84.2	1.1	43.8	-	-
Dem. People's Rep. of Korea	12 041	23 702	196.8	1.6	37.5	-	-
Gaza Strip	38	1 077	2 834.2	4.4	5.5	-	-
Georgia	6 831	5 006	71.8	-1.1	39.8	689	11.0
India	297 319	998 056	335.7	1.7	71.9	392	5.2
Indonesia	181 157	209 255	115.5	1.4	60.8	1 096	4.9
Iran, Islamic Rep. of	162 201	66 796	41.2	1.7	38.9	1 581	-
Iraq	43 737	22 450	51.3	2.8	23.6	-	-
Israel	2 062	6 101	295.9	2.2	8.9	15 456	2.2
Japan	37 652	126 505	336.0	0.2	21.3	43 574	0.8
Jordan	8 893	4 823	54.2	3.1	26.4	1 479	1.7
Kazakhstan	267 074	16 269	6.1	-0.3	38.7	1 277	1.7
Kuwait	1 782	1 897	106.5	3.1	2.5	-	-
Kyrgyzstan	19 180	4 669	24.3	0.6	60.2	817	9.9
Lao People's Dem. Rep.	23 080	5 297	23.0	2.6	77.1	414	6.5
Lebanon	1 024	3 236	316.3	1.8	10.7	-	-
Malaysia	32 855	21 830	66.4	2.0	43.5	4 469	7.8
Maldives	30	278	926.7	2.8	71.9	1 107	6.2
Mongolia	156 650	2 621	1.7	1.7	37.0	391	3.3
Myanmar	65 755	45 059	68.5	1.2	72.7	-	-
Nepal	14 300	23 385	163.5	2.4	88.4	216	4.0
Oman	21 246	2 460	11.6	3.4	17.8	-	-
Pakistan	77 087	152 331	197.6	2.8	63.5	502	-0.4
Philippines	29 817	74 454	249.7	2.1	42.3	1 170	5.2
Qatar	1 100	589	53.5	1.8	7.8	-	-
Republic of Korea	9 873	46 480	470.8	0.8	14.8	11 028	5.5
Saudi Arabia	214 969	20 899	9.7	3.4	14.9	6 739	1.9
Singapore	61	3 522	5 773.8	1.4	0.0	32 486	7.8
Sri Lanka	6 463	18 639	288.4	1.0	76.7	770	6.4
Syrian Arab Republic	18 377	15 725	85.6	2.6	46.0	1 138	4.0
Tajikistan	14 087	6 104	43.4	1.5	67.3	319	-
Thailand	51 089	60 856	119.1	0.9	78.8	2 821	-0.4
Timor-Leste	1 479	871	58.6	1.7	92.5	-	-
Turkey	76 963	65 546	85.2	1.7	25.9	3 119	7.7
Turkmenistan	46 992	4 384	9.3	1.8	54.6	642	-
United Arab Emirates	8 360	2 398	28.7	2.0	14.5	-	-
Uzbekistan	41 424	23 942	57.8	1.6	57.9	-	5.4
Viet Nam	32 550	78 705	241.8	1.6	80.3	299	8.8
West Bank	580	1 660	286.2	-	-	-	-
Yemen	52 797	17 488	33.1	3.8	62.9	223	5.4
Europe	**2 259 957**	**728 831**	**32.2**	**0.0**	**25.4**	**...**	**...**
Albania	2 740	3 113	113.6	-0.4	61.3	757	-7.0
Andorra	45	75	166.7	4.0	5.3	-	-
Austria	8 273	8 177	98.8	0.5	35.4	29 309	4.0
Belarus	20 748	10 274	49.5	-0.3	26.3	2 047	10.4
Belgium and Luxembourg	3 282	10 579	322.3	0.1	3.0	28 284	2.9
Bosnia and Herzegovina	5 100	3 839	75.3	3.1	57.3	-	-
Bulgaria	11 055	8 279	74.9	-0.7	30.3	1 273	-6.9
Croatia	5 592	4 477	80.1	-0.1	42.7	4 092	-
Czech Republic	7 728	10 262	132.8	-0.2	33.9	5 111	1.0
Denmark	4 243	5 282	124.5	0.3	14.4	36 418	3.3

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/area	Total land area ('000 ha)	Population				Economic indicators	
		Total, 1999 ('000)	Density, 1999 (population/km²)	Annual rate of change, 1995–2000 (%)	Rural, 1999 (%)	GDP per capita, 1997 (US$)	Annual growth rate of GDP, 1997 (%)
Estonia	4 227	1 412	33.4	-1.2	26.0	3 689	11.4
Finland	30 459	5 165	17.0	0.3	35.4	26 020	6.3
France	55 010	58 886	107.0	0.4	24.6	27 437	2.4
Germany	34 927	82 178	235.3	0.1	12.7	30 133	1.7
Greece	12 890	10 626	82.4	0.3	40.1	11 343	-
Hungary	9 234	10 076	109.1	-0.4	33.5	4 517	4.6
Iceland	10 025	279	2.8	0.9	7.9	-	-
Ireland	6 889	3 705	53.8	0.7	41.7	17 739	10.0
Italy	29 406	57 343	195.0	0.0	33.1	19 104	1.5
Latvia	6 205	2 389	38.5	-1.5	26.0	2 815	6.6
Liechtenstein	15	32	200.0	1.3	81.3	-	-
Lithuania	6 258	3 682	56.8	-0.3	25.9	2 015	5.7
Malta	32	386	1 206.25	0.7	9.8	9 368	2.9
Netherlands	3 392	15 735	463.9	0.4	10.7	27 402	3.4
Norway	30 683	4 442	14.5	0.5	26.0	35 947	3.4
Poland	30 442	38 740	127.3	0.1	34.8	3 472	6.9
Portugal	9 150	9 873	107.9	0.0	62.5	11 243	4.0
Republic of Moldova	3 296	4 380	132.8	0.0	45.5	641	1.3
Romania	23 034	22 402	97.3	-0.4	42.3	1 399	-6.6
Russian Federation	1 688 851	147 196	8.7	-0.2	22.7	2 235	0.8
San Marino	6	26	433.3	1.3	3.8	-	-
Slovakia	4 808	5 382	111.9	0.1	39.4	3 645	6.5
Slovenia	2 012	1 989	98.9	0.0	47.7	10 163	3.8
Spain	49 945	39 634	79.4	0.0	22.6	14 800	3.7
Sweden	41 162	8 892	21.6	0.2	16.7	25 685	1.2
Switzerland	3 955	7 344	185.7	0.7	37.7	46 448	1.7
The FYR of Macedonia	2 543	2 011	79.1	0.6	38.4	1 053	1.5
Ukraine	57 935	50 658	87.4	-0.4	28.0	1 452	-3.2
United Kingdom	24 160	58 974	244.1	0.2	10.7	19 946	3.5
Yugoslavia	10 200	10 637	104.3	0.1	40.8	-	-
North and Central America	**2 136 966**	**477 669**	**22.4**	**1.6**	**26.8**	**...**	**...**
Antigua and Barbuda	44	67	152.3	0.5	64.2	7 331	-
Bahamas	1 001	301	30.1	1.8	12.0	-	-
Barbados	43	269	625.6	0.5	50.6	-	-
Belize	2 280	235	10.3	2.4	53.6	2 547	2.6
Bermuda	5	64	1 280.0	0.8	n.a	-	-
British Virgin Islands	15	21	140.0	2.7	38.1	-	-
Canada	922 097	30 857	3.3	1.0	23.0	19 267	5.4
Cayman Islands	26	37	142.3	3.7	-	-	-
Costa Rica	5 106	3 933	77.0	2.5	48.7	2 626	3.2
Cuba	10 982	11 160	101.6	0.4	22.5	-	-
Dominica	75	71	94.7	-0.1	29.6	2 940	1.9
Dominican Republic	4 838	8 364	172.9	1.7	35.5	1 659	8.2
El Salvador	2 072	6 154	297.0	2.1	53.7	1 684	4.0
Greenland	34 170	56	0.2	0.1	17.9	-	-
Grenada	34	93	273.5	0.3	62.4	3 052	-
Guadeloupe	169	450	266.3	1.4	0.2	-	-
Guatemala	10 843	11 090	102.3	2.7	59.9	1 481	4.3
Haiti	2 756	8 087	293.4	1.7	65.8	364	1.1
Honduras	11 189	6 316	56.4	2.8	53.7	723	4.5
Jamaica	1 083	2 560	236.4	0.9	44.4	1 525	-2.4
Martinique	107	392	369.8	0.9	5.4	-	-
Mexico	190 869	97 365	51.0	1.6	25.8	3 304	7.0
Montserrat	11	11	110.0	-0.3	81.8	-	-
Netherlands Antilles	80	215	268.8	1.1	30.2	-	-
Nicaragua	12 140	4 938	40.7	2.8	35.8	408	-
Panama	7 443	2 812	37.8	1.7	42.7	2 993	-
Puerto Rico	887	3 839	432.8	0.8	25.1	-	-
Saint Kitts and Nevis	36	39	108.3	-0.8	66.7	6 032	-
Saint Lucia	61	152	249.2	1.4	62.5	3 454	-
Saint Pierre and Miquelon	23	7	30.4	0.3	14.3	-	-

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/area	Total land area ('000 ha)	Population				Economic indicators	
		Total, 1999 ('000)	Density, 1999 (population/km²)	Annual rate of change, 1995–2000 (%)	Rural, 1999 (%)	GDP per capita, 1997 (US$)	Annual growth rate of GDP, 1997 (%)
Saint Vincent and Grenadines	39	113	289.7	0.7	46.9	2 335	-
Trinidad and Tobago	513	1 289	251.3	0.5	26.5	4 119	3.2
United States	915 895	276 218	30.2	0.8	23.0	28 310	6.9
United States Virgin Islands	34	94	276.5	-0.8	54.3	-	-
Oceania	**849 096**	**29 984**	**3.5**	**1.3**	**29.8**	**...**	**...**
American Samoa	20	66	330.0	3.7	48.5	-	-
Australia	768 230	18 701	2.4	1.0	15.3	19 689	1.7
Cook Islands	23	19	82.6	0.6	36.8	-	-
Fiji	1 827	806	44.1	1.2	58.1	2 340	-1.8
French Polynesia	366	231	63.1	1.8	43.3	-	-
Guam	55	164	298.2	2.1	61.0	-	-
Kiribati	73	82	112.3	1.4	63.4	839	3.0
Marshall Islands	18	62	344.4	3.3	29.0	1 473	-5.2
Micronesia	69	116	165.7	2.0	70.7	1 886	-4.0
Nauru	2	11	550.0	1.9	-	-	-
New Caledonia	1 828	210	11.5	2.1	36.2	-	-
New Zealand	26 799	3 828	14.3	1.0	13.3	15 233	2.4
Niue	26	2	7.7	-1.9	50.0	-	-
Northern Mariana Islands	46	74	160.9	5.9	45.9	-	-
Palau	46	19	41.3	2.4	26.3	-	-
Papua New Guinea	45 239	4 702	10.4	2.2	82.9	931	-6.5
Samoa	282	177	62.5	1.4	78.5	1 239	4.0
Solomon Islands	2 856	430	15.4	3.2	80.9	797	-0.5
Tonga	73	98	136.1	0.3	55.1	1 635	-1.7
Vanuatu	1 218	186	15.3	2.4	80.1	1 315	2.7
South America	**1 754 741**	**340 754**	**19.4**	**1.5**	**20.7**	**...**	**...**
Argentina	273 669	36 577	13.4	1.3	10.9	8 755	8.6
Bolivia	108 438	8 142	7.5	2.4	36.0	912	4.2
Brazil	845 651	167 988	19.9	1.3	19.3	4 514	3.2
Chile	74 881	15 019	20.1	1.4	15.5	4 478	7.1
Colombia	103 871	41 564	40.0	1.9	25.5	2 039	3.1
Ecuador	27 684	12 411	44.8	2.0	38.3	1 531	3.4
Falkland Islands	1 217	2	0.2	0.5	-	-	-
French Guiana	8 815	174	2.0	4.3	22.4	-	-
Guyana	21 498	855	4.3	0.7	62.3	766	-
Paraguay	39 730	5 358	13.5	2.6	44.8	1 946	3.5
Peru	128 000	25 230	19.7	1.7	27.6	2 580	7.2
Suriname	15 600	415	2.7	0.4	48.4	940	-
Uruguay	17 481	3 313	19.0	0.7	8.9	6 076	5.1
Venezuela	88 206	23 706	26.9	2.0	13.0	3 499	5.1
World	**13 063 900**	**5 978 143**	**45.8**	**1.3**	**53.0**	**...**	**...**

Note: The regional breakdown reflects geographic rather than economic or political groupings.

