

***Box A—Amendments to the Foreign Assistance Act Concerning
Tropical Forests and Biological Diversity***

1977: Amended section 102 to 102 environment and natural resources to areas the U.S. Agency for International Development (AID) should address.

1977: Added new section 118 on ‘Environment and Natural Resources,’ authorizing AID to fortify “the capacity of less developed countries to protect and manage their environment and natural reSources” and to “maintain and where possible restore the land,vegetation, water, wildlife, and other resources upon which depend economic growth and well-being, especially that of the poor.”

1978: Amended section 118, requiring AID to carry out country studies in the developing world to identify natural resource problems and institutional mechanisms to solve them.

1978/79: Amended section 103 to emphasize forestry assistance, acknowledging that deforestation, with its attendant species loss, constitutes an impediment to meeting basic human needs in developing countries.

1981: Amended section 118, making AID’s environmental review regulations part of the Foreign Assistance Act, and added a subsection (d), expressing that “Congress is particularly concerned about the continuing and accelerating alteration, destruction, and loss of tropical forests in developing countries.” Instructs the President to take these concerns into account in formulating policies and programs relating to bilateral and multilateral assistance and to private sector activities m the developing world.

1983: Added section 119, directing AID in consultation with other Federal agencies to develop a U.S. strategy on conserving biological diversity in developing countries.

1986: Redesignated section 118 as section 117, with the new section 118 addressing tropical forest issues. Amended section 119, which among other things earmarked money for biological diversity projects.

1988: Directed AID to monitor the economic and environmental soundness of multilateral development bank programs and projects.

1990: Directed AID to increase the number and expertise of staff in environmental and natural resources fields, and to focus efforts on developing countries projected to produce substantial amounts of greenhouse gases to the atmosphere.

SOURCE: Adapted from Us. Congress, Office of Technology Assessment, *Technologies to Maintain Biological Diversity*, OTA-F-331 (Springfield, VA: National Technical Information Service, March 1987).

global ongoing renewable resource problems, and introduces new issues and approaches that have arisen since publication of the original OTA reports.

NEW PUBLIC AND CONGRESSIONAL ISSUES

Congressional committees in the early and mid-1980s requested OTA assessments of technologies to sustain tropical forests and biological diversity largely for two reasons: interest in promoting sustainable economic development in tropical developing countries, and concern over the loss of product opportunities and species of interest to U.S. citizens. Since then, new, related public policy issues have arisen. Some of these underscore the need to conserve forests and biodiversity, whereas others constrain efforts to do so. Governments,

development assistance agencies, and **nongovernmental** organizations are promoting a variety of policies to address these new issues as they grow in prominence.

Global Climate Change

Forests store a substantial part of the Earth’s carbon. Deforestation and forest degradation worldwide, but especially in tropical regions, release carbon stored in the wood and forest soil as carbon dioxide (C@) gas, one of the gases implicated in global climate change. Net tropical forest loss accounted for about one quarter of all carbon released to the atmosphere over the past decade [5,56]. Halting deforestation would reduce this contribution to climate change and preserve an important carbon “sink.” Further, tropical reforestation and careful forest management may have

significant potential to help remove carbon gas from the atmosphere. The growing season in many parts of the tropics is year-round, whereas in temperate regions the growing season is much shorter. Reforestation, therefore, will trap CO² more quickly in the tropics than in temperate areas. Once forests reach maturity in either region, however, their growth slows considerably and additional storage of CO² decreases, necessitating some amount of harvest and replanting to continue carbon sequestration.

Biodiversity is greatly at risk from global warming. First, natural ecosystems, for example the Serengeti Plain in East Africa and the Florida Everglades, cannot move as climate zones shift rapidly. Some species will not be able to adapt to the changing characteristics of their surroundings and, thus, probably will be lost. Secondly, because of potential sea level changes, coastal zones and wetlands-biologically the most diverse ecosystems next to tropical forests-are the ecosystems most at risk from the effects of climate change [4].