TABLE 2
FOREST AREA AND AREA CHANGE

Country/area	Land area ('000 ha)	Forest area, 2000				Forest cover change, 1990–2000	
		Total forest ('000 ha)	% of land area	Area per capita (ha)	Forest plantations ('000 ha)	Annual change ('000 ha)	Annual rate of change (%)
Africa	**2 978 394**	**649 866**	**21.8**	**0.8**	**8 036**	**-5 262**	**-0.8**
Algeria	238 174	2 145	0.9	0.1	718	27	1.3
Angola	124 670	69 756	56.0	5.6	141	-124	-0.2
Benin	11 063	2 650	24.0	0.4	112	-70	-2.3
Botswana	56 673	12 427	21.9	7.8	1	-118	-0.9
Burkina Faso	27 360	7 089	25.9	0.6	67	-15	-0.2
Burundi	2 568	94	3.7	n.s.	73	-15	-9.0
Cameroon	46 540	23 858	51.3	1.6	80	-222	-0.9
Cape Verde	403	85	21.1	0.2	85	5	9.3
Central African Republic	62 297	22 907	36.8	6.5	4	-30	-0.1
Chad	125 920	12 692	10.1	1.7	14	-82	-0.6
Comoros	186	8	4.3	n.s.	2	n.s.	-4.3
Congo	34 150	22 060	64.6	7.7	83	-17	-0.1
Cote d'Ivoire	31 800	7 117	22.4	0.5	184	-265	-3.1
Dem. Rep. of the Congo	226 705	135 207	59.6	2.7	97	-532	-0.4
Djibouti	2 317	6	0.3	n.s.	-	n.s.	n.s.
Egypt	99 545	72	0.1	n.s.	72	2	3.3
Equatorial Guinea	2 805	1 752	62.5	4.0		-11	-0.6
Eritrea	11 759	1 585	13.5	0.4	22	-5	-0.3
Ethiopia	110 430	4 593	4.2	0.1	216	-40	-0.8
Gabon	25 767	21 826	84.7	18.2	36	-10	n.s.
Gambia	1 000	481	48.1	0.4	2	4	1.0
Ghana	22 754	6 335	27.8	0.3	76	-120	-1.7
Guinea	24 572	6 929	28.2	0.9	25	-35	-0.5
Guinea-Bissau	3 612	2 187	60.5	1.8	2	-22	-0.9
Kenya	56 915	17 096	30.0	0.6	232	-93	-0.5
Lesotho	3 035	14	0.5	n.s.	14	n.s.	n.s.
Liberia	11 137	3 481	31.3	1.2	119	-76	-2.0
Libyan Arab Jamahiriya	175 954	358	0.2	0.1	168	5	1.4
Madagascar	58 154	11 727	20.2	0.8	350	-117	-0.9
Malawi	9 409	2 562	27.2	0.2	112	-71	-2.4
Mali	122 019	13 186	10.8	1.2	15	-99	-0.7
Mauritania	102 522	317	0.3	0.1	25	-10	-2.7
Mauritius	202	16	7.9	n.s.	13	n.s.	-0.6
Morocco	44 630	3 025	6.8	0.1	534	-1	n.s.
Mozambique	78 409	30 601	39.0	1.6	50	-64	-0.2
Namibia	82 329	8 040	9.8	4.7	n.s.	-73	-0.9
Niger	126 670	1 328	1.0	0.1	73	-62	-3.7
Nigeria	91 077	13 517	14.8	0.1	693	-398	-2.6
Réunion	250	71	28.4	0.1	3	-1	-0.8
Rwanda	2 466	307	12.4	n.s.	261	-15	-3.9
Saint Helena	31	2	6.5	0.3	2	n.s.	n.s.
Sao Tome and Principe	95	27	28.3	0.2	-	n.s.	n.s.
Senegal	19 252	6 205	32.2	0.7	263	-45	-0.7
Seychelles	45	30	66.7	0.4	5	n.s.	n.s.
Sierra Leone	7 162	1 055	14.7	0.2	6	-36	-2.9
Somalia	62 734	7 515	12.0	0.8	3	-77	-1.0
South Africa	121 758	8 917	7.3	0.2	1 554	-8	-0.1
Sudan	237 600	61 627	25.9	2.1	641	-959	-1.4
Swaziland	1 721	522	30.3	0.5	161	6	1.2
Togo	5 439	510	9.4	0.1	38	-21	-3.4
Tunisia	16 362	510	3.1	0.1	202	1	0.2
Uganda	19 964	4 190	21.0	0.2	43	-91	-2.0
United Republic of Tanzania	88 359	38 811	43.9	1.2	135	-91	-0.2
Western Sahara	26 600	152	0.6	0.5	-	n.s.	n.s.
Zambia	74 339	31 246	42.0	3.5	75	-851	-2.4
Zimbabwe	38 685	19 040	49.2	1.7	141	-320	-1.5

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/area	Land area ('000 ha)	Forest area, 2000				Forest cover change, 1990–2000	
		Total forest ('000 ha)	% of land area	Area per capita (ha)	Forest plantations ('000 ha)	Annual change ('000 ha)	Annual rate of change (%)
Asia	**3 084 746**	**547 793**	**17.8**	**0.2**	**115 847**	**-364**	**-0.1**
Afghanistan	64 958	1 351	2.1	0.1	-	n.s.	n.s.
Armenia	2 820	351	12.4	0.1	13	4	1.3
Azerbaijan	8 359	1 094	13.1	0.1	20	13	1.3
Bahrain	69	n.s.	n.s.	-	n.s.	n.s.	14.9
Bangladesh	13 017	1 334	10.2	n.s.	625	17	1.3
Bhutan	4 701	3 016	64.2	1.5	21	n.s.	n.s.
Brunei Darussalam	527	442	83.9	1.4	3	-1	-0.2
Cambodia	17 652	9 335	52.9	0.9	90	-56	-0.6
China	932 743	163 480	17.5	0.1	45 083	1 806	1.2
Cyprus	925	172	18.6	0.2	0	5	3.7
Dem. People's Rep. of Korea	12 041	8 210	68.2	0.3	-	n.s.	n.s.
Gaza Strip	38	-	-	-	-	-	-
Georgia	6 831	2 988	43.7	0.6	200	n.s.	n.s.
India	297 319	64 113	21.6	0.1	32 578	38	0.1
Indonesia	181 157	10 4986	58.0	0.5	9 871	-1 312	-1.2
Iran, Islamic Rep. of	162 201	7 299	4.5	0.1	2 284	n.s.	n.s.
Iraq	43 737	799	1.8	n.s.	10	n.s.	n.s.
Israel	2 062	132	6.4	n.s.	91	5	4.9
Japan	37 652	24 081	64.0	0.2	10 682	3	n.s.
Jordan	8 893	86	1.0	n.s.	45	n.s.	n.s.
Kazakhstan	267 074	12 148	4.5	0.7	5	239	2.2
Kuwait	1 782	5	0.3	n.s.	5	n.s.	3.5
Kyrgyzstan	19 180	1 003	5.2	0.2	57	23	2.6
Lao People's Dem. Rep.	23 080	12 561	54.4	2.4	54	-53	-0.4
Lebanon	1 024	36	3.5	n.s.	2	n.s.	-0.4
Malaysia	32 855	19 292	58.7	0.9	1 750	-237	-1.2
Maldives	30	1	3.3	n.s.	-	n.s.	n.s.
Mongolia	156 650	10 645	6.8	4.1	-	-60	-0.5
Myanmar	65 755	34 419	52.3	0.8	821	-517	-1.4
Nepal	14 300	3 900	27.3	0.2	133	-78	-1.8
Oman	21 246	1	0.0	n.s.	1	n.s.	5.3
Pakistan	77 087	2 361	3.1	n.s.	980	-39	-1.5
Philippines	29 817	5 789	19.4	0.1	753	-89	-1.4
Qatar	1 100	1	0.1	n.s.	1	n.s.	9.6
Republic of Korea	9 873	6 248	63.3	0.1	-	-5	-0.1
Saudi Arabia	214 969	1 504	0.7	0.1	4	n.s.	n.s.
Singapore	61	2	3.3	n.s.	-	n.s.	n.s.
Sri Lanka	6 463	1 940	30.0	0.1	316	-35	-1.6
Syrian Arab Republic	18 377	461	2.5	n.s.	229	n.s.	n.s.
Tajikistan	14 087	400	2.8	0.1	10	2	0.5
Thailand	51 089	14 762	28.9	0.2	4 920	-112	-0.7
Timor-Leste	1 479	507	34.3	0.6	-	-3	-0.6
Turkey	76 963	10 225	13.3	0.2	1 854	22	0.2
Turkmenistan	46 992	3 755	8.0	0.9	12	n.s.	n.s.
United Arab Emirates	8 360	321	3.8	0.1	314	8	2.8
Uzbekistan	41 424	1 969	4.8	0.1	300	5	0.2
Viet Nam	32 550	9 819	30.2	0.1	1 711	52	0.5
West Bank	580	-	-	-	-	-	-
Yemen	52 797	449	0.9	n.s.	-	-9	-1.9
Europe	**2 259 957**	**1 039 251**	**46.0**	**1.4**	**32 015**	**881**	**0.1**
Albania	2 740	991	36.2	0.3	102	-8	-0.8
Andorra	45	-	-	-	-	-	-
Austria	8 273	3 886	47.0	0.5	0	8	0.2
Belarus	20 748	9 402	45.3	0.9	195	256	3.2
Belgium and Luxembourg	3 282	728	22.2	0.1	0	-1	-0.2
Bosnia and Herzegovina	5 100	2 273	44.6	0.6	57	n.s.	n.s.
Bulgaria	11 055	3 690	33.4	0.4	969	20	0.6
Croatia	5 592	1 783	31.9	0.4	47	2	0.1
Czech Republic	7 728	2 632	34.1	0.3	0	1	n.s.
Denmark	4 243	455	10.7	0.1	341	1	0.2

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/area	Land area ('000 ha)	Forest area, 2000				Forest cover change, 1990–2000	
		Total forest ('000 ha)	% of land area	Area per capita (ha)	Forest plantations ('000 ha)	Annual change ('000 ha)	Annual rate of change (%)
Estonia	4 227	2 060	48.7	1.5	305	13	0.6
Finland	30 459	21 935	72.0	4.2	0	8	n.s.
France	55 010	15 341	27.9	0.3	961	62	0.4
Germany	34 927	10 740	30.7	0.1	0	n.s.	n.s.
Greece	12 890	3 599	27.9	0.3	120	30	0.9
Hungary	9 234	1 840	19.9	0.2	136	7	0.4
Iceland	10 025	31	0.3	0.1	12	1	2.2
Ireland	6 889	659	9.6	0.2	590	17	3.0
Italy	29 406	10 003	34.0	0.2	133	30	0.3
Latvia	6 205	2 923	47.1	1.2	143	13	0.4
Liechtenstein	15	7	46.7	0.2	0	n.s.	1.2
Lithuania	6 258	1 994	31.9	0.5	284	5	0.2
Malta	32	n.s.	n.s.	-	n.s.	n.s.	n.s.
Netherlands	3 392	375	11.1	n.s.	100	1	0.3
Norway	30 683	8 868	28.9	2.0	300	31	0.4
Poland	30 442	9 047	29.7	0.2	39	18	0.2
Portugal	9 150	3 666	40.1	0.4	834	57	1.7
Republic of Moldova	3 296	325	9.9	0.1	1	1	0.2
Romania	23 034	6 448	28.0	0.3	91	15	0.2
Russian Federation	1 688 851	851 392	50.4	5.8	17 340	135	n.s.
San Marino	6	-	-	-	-	-	-
Slovakia	4 808	2 177	45.3	0.4	15	18	0.9
Slovenia	2 012	1 107	55.0	0.6	1	2	0.2
Spain	49 945	14 370	28.8	0.4	1 904	86	0.6
Sweden	41 162	27 134	65.9	3.1	569	1	n.s.
Switzerland	3 955	1 199	30.3	0.2	4	4	0.4
The FYR of Macedonia	2 543	906	35.6	0.5	30	n.s.	n.s.
Ukraine	57 935	9 584	16.5	0.2	4 425	31	0.3
United Kingdom	24 160	2 794	11.6	n.s.	1 928	17	0.6
Yugoslavia	10 200	2 887	28.3	0.3	39	-1	-0.1
North and Central America	**2 136 966**	**549 304**	**25.7**	**1.1**	**17 533**	**-570**	**-0.1**
Antigua and Barbuda	44	9	20.5	0.1	0	n.s.	n.s.
Bahamas	1 001	842	84.1	2.8	-	n.s.	n.s.
Barbados	43	2	4.7	n.s.	0	n.s.	n.s.
Belize	2 280	1348	59.1	5.7	3	-36	-2.3
Bermuda	5	-	-	-	-	-	-
British Virgin Islands	15	3	20.0	0.1	-	n.s.	n.s.
Canada	922 097	244 571	26.5	7.9	0	n.s.	n.s.
Cayman Islands	26	13	-	0.4	-	n.s.	n.s.
Costa Rica	5 106	1 968	38.5	0.5	178	-16	-0.8
Cuba	10 982	2 348	21.4	0.2	482	28	1.3
Dominica	75	46	61.3	0.6	n.s.	n.s.	-0.7
Dominican Republic	4 838	1 376	28.4	0.2	30	n.s.	n.s.
El Salvador	2 072	121	5.8	n.s.	14	-7	-4.6
Greenland	34 170	-	-	-	-	-	-
Grenada	34	5	14.7	0.1	n.s.	n.s.	0.9
Guadeloupe	169	82	48.5	0.2	4	2	2.1
Guatemala	10 843	2 850	26.3	0.3	133	-54	-1.7
Haiti	2 756	88	3.2	n.s.	20	-7	-5.7
Honduras	11 189	5 383	48.1	0.9	48	-59	-1.0
Jamaica	1 083	325	30.0	0.1	9	-5	-1.5
Martinique	107	47	43.9	0.1	2	n.s.	n.s.
Mexico	190 869	55 205	28.9	0.6	267	-631	-1.1
Montserrat	11	3	27.3	0.3	-	n.s.	n.s.
Netherlands Antilles	80	1	n.s.	n.s.	-	n.s.	n.s.
Nicaragua	12 140	3 278	27.0	0.7	46	-117	-3.0
Panama	7 443	2 876	38.6	1.0	40	-52	-1.6
Puerto Rico	887	229	25.8	0.1	4	-1	-0.2
Saint Kitts and Nevis	36	4	11.1	0.1	0	n.s.	-0.6
Saint Lucia	61	9	14.8	0.1	1	-1	-4.9
Saint Pierre and Miquelon	23	-	-	-	-	-	-

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/area	Land area ('000 ha)	Forest area, 2000				Forest cover change, 1990–2000	
		Total forest ('000 ha)	% of land area	Area per capita (ha)	Forest plantations ('000 ha)	Annual change ('000 ha)	Annual rate of change (%)
Saint Vincent and Grenadines	39	6	15.4	0.1	0	n.s.	-1.4
Trinidad and Tobago	513	259	50.5	0.2	15	-2	-0.8
United States	915 895	225 993	24.7	0.8	16 238	388	0.2
United States Virgin Islands	34	14	41.2	0.1	-	n.s.	n.s.
Oceania	**849 096**	**197 623**	**23.3**	**6.6**	**2 848**	**-365**	**-0.2**
American Samoa	20	12	60.1	0.2	0	n.s.	n.s.
Australia	768 230	154 539	20.1	8.3	1 043	-282	-0.2
Cook Islands	23	22	95.7	1.2	1	n.s.	n.s.
Fiji	1 827	815	44.6	1.0	97	-2	-0.2
French Polynesia	366	105	28.7	0.5	5	n.s.	n.s.
Guam	55	21	38.2	0.1	n.s.	n.s.	n.s.
Kiribati	73	28	38.4	0.3	0	n.s.	n.s.
Marshall Islands	18	n.s.	-	-	-	n.s.	n.s.
Micronesia	69	15	21.7	0.1	n.s.	-1	-4.5
Nauru	2	n.s.	-	-	-	n.s.	n.s.
New Caledonia	1 828	372	20.4	1.8	10	n.s.	n.s.
New Zealand	26 799	7 946	29.7	2.1	1 542	39	0.5
Niue	26	6	-	3.0	n.s.	n.s.	n.s.
Northern Mariana Isl.	46	14	30.4	0.2	-	n.s.	n.s.
Palau	46	35	76.1	1.8	n.s.	n.s.	n.s.
Papua New Guinea	45 239	30 601	67.6	6.5	90	-113	-0.4
Samoa	282	105	37.2	0.6	5	-3	-2.1
Solomon Islands	2 856	2 536	88.8	5.9	50	-4	-0.2
Tonga	73	4	5.5	n.s.	1	n.s.	n.s.
Vanuatu	1 218	447	36.7	2.4	3	1	0.1
South America	**1 754 741**	**885 618**	**50.5**	**2.6**	**10 455**	**-3 711**	**-0.4**
Argentina	273 669	34 648	12.7	0.9	926	-285	-0.8
Bolivia	108 438	53 068	48.9	6.5	46	-161	-0.3
Brazil	845 651	543 905	64.3	3.2	4 982	-2 309	-0.4
Chile	74 881	15 536	20.7	1.0	2 017	-20	-0.1
Colombia	103 871	49 601	47.8	1.2	141	-190	-0.4
Ecuador	27 684	10 557	38.1	0.9	167	-137	-1.2
Falkland Islands	1 217	-	-	-	-	-	-
French Guiana	8 815	7 926	89.9	45.6	1	n.s.	n.s.
Guyana	21 498	16 879	78.5	19.7	12	-49	-0.3
Paraguay	39 730	23 372	58.8	4.4	27	-123	-0.5
Peru	128 000	65 215	50.9	2.6	640	-269	-0.4
Suriname	15 600	14 113	90.5	34.0	13	n.s.	n.s.
Uruguay	17 481	1 292	7.4	0.4	622	50	5.0
Venezuela	88 206	49 506	56.1	2.1	863	-218	-0.4
World	**13 063 900**	**3 869 455**	**29.6**	**0.6**	**186 733**	**-9 391**	**-0.2**

Note: The regional breakdown reflects geographic rather than economic or political groupings.

TABLE 3
Forest types, volume and biomass

Country/area	Forest types (% of country's forest area)				Wood volume in forests		Wood biomass in forests	
	Tropical	Subtropical	Temperate	Boreal/polar	(m^3/ha)	Total (million m^3)	(tonnes/ha)	Total (million tonnes)
Africa	**98**	**1**	**0**	**0**	**72**	**46 472**	**109**	**70 917**
Algeria	0	100	0	0	44	94	75	160
Angola	100	0	0	0	39	2 714	54	3 774
Benin	100	0	0	0	140	371	195	518
Botswana	100	0	0	0	45	560	63	779
Burkina Faso	100	0	0	0	10	74	16	113
Burundi	100	0	0	0	110	10	187	18
Cameroon	100	0	0	0	135	3 211	131	3 129
Cape Verde	100	0	0	0	83	7	127	11
Central African Republic	100	0	0	0	85	1 937	113	2 583
Chad	100	0	0	0	11	134	16	205
Comoros	100	0	0	0	60	0	65	1
Congo	100	0	0	0	132	2 916	213	4 699
Cote d'Ivoire	100	0	0	0	133	948	130	924
Dem. Rep. of the Congo	100	0	0	0	133	17 932	225	30 403
Djibouti	100	0	0	0	21	0	46	0
Egypt	0	100	0	0	108	8	106	8
Equatorial Guinea	100	0	0	0	93	163	158	277
Eritrea	100	0	0	0	23	36	32	50
Ethiopia	100	0	0	0	56	259	79	363
Gabon	100	0	0	0	128	2 791	137	2 991
Gambia	100	0	0	0	13	6	22	11
Ghana	100	0	0	0	49	311	88	556
Guinea	100	0	0	0	117	808	114	788
Guinea-Bissau	100	0	0	0	19	41	20	44
Kenya	100	0	0	0	35	593	48	826
Lesotho	0	100	0	0	34	0	34	0
Liberia	100	0	0	0	201	699	196	681
Libyan Arab Jamahiriya	0	100	0	0	14	5	20	7
Madagascar	100	0	0	0	114	1 339	194	2 270
Malawi	100	0	0	0	103	264	143	365
Mali	100	0	0	0	22	289	31	402
Mauritania	100	0	0	0	4	1	6	2
Mauritius	100	0	0	0	88	1	95	2
Morocco	0	100	0	0	27	80	41	123
Mozambique	100	0	0	0	25	774	55	1 683
Namibia	100	0	0	0	7	54	12	94
Niger	100	0	0	0	3	4	4	6
Nigeria	100	0	0	0	82	1 115	184	2 493
Réunion	100	0	0	0	115	8	160	11
Rwanda	100	0	0	0	110	34	187	58
Saint Helena	100	0	0	0	-	-	-	-
Sao Tome and Principe	100	0	0	0	108	3	116	3
Senegal	100	0	0	0	31	192	30	187
Seychelles	100	0	0	0	29	1	49	1
Sierra Leone	100	0	0	0	143	151	139	147
Somalia	100	0	0	0	18	138	26	192
South Africa	68	32	0	0	49	437	81	720
Sudan	100	0	0	0	9	531	12	740
Swaziland	86	14	0	0	39	20	115	60
Togo	100	0	0	0	92	47	155	79
Tunisia	0	100	0	0	18	9	27	14
Uganda	100	0	0	0	133	559	163	681
United Republic of Tanzania	100	0	0	0	43	1 676	60	2 333
Western Sahara	100	0	0	0	18	3	59	9
Zambia	100	0	0	0	43	1 347	104	3 262
Zimbabwe	100	0	0	0	40	765	56	1 065