Land-Based Sources of Coastal Pollution

Coastal zones, particularly wetlands, estuaries, and coral reefs, have high biodiversity and generally are of great economic importance. Pollution of these ecosystems from land-based sources-such as sediment eroded from cut-over forests and fertilizers and sediment transported from poorly managed farmlands-sharply reduces the ability of estuaries and coral reefs to support diverse marine species [9]. At Bacuit Bay in the Philippines, economists and natural and social scientists measured revenues from logging, fisheries, and tourism in an area where sediment pollution from the logging operations had damaged the marine environment. The analysis showed that total income would double if logging ceased [12]. However, as is commonly the case, normal market forces did not result in pollution control. As the timber company did not incur the costs of lost fishery and tourism income, apolitical decision was necessary to stop the logging.

Natural coastal mangrove forests typically have very high biological productivity. The high organic production is exploited by many fish, and certain marine crustaceans spend part of their life cycles inhabiting the mangrove environment. The net energy outflow from mangrove habitats has benefi-



Photo credit: Alison L Hess, Office of Technology Assessment

Coastal mangrove forests capture sediment from freshwater runoff, protect inland vegetation from salt spray and tidal surges, provide high levels of nutrients for nearshore aquatic life, and provide habitat for a diversity of species. Thus, loss of these forests can compromise the livelihoods of entire coastal communities through diminished agricultural and fishery productivity, increased exposure to weather hazards, or reduced tourist income.

cial effects on marine fisheries. The livelihoods of hundreds of thousands of people in coastal regions are at risk because mangrove forests are being degraded by pollution, overcutting, and human-caused hydrological changes [21].

Human Contact With New Diseases

AIDS¹, Ebola virus, and Marburg disease are a few of the highly infectious and commonly fatal “emerging viruses” that have struck human communities in recent years. Many of these viruses are not new, but derive from new human exposure to disease-carrying animal populations. As human settlement extends into previously uninhabited tropical forests, exposure increases to new organisms, some of which may carry diseases that can spread to more general populations [70]. For example, monkeypox is a new human orthopoxvirus infection that occurs in remote villages sited in tropical rainforests of West and Central Africa [2]. Tegumentary leishma-

¹ Acquired immunodeficiency syndrome.

niasis is a human parasitic disease prevalent in Colombia's Pacific coastal forested areas, where insect vectors and animal reservoirs seem impervious to control measures [64].

Moreover, "changes wrought by war, migration, agriculture, deforestation and population growth have expedited the movement of viruses from isolated animal reservoirs to the larger, human community" [29]. Rainforest clearing for agriculture in western Africa provided prime breeding grounds for the malaria-carrying mosquito, which subsequently supplanted other species that could not adapt to the new environment. Empty coconut and cacao hulls provide breeding pools for disease-carrying mosquitoes and midges around the tropical world; other insect species preferentially breed in artificial containers that accompany human settlement. Disease-carrying rodents flourish in expanding grasslands and grain fields. Even the yearly outbreaks of common influenza are associated strongly with fish-waterfowl-swine aquiculture systems practiced in Southeast Asia. Yet viral emergence is rarely if ever taken into consideration in development activities. One proposal to contain the spread of infectious disease would be to establish a worldwide network of research and response centers for international disease surveillance and health programs [29]. A complementary approach would be to include "viral traffic planning in development plans" and to conduct regular "viral impact assessments" for development projects likely to involve changes in land use or ecological systems [30].

Multiplied and Magnified Disasters

Rural populations continue to grow rapidly throughout the developing nations, and continue to spread agriculture into marginally productive and physically hazardous regions. The consequent damage to tropical forests is most severe in infertile dry woodlands of rapidly growing countries such as Kenya [24]. Even in wetter, more fertile areas, however, population growth coupled with land-extensive farming practices leads to deforestation. In the Philippines, for example, so many landless poor have emigrated from the fertile lowlands that nearly one-third of the country's population now lives in the once-forested upland areas. There, relatively infertile soils necessitate practicing shifting agriculture that exposes widening areas to erosion and loss of the soil's meager fertility.

During intensive rains, landslides on denuded hillsides claim lives and property [52], and sediment-laden runoff exacerbates flooding. For example, tropical storm Thelma is reportedly responsible for more Philippine deaths, largely by landslides, than the eruption of Mount Pinatubo [17]. Further, removal of coastal shelterbelt forests, such as mangroves, leaves large populations vulnerable to onshore strong winds and tidal surges during tropical storms. Such storms have repeatedly claimed thousands of lives in low-lying areas of Bangladesh.

Rights of Indigenous Peoples

Many tropical forest areas are inhabited by indigenous peoples who practice low-impact subsistence methods of survival. Their numbers are increasing in some places, such that renewability of biological resources is threatened. In other areas, subsistence lifestyles are being displaced by competing, more destructive land uses that give higher short-term returns. Politicians in countries such as the Philippines express growing concern over indigenous peoples' claims to forest land tenure [26]. In addition, legal claims of the forest dwelling people are mired in highly disordered land law in many tropical countries [18].

NGOS and some scientists advocate secure forest land tenure and modified subsistence practices as the basis for the sustainable economic development of indigenous communities and for old-growth forest protection [13]. In most places, however, little scientific effort has been made to determine whether and how tribal practices can be made more productive without degrading natural resources.

Tropical Countries' Mounting Debt Burdens

Conservation becomes increasingly difficult as tropical countries' debts increase. The need for foreign exchange to service debts and rebuild economies provides a strong incentive for national decisionmakers to approve rapid liquidation of exportable timber [8]. Public funds are lacking for direct investment in forest conservation and for investment in job-generating development programs that could relieve the need to convert forests to marginal farmland. Even when low-interest loans are available from international development banks, poor countries are reluctant to add to their debt by borrowing for forest conservation and management projects; such investments are at risk for a long period before payback is realized.

International Trade and the Environment

Although international agreements exist to control or prohibit trade in products from threatened or endangered species (e.g., the Convention on International Trade in Endangered Species), the broader relationship between trade and environment is little understood. Trade may promote competition and thus efficiency in production, thereby reducing waste and, potentially, pollution. Further, some argue that trade sanctions can serve as a strong incentive for countries to institute biodiversity and forest protection policies. Conversely, international trading patterns may increase developing countries' dependence on extraction of natural resources and intensive production of tropical cash crops, hence promoting resource degradation.

The main organization governing international trade agreements and promoting liberalized trade—the General Agreement on Tariffs and Trade (GATT)—has been increasingly criticized for neglect of the environmental consequences of trade. Several international agreements dealing with global environmental problems, on the other hand, contain trade-related measures such as allowing discriminatory treatment of imports that contain stratospheric ozone-depleting chlorofluorocarbons. Some environmental protection measures may be eliminated under current international trade negotiations [63]. In fact, a recent GATT dispute resolution panel ruled that the United States could not restrict tuna imports from Mexico because of Mexico's noncompliance with a U.S. domestic law prohibiting tuna harvest technologies that kill excessive numbers of dolphins [7,55]. National and international conflicts between environmental protection efforts and trade liberalization efforts are likely to increase, with uncertain outcome.

Threats of War and Ecoterrorism

Political unrest and its most extreme expression—war—is a widespread and pervasive threat to tropical forests and biodiversity. Valuable tropical timber, such as Myanmar's (formerly Burma) teak forests, may be harvested at unsustainable rates to fund military actions [41]. Forested areas are common sites for militants to hide, and fight. In addition to deliberate efforts to devegetate such areas, as occurred in Vietnam, subsequent actions may compound forest and biodiversity loss. For example, farmers may shift from areas degraded by craters,

shrapnel, and live munitions into forested areas. Due in large part to an international trade embargo imposed on Vietnam after 1975, much of its energy is supplied by firewood and charcoal, resulting in further forest loss [28].