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/area	Forest types (% of country's forest area)				Wood volume in forests		Wood biomass in forests	
	Tropical	Subtropical	Temperate	Boreal/polar	(m^3/ha)	Total (million m^3)	(tonnes/ha)	Total (million tonnes)
Asia	**61**	**23**	**14**	**2**	**63**	**34 506**	**82**	**45 062**
Afghanistan	0	100	0	0	22	30	27	37
Armenia	0	61	39	0	128	45	66	23
Azerbaijan	0	38	62	0	136	149	105	115
Bahrain	0	100	0	0	14	-	14	-
Bangladesh	100	0	0	0	23	31	39	52
Bhutan	69	31	0	0	163	492	178	537
Brunei Darussalam	100	0	0	0	119	52	205	90
Cambodia	100	0	0	0	40	376	69	648
China	3	59	29	8	52	8 437	61	10 038
Cyprus	0	100	0	0	43	7	21	4
Dem. People's Rep. of Korea	0	0	100	0	41	333	25	209
Gaza Strip	0	0	0	0	-	-	-	-
Georgia	0	41	59	0	145	434	97	291
India	95	5	0	0	43	2 730	73	4 706
Indonesia	100	0	0	0	79	8 242	136	14 226
Iran, Islamic Rep. of	0	98	2	0	86	631	149	1 089
Iraq	0	100	0	0	29	23	28	22
Israel	0	100	0	0	49	6	-	-
Japan	0	54	46	0	145	3 485	88	2 128
Jordan	0	100	0	0	38	3	37	3
Kazakhstan	0	0	83	17	35	428	18	214
Kuwait	0	100	0	0	21	0	21	0
Kyrgyzstan	0	0	100	0	32	32	-	-
Lao People's Dem. Rep.	100	0	0	0	29	359	31	391
Lebanon	0	100	0	0	23	1	22	1
Malaysia	100	0	0	0	119	2 288	205	3 949
Maldives	100	0	0	0	-	-	-	-
Mongolia	0	0	100	0	128	1 359	80	853
Myanmar	99	1	0	0	33	1 137	57	1 965
Nepal	58	42	0	0	100	391	109	427
Oman	100	0	0	0	17	0	17	0
Pakistan	2	98	0	0	22	53	27	64
Philippines	100	0	0	0	66	383	114	661
Qatar	0	100	0	0	13	0	12	0
Republic of Korea	0	15	85	0	58	362	36	227
Saudi Arabia	91	9	0	0	12	18	12	18
Singapore	100	0	0	0	119	0	205	0
Sri Lanka	100	0	0	0	34	66	59	114
Syrian Arab Republic	0	100	0	0	29	13	28	13
Tajikistan	0	0	100	0	14	6	10	4
Thailand	100	0	0	0	17	252	29	434
Timor-Leste	100	0	0	0	79	40	136	69
Turkey	0	92	8	0	136	1 386	74	754
Turkmenistan	0	4	96	0	4	14	3	10
United Arab Emirates	100	0	0	0	-	-	-	-
Uzbekistan	0	0	100	0	6	11	-	-
Viet Nam	98	2	0	0	38	372	66	643
West Bank	0	0	0	0	-	-	-	-
Yemen	100	0	0	0	14	6	19	9
Europe	**0**	**5**	**22**	**73**	**112**	**116 448**	**59**	**61 070**
Albania	0	83	17	0	81	80	58	57
Andorra	0	0	100	0	0	-	0	-
Austria	0	0	100	0	286	1 110	250	970
Belarus	0	0	100	0	153	1 436	80	755
Belgium and Luxembourg	0	0	100	0	218	159	101	74
Bosnia and Herzegovina	0	19	81	0	110	250	-	-
Bulgaria	0	6	94	0	130	480	76	279
Croatia	0	28	71	0	201	358	107	190
Czech Republic	0	0	100	0	260	684	125	329
Denmark	0	0	100	0	124	56	58	26

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/area	Forest types (% of country's forest area)				Wood volume in forests		Wood biomass in forests	
	Tropical	Subtropical	Temperate	Boreal/polar	(m^3/ha)	Total (million m^3)	(tonnes/ha)	Total (million tonnes)
Estonia	0	0	100	0	156	321	85	175
Finland	0	0	2	98	89	1 945	50	1 089
France	0	0	100	0	191	2 927	92	1 418
Germany	0	0	100	0	268	2 880	134	1 440
Greece	0	97	3	0	45	163	25	90
Hungary	0	0	100	0	174	320	112	207
Iceland	0	0	0	100	27	1	17	1
Ireland	0	0	100	0	74	49	25	16
Italy	0	84	16	0	145	1 450	74	742
Latvia	0	0	100	0	174	509	93	272
Liechtenstein	0	0	100	0	254	2	119	1
Lithuania	0	0	100	0	183	366	99	197
Malta	0	100	0	0	232	0	-	-
Netherlands	0	0	100	0	160	60	107	40
Norway	0	0	7	93	89	785	49	432
Poland	0	0	100	0	213	1 930	94	851
Portugal	0	81	19	0	82	299	33	120
Republic of Moldova	0	0	100	0	128	42	64	21
Romania	0	0	100	0	213	1373	124	801
Russian Federation	0	0	14	86	105	89 136	56	47 423
San Marino	0	0	0	0	0	-	0	-
Slovakia	0	0	100	0	253	552	142	308
Slovenia	0	12	88	0	283	313	178	197
Spain	0	80	20	0	44	632	24	347
Sweden	0	0	28	72	107	2 914	63	1 722
Switzerland	0	0	100	0	337	404	165	198
The FYR of Macedonia	0	64	36	0	70	63	-	-
Ukraine	0	0	100	0	179	1 719	-	-
United Kingdom	0	0	87	13	128	359	76	213
Yugoslavia	0	16	84	0	111	321	23	67
North and Central America	**15**	**16**	**29**	**40**	**123**	**67 329**	**95**	**52 357**
Antigua and Barbuda	100	0	0	0	116	1	210	2
Bahamas	100	0	0	0	-	-	-	-
Barbados	100	0	0	0	-	-	-	-
Belize	100	0	0	0	202	272	211	284
Bermuda	0	0	0	0	-	-	-	-
British Virgin Islands	100	0	0	0	-	-	-	-
Canada	0	0	26	74	120	29 364	83	20 240
Cayman Islands	100	0	0	0	-	-	-	-
Costa Rica	100	0	0	0	211	414	220	433
Cuba	100	0	0	0	71	167	114	268
Dominica	100	0	0	0	91	4	166	8
Dominican Republic	100	0	0	0	29	40	53	73
El Salvador	100	0	0	0	223	27	202	24
Greenland	0	0	0	0	-	-	-	-
Grenada	100	0	0	0	83	0	150	1
Guadeloupe	100	0	0	0	-	-	-	-
Guatemala	100	0	0	0	355	1 012	371	1 057
Haiti	100	0	0	0	28	2	101	9
Honduras	100	0	0	0	58	311	105	566
Jamaica	100	0	0	0	82	27	171	56
Martinique	100	0	0	0	5	0	5	0
Mexico	70	30	0	0	52	2 871	54	2 981
Montserrat	100	0	0	0	-	-	-	-
Netherlands Antilles	100	0	0	0	-	-	-	-
Nicaragua	100	0	0	0	154	506	161	528
Panama	100	0	0	0	308	887	322	926
Puerto Rico	100	0	0	0	-	-	-	-
Saint Kitts and Nevis	100	0	0	0	-	-	-	-
Saint Lucia	100	0	0	0	190	2	198	2
Saint Pierre and Miquelon	0	0	0	100	-	-	-	-

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/area	Forest types (% of country's forest area)				Wood volume in forests		Wood biomass in forests	
	Tropical	Subtropical	Temperate	Boreal/polar	(m^3/ha)	Total (million m^3)	(tonnes/ha)	Total (million tonnes)
Saint Vincent and Grenadines	100	0	0	0	166	1	173	1
Trinidad and Tobago	100	0	0	0	71	18	129	33
United States	0	37	48	15	136	30 838	108	24 428
United States Virgin Islands	100	0	0	0	-	-	-	-
Oceania	**62**	**30**	**8**	**0**	**55**	**10 771**	**64**	**12 640**
American Samoa	100	0	0	0	-	-	-	-
Australia	54	38	8	0	55	8 506	57	8 840
Cook Islands	100	0	0	0	-	-	-	-
Fiji	100	0	0	0	-	-	-	-
French Polynesia	100	0	0	0	-	-	-	-
Guam	100	0	0	0	-	-	-	-
Kiribati	100	0	0	0	-	-	-	-
Marshall Islands	100	0	0	0	-	-	-	-
Micronesia	100	0	0	0	-	-	-	-
Nauru	100	0	0	0	-	-	-	-
New Caledonia	100	0	0	0	-	-	-	-
New Zealand	0	51	49	0	125	992	217	1 726
Niue	100	0	0	0	-	-	-	-
Northern Mariana Islands	100	0	0	0	-	-	-	-
Palau	100	0	0	0	-	-	-	-
Papua New Guinea	100	0	0	0	34	1 025	58	1 784
Samoa	100	0	0	0	-	-	-	-
Solomon Islands	100	0	0	0	-	-	-	-
Tonga	100	0	0	0	-	-	-	-
Vanuatu	100	0	0	0	-	-	-	-
South America	**96**	**2**	**1**	**0**	**125**	**110 826**	**203**	**180 210**
Argentina	91	5	4	0	25	866	68	2 356
Bolivia	100	0	0	0	114	6 050	183	9 711
Brazil	98	2	0	0	131	71 252	209	113 676
Chile	0	54	45	0	160	2 486	268	4 164
Colombia	100	0	0	0	108	5 359	196	9 722
Ecuador	100	0	0	0	121	1 275	151	1 594
Falkland Islands	0	0	100	0	-	-	-	-
French Guiana	100	0	0	0	145	1 151	253	2 003
Guyana	100	0	0	0	145	2 451	253	4 264
Paraguay	100	0	0	0	34	792	59	1 379
Peru	100	0	0	0	158	10 304	245	15 978
Suriname	100	0	0	0	145	2 049	253	3 566
Uruguay	0	100	0	0	-	-	-	-
Venezuela	100	0	0	0	134	6 629	233	11 535
World	**52**	**9**	**13**	**25**	**100**	**386 352**	**109**	**422 256**

Note: The regional breakdown reflects geographic rather than economic or political groupings.