Biodiversity in entire ecosystems is threatened by acts of war. Examples include the deliberate oil spills and well fires that have occurred in Kuwait [37]. As biodiversity has been proclaimed an important value to political constituencies in developed countries, it has become a concern during the destruction caused by war and a potential target for terrorist acts. In the United States, forest rangers and endangered spotted owls have become the targets of "environmental terrorists" protesting restriction of timber harvest to protect the owl's habitat [14], and old-growth trees have been spiked with nails, thus endangering the loggers and sawmillers. Charismatic tropical species—such as gorillas—may be similarly threatened by some people to gain attention or to extort concessions. Conversely, efforts to educate people about the "world heritage" value of mountain gorillas seems to have fostered special efforts to protect them during recent Ugandan-Ruandan conflicts in the gorilla's habitat [43].

Unintended Impacts of Forest Protection Policies

Because of the diversity of cultural and governmental systems, general policies may, in some places, have counterproductive results. In such countries as the Philippines and India, political momentum is building for logging bans. At the same time, conservation groups in Europe and North America have discovered that forest policies of development assistance organizations are vulnerable to political lobbying. As a result, the World Bank declared it will no longer lend for projects that include cutting natural tropical forests [67]. Consequently, logging may be officially banned in some areas and investments to improve management of production forests may be deferred in others. However, illegal and unmonitored logging may continue [cf: 1], and laborers who previously supported themselves through logging may turn to agriculture in forested areas. Where governments have made tree cutting illegal (e.g., the sal forest area of Bangladesh), forest degradation and deforestation often continues and may even accelerate [68]. Government agencies may not be capable of or motivated to



Photo credit: Walter E. Parham, Office of Technology Assessment

Although harvest restrictions may be required in many cases to protect tropical forests and the environmental services they provide, total logging bans may lead to illegal "timber poaching" in areas where forests are not monitored.

protect forests that have no readily apparent or immediately accessible economic value.

NEW CONSERVATION APPROACHES

Several new approaches to conservation of tropical forests and natural areas have been developed in recent years. Congress has supported these significantly, but will need to monitor and evaluate them, as the efficacy of most of these approaches is not yet proven.

Development Assistance Focus on Improving Policies

The OTA assessments and similar analyses of tropical forestry and biodiversity problems conducted in the mid- 1980s concluded that government policies-especially land/resource use rights and economic policies (e.g., taxes, prices, equity, and sector development priorities)-strongly foster destruction of forests and their genetic resources. Policy reform was recognized as a necessary condition for effective conservation.

Several influential policy studies [cf:3] in the late 1980s identified specific opportunities for policy reform. The United Nations, with its Tropical Forestry Action Plan (TFAP) program, the multilateral development banks, and AID (especially the

Asia missions) all began to develop ways to use development assistance to promote policy reform. Commonly, development assistance agencies conduct policy studies jointly with host governments, often in the context of forestry action plans, forestry master plans, or planning for specific forestry sector assistance projects. Then development assistance agencies encourage the host governments to act on recommendations. For example, funds for development projects may not be released to the host governments until key policy reforms are adopted and implemented.

Tropical Forestry Action Plan

TFAP, initiated in 1985, was designed to help governments: 1) reassess forest development priorities, 2) increase the amount of international investment in forestry, and 3) coordinate forestry sector development assistance funding. The OTA assessment and other reports indicated that poor coordination among donors was an important constraint on efficient use of development assistance from AID and other assistance providers. The United Nations' Food and Agriculture Organization (FAO), together with World Bank, the United Nations Development Programme (UNDP), and the World Resources Institute, developed TFAP to set out development efforts on fuelwood and agroforestry; industrial forestry; research, training, and extension institutions; land use on upland watersheds; and ecosystem conservation. It was estimated in 1985 that investment needs for these aspects of tropical forestry would be \$5.3 billion over 5 years.

Development assistance investments have reached nearly 70 percent of the 1985 estimate of needs [67]. The TFAP program stimulated many people and organizations to discuss the causes of and possible remedies for deforestation. About 60 countries decided to prepare national forestry plans (forestry "action" plans in some and forestry "master" plans in others). The plans are beginning to prove effective in coordinating and focusing international forestry assistance. For example, the Forestry Master Plan in Nepal was developed with support from the Asian Development Bank and technical assistance from the Government of Finland. The AID mission in Nepal now is providing technical assistance for the plan's implementation.