TABLE 4

Production, trade and consumption of forest products, 2000

Country/area	Woodfuel ('000 m³)				Industrial roundwood ('000 m³)				Sawnwood ('000 m³)			
	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption
Africa	**527 547**	**4**	**1**	**527 550**	**68 826**	**930**	**6 102**	**63 655**	**7 667**	**4 708**	**1 875**	**10 499**
Algeria	7 074	-	-	7 074	451	39	0	490	13	813	0	825
Angola	3 163	0	-	3 163	1 116	0	6	1 110	5	1	0	6
Benin	5 910	0	-	5 910	332	48	0	380	13	0	2	11
Botswana	635	0	-	636	105	-	-	105	-	15	-	15
Burkina Faso	7 402	-	-	7 402	594	0	-	594	1	3	0	4
Burundi	5 420	-	-	5 420	333	-	0	333	83	0	0	83
Cameroon	9 111	-	-	9 111	2 960	0	575	2 385	650	0	540	110
Cape Verde	-	0	-	0	-	0	0	0	-	2	0	2
Central African Republic	2 000	-	-	2 000	1 011	0	250	761	102	0	66	36
Chad	5 885	-	-	5 885	761	-	-	761	2	17	-	20
Comoros	-	0	-	0	9	0	0	9	-	1	0	1
Congo	1 153	-	-	1 153	646	0	757	0	74	0	70	4
Côte d'Ivoire	8 529	-	-	8 529	3 416	180	136	3 460	603	0	460	143
Dem. Rep. of the Congo	64 903	-	0	64 903	3 727	0	19	3 708	80	0	20	60
Djibouti	0	3	-	3	0	0	-	0	-	1	0	1
Egypt	16 182	0	0	16 182	268	184	0	452	4	2 133	0	2 137
Equatorial Guinea	447	-	-	447	364	0	504	0	4	0	2	2
Eritrea	2 244	-	-	2 244	2	-	-	2	-	13	-	13
Ethiopia	87 471	-	-	87 471	2 459	0	0	2 459	60	13	0	73
Gabon	515	-	-	515	2 584	0	2 584	0	68	0	79	0
Gambia	603	-	-	603	113	0	0	113	1	1	0	2
Ghana	20 678	-	0	20 678	1 087	0	0	1 087	243	0	244	0
Guinea	11 444	-	-	11 444	651	0	32	619	26	1	0	27
Guinea-Bissau	422	-	0	422	170	0	7	163	16	0	0	15
Kenya	19 658	0	0	19 658	1 977	0	0	1 977	185	0	0	185
Lesotho	2 022	0	-	2 022	-	-	-	0	-	0	-	0
Liberia	4 725	-	-	4 725	337	0	637	0	90	0	6	84
Libyan Arab Jamahiriya	536	0	-	536	116	4	0	120	31	41	0	72
Madagascar	9 637	-	-	9 637	93	0	160	0	485	0	19	466
Malawi	4 964	-	0	4 964	520	0	0	520	45	0	7	38
Mali	4 731	0	-	4 731	413	3	3	413	13	6	0	18
Mauritania	1 428	-	-	1 428	6	0	0	6	-	0	0	0
Mauritius	12	0	0	12	13	16	0	29	5	40	0	45
Morocco	487	0	0	487	569	401	0	970	83	401	19	465
Mozambique	16 724	0	0	16 724	1 319	0	74	1 245	28	2	7	23
Namibia	-	-	-	0	-	5	-	5	-	9	-	9
Niger	7 805	-	-	7 805	411	0	1	410	4	1	0	5
Nigeria	59 349	-	1	59 348	9 418	0	7	9 411	2 000	1	54	1 947
Réunion	31	-	-	31	5	1	2	3	2	85	0	87
Rwanda	7 500	-	-	7 500	336	0	0	336	79	0	0	79
Saint Helena	-	-	-	0	-	0	-	0	-	0	0	0
Sao Tome and Principe	-	0	-	0	9	0	0	9	5	0	0	5
Senegal	5 114	-	-	5 114	794	9	0	803	23	54	0	77
Seychelles	-	-	-	0	-	0	0	0	-	0	0	0
Sierra Leone	5 358	-	-	5 358	124	0	0	124	5	2	0	7
Somalia	9 228	-	0	9 228	110	1	4	106	14	0	0	14
South Africa	12 000	0	0	12 000	18 616	13	301	18 328	1 498	510	134	1 874
Sudan	16 680	0	0	16 680	2 173	0	0	2 173	51	71	0	122
Swaziland	560	-	-	560	330	0	0	330	102	0	0	102
Togo	5 499	-	-	5 499	306	5	28	283	19	4	2	21
Tunisia	2 094	0	-	2 094	214	18	0	232	20	467	0	487
Uganda	34 090	-	-	34 090	3 175	0	0	3 175	264	0	0	264
United Republic of Tanzania	20 787	0	0	20 787	2 314	3	12	2 304	24	0	3	21
Western Sahara	-	-	-	0	-	-	-	0	-	0	-	0
Zambia	7 219	0	-	7 219	834	0	1	833	157	0	26	131
Zimbabwe	8 115	0	0	8 115	1 136	0	0	1 136	386	0	112	274

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Wood-based panels ('000 m³)				Pulp for paper ('000 tonnes)				Paper and paperboard ('000 tonnes)				Country/area
Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	
2 058	**779**	**699**	**2 138**	**2 252**	**284**	**602**	**1 934**	**2 916**	**2 071**	**623**	**4 363**	**Africa**
50	56	0	105	21	13	0	34	44	182	0	226	Algeria
11	1	0	12	15	0	0	15	0	2	0	2	Angola
-	1	0	0	-	0	0	0	-	3	0	3	Benin
-	0	-	0	-	-	-	0	-	10	-	10	Botswana
-	3	0	3	-	0	-	0	-	4	0	4	Burkina Faso
-	1	0	1	-	0	-	0	-	2	0	2	Burundi
145	0	75	70	0	0	-	0	0	31	0	31	Cameroon
-	2	0	2	-	-	-	0	-	0	0	0	Cape Verde
2	0	0	2	-	-	0	0	-	0	0	0	Central African Republic
-	0	0	0	-	0	0	0	-	1	0	1	Chad
-	0	0	0	-	0	-	0	-	0	-	0	Comoros
22	0	4	18	-	0	0	0	-	2	0	2	Congo
377	0	153	224	-	0	-	0	-	90	0	90	Côte d'Ivoire
21	0	1	20	-	0	-	0	3	5	0	8	Dem. Rep. of the Congo
-	3	0	3	-	0	0	0	-	8	0	8	Djibouti
131	366	0	497	60	88	-	148	343	594	8	929	Egypt
15	0	11	4	-	0	-	0	-	0	0	0	Equatorial Guinea
-	5	-	5	-	-	-	0	-	2	-	2	Eritrea
25	12	-	38	9	7	0	17	9	20	0	30	Ethiopia
122	0	169	0	-	0	-	0	-	2	0	2	Gabon
-	2	0	2	-	-	-	0	-	1	0	1	Gambia
166	0	157	9	-	0	0	0	-	36	0	36	Ghana
0	5	0	5	-	0	-	0	-	4	0	4	Guinea
-	0	0	0	-	-	-	0	-	0	0	0	Guinea-Bissau
52	4	2	54	66	5	0	71	129	32	10	151	Kenya
-	-	-	0	-	-	-	0	-	-	-	0	Lesotho
78	0	0	78	-	0	-	0	-	1	-	1	Liberia
-	11	0	11	-	4	0	4	6	24	0	30	Libyan Arab Jamahiriya
5	1	0	6	3	0	0	3	4	7	0	11	Madagascar
18	3	1	19	-	0	-	0	-	6	0	6	Malawi
-	1	6	0	-	0	-	0	-	5	0	5	Mali
-	0	1	0	-	0	-	0	-	2	0	2	Mauritania
0	36	0	36	-	0	-	0	-	43	1	42	Mauritius
35	36	19	52	112	21	114	19	109	221	21	309	Morocco
3	4	16	0	-	0	0	0	0	2	0	2	Mozambique
-	-	-	0	-	-	-	0	-	15	-	15	Namibia
-	0	0	0	-	1	0	1	-	1	0	1	Niger
95	49	0	144	23	17	-	40	19	189	2	206	Nigeria
-	24	0	23	-	0	0	0	-	15	0	15	Réunion
0	4	-	4	-	-	0	0	-	1	0	1	Rwanda
-	0	-	0	-	-	-	0	-	0	-	0	Saint Helena
-	0	0	0	-	0	-	0	-	1	0	0	Sao Tome and Principe
-	10	0	10	-	2	-	2	-	22	0	22	Senegal
-	1	-	1	-	-	-	0	-	0	0	0	Seychelles
-	9	0	9	-	1	1	0	-	2	1	1	Sierra Leone
0	1	0	1	-	0	0	0	-	3	0	2	Somalia
476	68	53	491	1 642	69	284	1 426	2 041	284	569	1 756	South Africa
2	7	0	9	-	0	-	0	3	14	0	17	Sudan
8	-	0	8	191	-	191	0	-	-	-	0	Swaziland
-	1	0	1	-	0	-	0	-	2	0	2	Togo
104	25	1	128	14	48	11	51	94	109	4	199	Tunisia
5	1	0	5	-	0	-	0	3	23	0	26	Uganda
4	10	1	13	54	0	0	54	25	10	1	34	United Republic of Tanzania
-	-	-	0	-	-	-	0	-	-	-	0	Western Sahara
18	6	0	24	-	0	-	0	4	3	0	7	Zambia
69	11	27	53	42	9	0	51	80	35	5	111	Zimbabwe

Country/area	Woodfuel ('000 m³)				Industrial roundwood ('000 m³)				Sawnwood ('000 m³)			
	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption
Asia	**782 420**	**496**	**57**	**792 909**	**209 408**	**45 038**	**11 298**	**243 149**	**64 172**	**22 723**	**6 543**	**80 352**
Afghanistan	1 279	0	0	1 279	1 760	0	2	1 758	400	1	0	401
Armenia	57	0	0	57	0	0	0	0	4	9	3	10
Azerbaijan	6	0	-	6	7	1	2	7	1	192	6	188
Bahrain	-	0	-	0	-	0	0	0	-	32	0	32
Bangladesh	27 836	-	0	27 836	623	5	131	497	70	4	1	73
Bhutan	4 221	-	-	4 221	45	0	0	45	18	-	0	18
Brunei Darussalam	12	0	0	12	217	0	1	216	90	1	0	91
Cambodia	10 119	-	0	10 119	809	-	0	809	3	0	3	0
China	191 051	108	42	191 117	96 421	15 532	781	111 172	7 202	5 715	812	12 105
Cyprus	5	0	0	5	15	2	0	17	9	67	1	74
Dem. People's Rep. of Korea	5 503	-	0	5 503	1 500	11	219	1 292	280	1	5	276
Georgia	0	0	1	0	0	0	56	0	-	3	18	0
India	287 380	10	0	287 390	1 575	2 232	3	3 804	16 293	9	6	16 297
Indonesia	88 981	0	0	88 981	31 358	201	1 504	30 055	2 427	73	2 023	477
Iran, Islamic Rep. of	54	0	0	54	1 060	8	0	1 068	106	127	0	233
Iraq	51	0	-	51	59	0	-	59	12	0	0	12
Israel	8	0	0	8	73	140	0	212	0	454	0	454
Japan	134	0	0	134	17 987	15 948	4	33 931	17 094	9 951	7	27 038
Jordan	222	0	-	222	4	8	0	12	-	140	0	140
Kazakhstan	0	1	13	0	0	75	546	0	460	482	357	585
Kuwait	-	0	0	0	-	2	0	2	-	66	0	66
Kyrgyzstan	20	0	0	20	9	3	0	12	6	43	2	47
Lao People's Dem. Rep.	5 872	0	0	5 872	866	0	205	661	350	0	41	309
Lebanon	19	0	0	19	7	1	0	8	9	339	1	348
Malaysia	3 346	0	0	3 345	24 468	758	6 845	18 381	5 740	500	2 419	3 820
Maldives	-	0	-	0	-	0	-	0	-	0	0	0
Mongolia	186	0	0	186	445	7	1	451	300	2	3	299
Myanmar	19 226	-	0	19 226	3 574	0	949	2 625	343	0	155	188
Nepal	12 763	-	-	12 763	620	0	0	620	620	0	0	620
Oman	-	0	0	0	-	5	0	5	-	5	0	5
Pakistan	30 880	0	-	30 880	2 680	355	0	3 035	1 087	36	0	1 123
Philippines	40 950	0	0	40 950	3 079	562	0	3 641	151	359	120	390
Qatar	-	0	-	0	-	0	-	0	-	15	0	15
Republic of Korea	2 449	0	0	2 449	1 592	6 869	0	8 461	4 300	729	17	5 012
Saudi Arabia	-	8	0	8	-	22	0	22	-	560	0	560
Singapore	-	1	0	1	-	16	7	9	25	354	172	206
Sri Lanka	5 907	0	0	5 907	636	0	2	634	5	21	1	26
Syrian Arab Republic	16	0	0	16	35	1	0	36	9	291	0	299
Tajikistan	0	0	0	0	0	0	0	0	-	40	0	40
Thailand	20 553	0	0	20 553	2 894	714	0	3 608	294	1 135	311	1 118
Turkey	6 358	368	0	6 726	10 429	1 515	4	11 940	5 743	312	43	6 012
Turkmenistan	0	0	0	0	0	0	0	0	-	24	0	24
United Arab Emirates	-	0	0	0	-	35	0	35	-	425	0	425
Uzbekistan	19	0	0	19	6	0	0	6	-	11	1	11
Viet Nam	26 686	-	0	26 686	4 556	8	35	4 529	721	101	14	807
Yemen	302	0	-	302	-	1	0	1	-	95	0	95
Europe	**105 816**	**1 442**	**3 378**	**103 879**	**478 699**	**64 561**	**70 634**	**472 626**	**125 838**	**48 387**	**56 533**	**117 692**
Albania	324	0	0	324	119	0	0	119	90	15	9	96
Andorra	-	2	0	2	-	0	0	0	-	10	0	10
Austria	2 860	0	9	2 851	10 416	8 464	950	17 930	10 390	1 869	6 456	5 803
Belarus	928	1	16	913	5 208	105	929	4 384	1 808	71	711	1 167
Belgium	550	32	12	570	3 960	3 992	1 169	6 783	1 150	2 223	1 025	2 349
Bosnia and Herzegovina	0	0	0	0	0	0	0	0	20	21	226	0
Bulgaria	2 107	0	73	2 034	2 677	105	287	2 495	312	18	265	65
Croatia	1 094	0	0	1 094	2 392	140	361	2 171	685	78	402	361
Czech Republic	940	4	173	771	13 501	950	1 857	12 594	4 106	336	1 778	2 664
Denmark	512	107	1	618	2 768	530	876	2 422	364	3 477	117	3 724
Estonia	1 640	0	175	1 465	7 270	346	4 257	3 360	1 436	199	1 070	566
Faeroe Islands	-	0	-	0	-	1	0	1	-	4	0	4
Finland	4 115	129	14	4 230	50 147	9 875	519	59 503	13 420	341	8 431	5 330
France	2 388	31	337	2 082	43 440	2 012	5 522	39 930	10 536	3 341	1 386	12 491

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Wood-based panels ('000 m³)				Pulp for paper ('000 tonnes)				Paper and paperboard ('000 tonnes)				Country/area
Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	
47 267	**19 471**	**14 644**	**52 095**	**38 373**	**11 169**	**1 955**	**47 587**	**94 856**	**20 702**	**12 032**	**103 525**	**Asia**
1	1	0	2	-	0	0	0	-	1	0	1	Afghanistan
2	9	0	10	-	-	-	0	20	5	0	25	Armenia
4	58	0	62	-	0	0	0	28	10	0	38	Azerbaijan
-	20	0	20	-	5	-	5	-	19	0	19	Bahrain
9	10	0	19	37	14	-	51	46	188	0	234	Bangladesh
13	0	0	13	-	1	0	0	-	0	0	0	Bhutan
-	3	0	3	-	0	-	0	-	3	0	3	Brunei Darussalam
72	0	137	0	0	0	-	0	0	10	-	10	Cambodia
18 647	7 499	2 120	24 026	17 961	3 818	47	21 732	35 529	10 448	3 621	42 356	China
12	81	0	93	0	2	0	2	0	55	1	54	Cyprus
-	1	0	1	106	12	0	117	80	5	1	84	Dem. People's Rep. of Korea
10	5	0	15	-	0	0	0	-	6	0	6	Georgia
357	86	14	429	2 603	145	17	2 732	3 673	647	72	4 248	India
8 425	78	6 360	2 143	3 726	756	1 358	3 124	6 977	251	2 802	4 426	Indonesia
414	50	0	464	45	34	0	79	46	576	0	622	Iran, Islamic Rep. of
5	11	0	16	11	0	0	11	20	4	0	24	Iraq
220	289	13	495	15	139	17	137	275	553	20	808	Israel
5 719	6 200	32	11 887	11 319	2 961	122	14 158	31 794	1 647	1 615	31 826	Japan
-	85	0	85	8	41	0	49	32	72	16	88	Jordan
33	147	1	179	-	2	0	2	19	54	0	73	Kazakhstan
-	76	0	76	-	18	-	18	-	67	0	67	Kuwait
-	40	0	39	-	0	0	0	2	10	0	13	Kyrgyzstan
125	0	0	125	-	0	-	0	-	3	0	3	Lao People's Dem. Rep.
46	108	0	154	-	29	0	29	42	138	4	176	Lebanon
5 895	105	4 645	1 355	124	61	0	185	791	1 013	139	1 665	Malaysia
-	4	0	4	-	-	-	0	-	1	0	1	Maldives
2	4	1	5	-	0	0	0	-	5	0	5	Mongolia
15	2	13	4	42	0	0	42	40	31	0	71	Myanmar
-	4	0	4	15	0	0	15	13	4	1	16	Nepal
-	6	0	6	-	1	0	1	-	17	0	17	Oman
137	68	0	205	214	34	-	248	609	166	0	775	Pakistan
510	219	16	713	202	60	0	262	870	388	111	1 146	Philippines
-	15	0	15	-	0	0	0	-	7	0	7	Qatar
2 462	2 031	219	4 274	587	2 162	0	2 749	9 763	544	2 470	7 837	Republic of Korea
-	548	0	548	-	15	0	15	-	500	15	485	Saudi Arabia
355	434	169	620	-	73	144	0	87	893	213	768	Singapore
15	25	0	40	10	12	0	22	25	104	0	128	Sri Lanka
27	106	0	132	-	11	0	11	1	102	1	102	Syrian Arab Republic
-	9	-	9	-	-	-	0	-	1	0	1	Tajikistan
1 327	89	832	584	844	387	250	981	2 315	433	813	1 935	Thailand
2 370	535	64	2 841	372	320	0	692	1 567	1 254	65	2 756	Turkey
-	3	1	2	-	0	-	0	-	1	0	1	Turkmenistan
-	206	0	206	-	7	0	7	-	268	50	218	United Arab Emirates
-	69	0	69	-	1	0	1	-	18	0	18	Uzbekistan
39	98	7	130	133	47	0	180	192	141	2	331	Viet Nam
-	35	0	35	-	0	-	0	-	38	0	38	Yemen
60 395	**23 670**	**24 134**	**59 931**	**46 978**	**16 686**	**11 086**	**52 578**	**100 419**	**46 087**	**56 849**	**89 657**	**Europe**
37	11	1	46	0	4	0	4	3	18	1	20	Albania
-	2	0	2	-	0	-	0	-	2	0	2	Andorra
2 329	720	1 939	1 109	1 580	601	318	1 863	4 386	1 403	3 394	2 395	Austria
548	106	363	290	56	22	0	78	236	144	71	308	Belarus
2 887	1 538	2 789	1 635	431	1 083	709	805	1 727	3 218	2 301	2 644	Belgium
34	31	15	50	-	2	0	2	-	14	3	11	Bosnia and Herzegovina
470	42	182	330	95	14	60	49	136	130	55	211	Bulgaria
93	62	21	135	95	4	40	59	417	184	113	488	Croatia
921	462	639	744	638	118	290	466	804	581	536	849	Czech Republic
448	1 032	144	1 336	0	52	1	51	263	1 151	239	1 175	Denmark
411	182	436	157	54	1	0	54	54	65	53	66	Estonia
-	1	0	1	-	-	0	0	-	2	0	1	Faeroe Islands
1 792	197	1 381	608	11 919	92	1 681	10 329	13 509	356	11 642	2 223	Finland
6 438	1 692	2 269	5 861	2 582	2 406	384	4 604	10 006	6 131	4 743	11 394	France

Country/area	Woodfuel ('000 m³)				Industrial roundwood ('000 m³)				Sawnwood ('000 m³)			
	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption
Germany	2 622	47	46	2 623	51 088	3 549	5 558	49 079	16 340	6 344	3 911	18 773
Gibraltar	-	0	-	0	-	0	0	0	-	1	0	1
Greece	1 375	219	225	1 370	796	286	3	1 078	137	731	108	759
Hungary	2 597	9	311	2 295	3 305	344	1 282	2 367	291	1 113	290	1 114
Iceland	0	0	0	0	0	4	0	4	0	94	0	94
Ireland	73	1	0	74	2 600	113	91	2 622	888	682	274	1 296
Italy	5 680	490	0	6 170	3 649	5 805	24	9 430	1 630	8 380	208	9 802
Latvia	1 680	0	163	1 517	12 624	136	4 190	8 570	3 900	135	3 077	958
Liechtenstein	4	0	0	4	3	0	0	3	-	-	-	0
Lithuania	1 450	1	3	1 447	4 050	60	1 200	2 910	1 300	279	823	756
Luxembourg	18	3	10	11	242	889	461	670	133	71	31	173
Malta	0	0	0	0	0	4	0	4	0	22	0	22
Netherlands	160	54	24	190	879	383	220	1 042	390	3 705	383	3 712
Norway	678	33	0	711	7 478	3 315	514	10 279	2 280	945	679	2 546
Poland	1 536	0	25	1 511	24 489	732	322	24 899	4 262	379	1 100	3 540
Portugal	600	2	13	589	10 231	1 340	557	11 015	1 427	297	283	1 441
Republic of Moldova	30	2	0	32	29	28	0	57	5	110	0	115
Romania	3 032	0	4	3 028	10 116	20	531	9 606	3 396	8	2 322	1 081
Russian Federation	52 300	2	1 214	51 088	105 800	525	30 835	75 490	20 000	21	7 764	12 257
Slovakia	167	0	62	105	5 046	129	1 550	3 625	701	102	920	0
Slovenia	532	2	62	472	1 721	494	242	1 973	439	198	344	293
Spain	1 650	18	75	1 593	13 160	7 515	349	20 326	3 178	3 231	91	6 318
Sweden	5 900	177	31	6 046	58 920	11 721	1 431	69 209	16 176	348	11 048	5 476
Switzerland	1 626	6	0	1 632	7 612	298	3 754	4 156	1 625	453	193	1 886
The FYR of Macedonia	875	37	0	912	177	1	1	177	36	154	19	171
Ukraine	1 766	1	66	1 701	4 154	57	639	3 572	-	250	349	0
United Kingdom	234	20	233	21	7 051	289	129	7 212	2 482	7 963	195	10 250
Yugoslavia	1 772	12	0	1 784	1 582	2	23	1 560	504	371	243	631
North and Central America	**155 606**	**39**	**154**	**155 491**	**617 330**	**13 648**	**14 911**	**616 068**	**189 030**	**51 373**	**55 485**	**184 917**
Antigua and Barbuda	-	-	-	0	-	0	-	0	-	11	0	11
Aruba	-	0	-	0	-	1	-	1	-	16	0	16
Bahamas	-	-	-	0	17	17	0	34	1	78	2	77
Barbados	-	1	-	1	5	2	0	7	-	63	0	63
Belize	126	-	0	126	62	1	0	62	35	15	8	42
Bermuda	-	-	-	0	-	-	-	0	-	-	-	0
British Virgin Islands	-	-	-	0	-	0	-	0	-	4	-	4
Canada	1 499	32	145	1 386	176 572	6 507	2 903	180 177	69 640	1 951	50 051	21 540
Cayman Islands	-	-	-	0	-	2	-	2	-	14	0	14
Costa Rica	3 486	-	0	3 486	1 687	5	0	1 692	812	30	3	838
Cuba	2 854	-	-	2 854	406	0	0	406	146	11	0	157
Dominica	-	0	0	0	-	0	0	0	-	7	0	7
Dominican Republic	556	0	-	556	6	9	0	16	0	289	0	289
El Salvador	4 073	0	-	4 073	682	1	0	683	58	80	0	138
Grenada	-	-	-	0	-	0	-	0	-	10	-	10
Guadeloupe	15	0	-	15	0	5	0	5	1	46	0	47
Guatemala	14 540	-	0	14 540	467	2	0	468	355	3	45	313
Haiti	1 964	-	-	1 964	239	1	0	240	14	22	0	36
Honduras	8 732	0	0	8 732	759	0	40	719	437	6	139	304
Jamaica	599	0	-	599	282	1	0	283	66	221	0	287
Martinique	10	0	-	10	2	3	0	5	1	29	0	30
Mexico	37 561	4	8	37 557	8 105	32	10	8 128	3 110	1 250	168	4 192
Montserrat	-	-	-	0	-	-	-	0	-	4	-	4
Netherlands Antilles	-	0	-	0	-	0	0	0	-	32	0	31
Nicaragua	5 756	0	0	5 756	228	0	2	226	148	1	47	103
Panama	1 280	0	-	1 280	77	1	4	74	48	6	0	54
Saint Kitts and Nevis	-	-	-	0	-	1	-	1	-	5	0	5
Saint Lucia	-	0	-	0	-	7	-	7	-	15	-	15
Saint Pierre and Miquelon	-	-	-	0	-	0	0	0	-	2	0	2
Saint Vincent and Grenadines	-	0	-	0	-	0	-	0	-	21	0	21
Trinidad and Tobago	37	0	-	37	80	10	0	90	37	30	1	66
Turks and Caicos Islands	-	0	0	0	-	0	-	0	-	4	0	4
United States	72 520	0	0	72 520	427 654	7 038	11 952	422 740	114 120	47 092	5 020	156 192
United States Virgin Islands	-	-	-	0	-	0	-	0	-	-	-	0

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Wood-based panels ('000 m³)				Pulp for paper ('000 tonnes)				Paper and paperboard ('000 tonnes)				Country/area
Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	
14 064	4 250	4 620	13 694	2 215	3 862	383	5 694	18 182	9 810	8 905	19 087	Germany
-	0	0	0	-	-	0	0	-	0	0	0	Gibraltar
527	378	118	786	5	128	2	132	350	573	43	879	Greece
563	251	319	495	24	169	8	185	506	503	231	779	Hungary
0	31	3	28	0	0	0	0	0	18	0	18	Iceland
745	246	520	471	0	18	0	18	43	439	62	420	Ireland
5 425	1 729	1 121	6 033	615	3 182	22	3 775	9 129	2 419	1 347	10 201	Italy
291	42	233	100	0	0	0	0	16	85	9	92	Latvia
-	-	-	0	-	-	-	0	-	-	-	0	Liechtenstein
270	115	211	175	0	8	6	2	53	78	37	94	Lithuania
150	31	141	40	0	0	0	0	0	80	52	28	Luxembourg
0	26	0	26	0	0	0	0	0	36	0	36	Malta
61	1 860	288	1 633	137	814	315	636	3 332	3 517	2 938	3 911	Netherlands
535	217	341	411	2 435	156	408	2 183	2 300	466	1 981	785	Norway
4 615	688	1 337	3 966	994	266	33	1 227	1 934	1 229	754	2 409	Poland
1 293	246	748	792	1 774	92	969	897	1 290	644	744	1 189	Portugal
10	25	0	34	-	0	1	0	-	27	8	19	Republic of Moldova
306	226	153	379	293	4	31	265	340	147	115	372	Romania
4 750	376	1 404	3 722	5 752	36	1 615	4 174	5 310	358	2 253	3 415	Russian Federation
126	334	240	220	608	72	75	605	925	247	349	823	Slovakia
537	132	186	483	153	164	35	282	411	182	422	170	Slovenia
4 436	1 865	908	5 393	1 762	616	548	1 830	4 755	3 259	1 337	6 677	Spain
1 012	667	265	1 414	11 903	324	2 975	9 252	10 786	754	9 031	2 509	Sweden
740	517	370	887	244	468	135	577	1 780	979	1 183	1 576	Switzerland
153	58	1	210	0	3	0	3	17	37	7	47	The FYR of Macedonia
275	109	49	335	48	37	0	84	373	275	63	586	Ukraine
2 986	3 111	352	5 744	517	1 822	9	2 330	6 868	6 420	1 794	11 495	United Kingdom
118	63	25	157	50	47	32	65	180	106	32	253	Yugoslavia
60 343	**17 069**	**13 371**	**64 042**	**84 311**	**7 441**	**17 251**	**74 501**	**111 720**	**24 289**	**25 017**	**110 992**	**North and Central America**
-	4	0	4	-	-	-	0	-	0	0	0	Antigua and Barbuda
-	6	-	6	-	0	-	0	-	1	-	1	Aruba
-	17	0	17	-	0	-	0	-	8	0	8	Bahamas
-	15	0	15	-	2	0	2	-	11	0	11	Barbados
-	19	3	16	-	2	2	0	-	2	0	2	Belize
-	-	-	0	-	0	-	0	-	-	-	0	Bermuda
-	1	-	1	-	-	0	0	-	0	0	0	British Virgin Islands
14 533	1 549	10 972	5 110	26 495	356	11 653	15 198	20 921	3 810	15 613	9 118	Canada
-	5	0	5	-	-	0	0	-	1	0	1	Cayman Islands
65	26	33	59	10	9	0	19	20	314	12	322	Costa Rica
149	10	1	158	52	2	-	54	57	35	0	92	Cuba
-	6	0	6	-	0	0	0	-	7	1	6	Dominica
-	44	0	44	-	0	-	0	130	181	0	311	Dominican Republic
-	15	0	15	-	8	-	8	56	103	11	148	El Salvador
-	4	-	4	-	-	-	0	-	0	0	0	Grenada
-	23	0	23	-	0	-	0	-	6	0	6	Guadeloupe
43	27	9	61	-	1	-	1	31	196	5	222	Guatemala
-	4	-	4	-	0	-	0	-	6	0	6	Haiti
7	9	6	10	7	1	0	8	95	72	0	166	Honduras
0	51	-	51	-	0	-	0	0	78	0	78	Jamaica
-	7	0	7	-	0	0	0	-	5	0	5	Martinique
0	874	214	660	569	502	13	1 058	3 865	2 997	221	6 640	Mexico
-	0	-	0	-	-	-	0	-	0	-	0	Montserrat
-	15	0	14	-	0	-	0	-	5	0	5	Netherlands Antilles
8	19	5	21	-	0	-	0	-	16	1	16	Nicaragua
15	15	0	30	-	1	0	1	0	68	12	56	Panama
-	1	-	1	-	-	-	0	-	0	-	0	Saint Kitts and Nevis
-	7	-	7	-	0	-	0	-	10	0	10	Saint Lucia
-	1	0	0	-	-	-	0	-	0	-	0	Saint Pierre and Miquelon
-	16	0	16	-	-	-	0	-	5	0	5	Saint Vincent and Grenadines
-	5	0	5	0	6	0	6	-	70	1	69	Trinidad and Tobago
-	1	0	1	-	-	-	0	-	0	-	0	Turks and Caicos Islands
45 523	14 269	2 127	57 665	57 178	6 550	5 583	58 145	86 545	16 279	9 139	93 685	United States
-	-	-	0	-	-	-	0	-	-	-	0	United States Virgin Islands

Country/area	Woodfuel ('000 m³)				Industrial roundwood ('000 m³)				Sawnwood ('000 m³)			
	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption
Oceania	**12 202**	**2**	**1**	**12 203**	**47 418**	**10**	**9 079**	**38 349**	**8 202**	**1 177**	**1 662**	**7 718**
American Samoa	-	-	-	0	-	0	-	0	-	1	-	1
Australia	6 333	0	0	6 333	24 160	3	969	23 194	3 977	1 025	86	4 916
Cook Islands	-	-	-	0	5	0	4	1	-	2	-	2
Fiji	37	-	-	37	449	0	1	448	72	0	17	55
French Polynesia	-	-	-	0	-	0	0	0	-	57	0	57
Kiribati	-	0	-	0	-	0	-	0	-	2	-	2
Marshall Islands	-	-	-	0	-	-	-	0	-	6	-	6
Micronesia	-	0	-	0	-	0	-	0	-	7	-	7
Nauru	-	-	-	0	-	0	-	0	-	0	0	0
New Caledonia	-	0	-	0	5	1	0	5	3	20	0	24
New Zealand	0	0	-	0	18 898	5	5 772	13 131	3 879	36	1 523	2 392
Niue	-	-	-	0	-	0	0	0	-	0	0	0
Norfolk Island	-	-	-	0	-	0	-	0	-	1	0	1
Northern Mariana Islands	-	-	-	0	-	-	-	0	-	0	-	0
Palau	-	-	-	0	-	1	-	1	-	3	-	3
Papua New Guinea	5 533	0	-	5 533	3 064	0	1 902	1 163	218	0	20	198
Samoa	70	0	-	70	61	0	6	55	21	8	1	27
Solomon	138	-	0	138	734	-	424	310	12	0	4	8
Tonga	-	2	-	2	2	0	0	2	2	7	0	9
Vanuatu	91	-	1	90	40	0	0	40	18	1	10	9
South America	**185 046**	**0**	**0**	**185 046**	**152 953**	**150**	**2 199**	**150 904**	**29 579**	**460**	**4 585**	**25 454**
Argentina	3 950	0	0	3 950	6 652	4	123	6 533	1 408	196	44	1 560
Bolivia	2 142	0	0	2 142	468	0	3	465	254	5	43	216
Brazil	132 408	0	0	132 408	102 994	32	752	102 275	18 100	159	2 380	15 879
Chile	11 280	-	0	11 280	24 437	0	681	23 756	5 698	0	1 718	3 980
Colombia	8 313	0	-	8 313	3 783	0	21	3 763	915	2	5	913
Ecuador	5 129	0	-	5 129	5 719	88	128	5 679	1 455	0	28	1 427
French Guiana	75	-	-	75	60	1	2	59	15	1	4	12
Guyana	880	-	0	880	308	0	54	254	29	0	42	0
Paraguay	5 551	-	0	5 551	4 044	0	0	4 044	550	2	183	369
Peru	7 777	0	0	7 777	927	23	0	950	623	7	82	548
Suriname	43	0	-	43	184	0	10	174	78	0	7	71
Uruguay	3 894	0	-	3 894	1 828	2	421	1 409	269	46	49	266
Venezuela	3 605	0	-	3 605	1 549	0	5	1 544	185	42	0	227
World	**1 778 686**	**1 984**	**3 591**	**1 777 069**	**1 574 634**	**124 338**	**114 222**	**1 584 751**	**424 488**	**128 827**	**126 683**	**426 632**

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Wood-based panels ('000 m³)				Pulp for paper ('000 tonnes)				Paper and paperboard ('000 tonnes)				Country/area
Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	Production	Imports	Exports	Consumption	
3 504	**299**	**1 101**	**2 701**	**4 195**	**307**	**675**	**3 827**	**3 718**	**1 741**	**931**	**4 528**	**Oceania**
-	0	-	0	-	-	-	0	-	0	0	0	American Samoa
1 801	250	255	1 796	2 590	303	0	2 893	2 844	1 399	455	3 788	Australia
-	1	0	1	-	-	-	0	-	0	0	0	Cook Islands
12	3	7	8	-	0	-	0	-	18	0	18	Fiji
-	10	0	9	-	0	-	0	-	4	0	4	French Polynesia
-	0	-	0	-	-	-	0	-	0	-	0	Kiribati
-	3	-	3	-	-	-	0	-	0	-	0	Marshall Islands
-	1	-	1	-	-	-	0	-	0	-	0	Micronesia
-	0	0	0	-	-	-	0	-	0	0	0	Nauru
-	5	0	5	-	0	-	0	-	5	0	5	New Caledonia
1 676	18	827	867	1605	4	675	934	874	295	476	694	New Zealand
-	0	-	0	-	0	0	0	-	0	0	0	Niue
-	0	-	0	-	-	-	0	-	0	0	0	Norfolk Island
-	0	-	0	-	-	-	0	-	0	-	0	Northern Mariana Islands
-	1	-	1	-	-	-	0	-	0	0	0	Palau
15	2	12	5	-	-	-	0	-	18	0	18	Papua New Guinea
0	2	-	2	-	0	0	0	-	0	0	0	Samoa
0	0	-	0	-	-	-	0	-	0	0	0	Solomon
-	1	-	1	-	-	-	0	-	0	0	0	Tonga
-	2	0	2	-	-	-	0	-	0	0	0	Vanuatu
8 064	**487**	**2 653**	**5 898**	**11 363**	**817**	**4 993**	**7 187**	**9 940**	**2 993**	**1 472**	**11 461**	**South America**
690	90	233	547	665	103	240	528	1 012	720	55	1 677	Argentina
11	8	2	16	0	2	0	2	0	73	0	73	Bolivia
5 157	201	1 666	3 692	7 341	329	2 917	4 754	6 473	814	815	6 472	Brazil
1 187	0	435	752	2 592	13	1 835	770	861	256	313	804	Chile
206	41	78	169	362	175	1	535	741	510	130	1 121	Colombia
359	9	44	324	2	15	0	17	91	132	3	221	Ecuador
0	3	0	3	-	0	-	0	-	0	0	0	French Guiana
92	0	87	5	-	0	-	0	-	6	0	6	Guyana
161	1	84	78	-	0	0	0	13	34	3	44	Paraguay
42	42	22	62	17	27	0	44	63	173	24	212	Peru
4	0	1	3	-	0	-	0	-	2	0	2	Suriname
6	24	0	29	38	20	0	58	92	79	38	133	Uruguay
150	68	1	217	346	134	0	480	594	195	91	697	Venezuela
181 631	**61 775**	**56 602**	**186 804**	**187 472**	**36 704**	**36 562**	**187 614**	**323 569**	**97 884**	**96 925**	**324 527**	**World**

TABLE 5

Status of ratification of international conventions and agreements as of 1 December 2002

Country/territory	CBD	UNFCCC	Kyoto Protocol	CCD	CITES	Ramsar Convention	World Heritage Convention
Africa							
Algeria	X	X		X	X	X	X
Angola	X	X		X			X
Benin	X	X	X	X	X	X	X
Botswana	X	X		X	X	X	X
Burkina Faso	X	X		X	X	X	X
Burundi	X	X	X	X	X	X	X
Cameroon	X	X		X	X		X
Cape Verde	X	X		X			X
Central African Republic	X	X		X	X		X
Chad	X	X		X	X	X	X
Comoros	X	X		X	X	X	X
Congo	X	X		X	X	X	X
Cote d'Ivoire	X	X		X	X	X	X
Dem. Rep. of the Congo	X	X		X	X	X	X
Djibouti	X	X	X	X	X		
Egypt	X	X		X	X	X	X
Equatorial Guinea	X	X	X	X	X		
Eritrea	X	X		X	X		X
Ethiopia	X	X		X	X		X
Gabon	X	X		X	X	X	X
Gambia	X	X	X	X	X	X	X
Ghana	X	X		X	X	X	X
Guinea	X	X	X	X	X	X	X
Guinea-Bissau	X	X		X	X	X	
Kenya	X	X		X	X	X	X
Lesotho	X	X	X	X			
Liberia	X	X	X	X	X		X
Libyan Arab Jamahiriya	X	X		X		X	X
Madagascar	X	X		X	X	X	X
Malawi	X	X	X	X	X	X	X
Mali	X	X	X	X	X	X	X
Mauritania	X	X		X	X	X	X
Mauritius	X	X	X	X	X	X	X
Morocco	X	X	X	X	X	X	X
Mozambique	X	X		X	X		X
Namibia	X	X		X	X	X	X
Niger	X	X		X	X	X	X
Nigeria	X	X		X	X	X	X
Rwanda	X	X		X	X		X
Sao Tome and Principe	X	X		X	X		
Senegal	X	X	X	X	X	X	X
Seychelles	X	X	X	X	X		X
Sierra Leone	X	X		X	X	X	
Somalia				X	X		
South Africa	X	X		X	X	X	X
Sudan	X	X		X	X		X
Swaziland	X	X		X	X		
Togo	X	X		X	X	X	X
Tunisia	X	X		X	X	X	X
Uganda	X	X	X	X	X	X	X
United Republic of Tanzania	X	X	X	X	X	X	X
Zambia	X	X		X	X	X	X
Zimbabwe	X	X		X	X		X
Asia							
Afghanistan	X	X		X	X		X
Armenia	X	X		X		X	X
Azerbaijan	X	X	X	X	X	X	X
Bahrain	X	X		X		X	X

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/territory	CBD	UNFCCC	Kyoto Protocol	CCD	CITES	Ramsar Convention	World Heritage Convention
Bangladesh	X	X	X	X	X	X	X
Bhutan	X	X			X		X
Brunei Darussalam					X		
Cambodia	X	X		X	X	X	X
China	X	X		X	X	X	X
Cyprus	X	X	X	X	X	X	X
Dem. People's Rep. of Korea	X	X					X
Georgia	X	X	X	X	X	X	X
India	X	X	X	X	X	X	X
Indonesia	X	X		X	X	X	X
Iran, Islamic Rep. of	X	X		X	X	X	X
Iraq							X
Israel	X	X		X	X	X	X
Japan	X	X	X	X	X	X	X
Jordan	X	X		X	X	X	X
Kazakhstan	X	X		X	X		X
Kuwait	X	X		X	X		X
Kyrgyzstan	X	X		X			X
Lao People's Dem. Rep.	X	X		X			X
Lebanon	X	X		X		X	X
Malaysia	X	X	X	X	X	X	X
Maldives	X	X	X	X			X
Mongolia	X	X	X	X	X	X	X
Myanmar	X	X		X	X		X
Nepal	X	X		X	X	X	X
Oman	X	X		X			X
Pakistan	X	X		X	X	X	X
Philippines	X	X		X	X	X	X
Qatar	X	X		X	X		X
Republic of Korea	X	X	X	X	X	X	X
Saudi Arabia	X	X		X	X		X
Singapore	X	X		X	X		
Sri Lanka	X	X	X	X	X	X	X
Syrian Arab Republic	X	X		X		X	X
Tajikistan	X	X		X		X	X
Thailand		X	X	X	X	X	X
Timor-Leste							
Turkey	X			X	X	X	X
Turkmenistan	X	X	X	X			X
United Arab Emirates	X	X		X	X		X
Uzbekistan	X	X	X	X	X	X	X
Viet Nam	X	X	X	X	X	X	X
Yemen	X	X		X	X		X
Europe							
Albania	X	X		X		X	X
Andorra				X			X
Austria	X	X	X	X	X	X	X
Belarus	X	X		X	X	X	X
Belgium and Luxembourg	X	X	X	X	X	X	X
Bosnia and Herzegovina	X	X				X	X
Bulgaria	X	X	X	X	X	X	X
Croatia	X	X		X	X	X	X
Czech Republic	X	X	X	X	X	X	X
Denmark	X	X	X	X	X	X	X
Estonia	X	X	X		X	X	X
Finland	X	X	X	X	X	X	X
France	X	X	X	X	X	X	X
Germany	X	X	X	X	X	X	X
Greece	X	X	X	X	X	X	X
Hungary	X	X	X	X	X	X	X
Iceland	X	X	X	X	X	X	X
Ireland	X	X	X	X	X	X	X
Italy	X	X	X	X	X	X	X
Latvia	X	X	X		X	X	X

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/territory	CBD	UNFCCC	Kyoto Protocol	CCD	CITES	Ramsar Convention	World Heritage Convention
Liechtenstein	X	X		X	X	X	
Lithuania	X	X			X	X	X
Malta	X	X	X	X	X	X	X
Netherlands	X	X	X	X	X	X	X
Norway	X	X	X	X	X	X	X
Poland	X	X		X	X	X	X
Portugal	X	X	X	X	X	X	X
Republic of Moldova	X	X		X	X	X	X
Romania	X	X	X	X	X	X	X
Russian Federation	X	X			X	X	X
San Marino	X	X		X			X
Slovakia	X	X	X	X	X	X	X
Slovenia	X	X	X	X	X	X	X
Spain	X	X	X	X	X	X	X
Sweden	X	X	X	X	X	X	X
Switzerland	X	X		X	X	X	X
The FYR of Macedonia	X	X		X	X	X	X
Ukraine	X	X		X	X	X	X
United Kingdom	X	X	X	X	X	X	X
Yugoslavia	X	X			X	X	X
North and Central America							
Antigua and Barbuda	X	X	X	X	X		X
Bahamas	X	X	X	X	X	X	
Barbados	X	X	X	X	X		X
Belize	X	X		X	X	X	X
Canada	X	X		X	X	X	X
Cayman Islands							
Costa Rica	X	X	X	X	X	X	X
Cuba	X	X	X	X	X	X	X
Dominica	X	X		X	X		X
Dominican Republic	X	X	X	X	X	X	X
El Salvador	X	X	X	X	X	X	X
Greenland							
Grenada	X	X	X	X	X		X
Guatemala	X	X	X	X	X	X	X
Haiti	X	X		X			X
Honduras	X	X	X	X	X	X	X
Jamaica	X	X	X	X	X	X	X
Mexico	X	X	X	X	X	X	X
Nicaragua	X	X	X	X	X	X	X
Panama	X	X	X	X	X	X	X
Saint Kitts and Nevis	X	X		X	X		X
Saint Lucia	X	X		X	X	X	X
Saint Vincent and Grenadines	X	X		X	X		
Trinidad and Tobago	X	X	X	X	X	X	
United States		X		X	X	X	X
United States Virgin Islands							
Oceania							
American Samoa							
Australia	X	X		X	X	X	X
Cook Islands	X	X	X	X			
Fiji	X	X	X	X	X		X
French Polynesia							
Guam							
Kiribati	X	X	X	X			X
Marshall Islands	X	X		X			X
Micronesia	X	X	X	X			X
Nauru	X	X	X	X			
New Caledonia							
New Zealand	X	X		X	X	X	X
Niue	X	X	X	X			X
Northern Mariana Islands							
Palau	X	X	X	X			X

Note: The regional breakdown reflects geographic rather than economic or political groupings.

Country/territory	CBD	UNFCCC	Kyoto Protocol	CCD	CITES	Ramsar Convention	World Heritage Convention
Papua New Guinea	X	X	X	X	X	X	X
Samoa	X	X	X	X			X
Solomon Islands	X	X		X			X
Tonga	X	X		X			
Vanuatu	X	X	X	X	X		X
South America							
Argentina	X	X	X	X	X	X	X
Bolivia	X	X	X	X	X	X	X
Brazil	X	X	X	X	X	X	X
Chile	X	X	X	X	X	X	X
Colombia	X	X	X	X	X	X	X
Ecuador	X	X	X	X	X	X	X
Guyana	X	X		X	X		X
Paraguay	X	X	X	X	X	X	X
Peru	X	X	X	X	X	X	X
Suriname	X	X		X	X	X	X
Uruguay	X	X	X	X	X	X	X
Venezuela	X	X		X	X	X	X

Note: The regional breakdown reflects geographic rather than economic or political groupings.

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