TFAP has, however, been criticized heavily. Plans are viewed as too government-oriented and too

focused on harvesting timber as opposed to reducing deforestation. Some NGOs argue that TFAP-sponsored national plans give little consideration to needs and priorities of people living in or near the forests. In addition, some feel the plans do not adequately address institutional weaknesses or government corruption—major causes of forest degradation in some countries.

FAO has undertaken a major evaluation of TFAP [19]. Concerned multilateral and bilateral development assistance agencies are meeting with key tropical governments and NGOs to reformulate the plan's goals, objectives, and procedures. Changes are likely to include improved integration of the national forestry plans with other national planning, increased participation by people whose livelihoods depend on the forests, greater emphasis on multisectoral actions, and increased attention to government policies that directly and indirectly affect forest sustainability [67]. An international consultative group on tropical forests reportedly has been proposed to oversee and advise TFAP and periodically review its impact [19].

The U.S. Government has participated in TFAP through support for FAO and other multilateral sponsors, through AID participation in development of the national forestry action plans and master plans, and through Forest Service and AID participation in efforts to evaluate and revamp the program. The extent to which AID forestry activities are guided by TFAP and the national forestry plans varies from country to country, depending on AID officers' judgments and on the extent to which the host governments use the plans to coordinate donors.

Planning and Coordinating Interventions

Where destruction of genetic resources is imminent, biologists may use structured "rapid appraisal" techniques to focus research and programs on threatened organisms and habitats. For example, the Rapid Assessment program sponsored by Conservation International uses satellite imagery, aerial reconnaissance, and "quick and dirty" field surveys to inventory species and provide preliminary identification of regions of particular biological richness [45]. The methods can lead to efforts to conserve habitats, rescue genetic resources, or at least capture some material and information of scientific value before the resource is lost. The techniques developed for this purpose also may help to make scientific

investigations more cost-effective on the sites that are not threatened, hastening discoveries that demonstrate the economic potential of biodiversity. This is one of several approaches being used to set priorities for, plan, and coordinate tropical forest and biodiversity conservation projects.

Other approaches focus on conservation planning. The World Bank, for example, has developed biodiversity profiles of numerous countries to assist in project planning and assessment, and is preparing regional strategies to support biodiversity conservation. National Conservation Strategies developed in many tropical countries in recent years have identified policy reforms that can enhance tropical forest and biodiversity conservation.

Debt-for-Nature Swaps

An officer of the U.S. World Wildlife Federation in 1984 proposed a way to use debt reduction to fund environmental protection in developing countries. The mechanism, commonly referred to as "debt-for-nature swaps," was first applied to Bolivia, Ecuador, and Costa Rica in 1987. At first, this mechanism could only use commercial debt. Since then, with support from the U.S. Congress and other donor governments (e.g., Germany, England, the Netherlands, Sweden), the approach has been broadened to be applicable to some public debt and has been used to fund nature conservation in African and Asian tropical countries as well. Funding from many such swaps has been used to establish and manage natural forest protected areas. Thus, the biodiversity benefits probably are substantial. Some arrangements have been used to fund other types of conservation and development programs, and the largest have been used as incentives for policy commitments.

The significance of debt swaps for reducing international debt or for meeting the needs for conservation funding seemed modest in mid-1989 [34], when only about \$100 million in debt-for-nature swaps had been negotiated. Since then, however, the pace of this activity has increased rapidly. For example, in late 1989 the Government of Germany wrote off \$405 million of Kenya's debts in return for commitments to protect the environment. AID initiated a natural resources management program in 1991 that will pay off about \$100 million of the Philippines debt as the Philippines Government adopts and implements policies that lead to sustainable tropical forest management. While debt

swaps may become a significant factor in development assistance funding to conserve tropical forests and biodiversity, it is unlikely they will retire a significant portion of developing countries' debts. For 13 countries involved in debt swaps between 1987 and 1990, under one-twentieth of 1 percent of countries' external debts was retired [62].

Most debt-for-nature swaps to date have been arrangements negotiated among the central bank of a developing country, an international NGO acting as broker, one or more public or private donors, a local developing country NGO, and the natural resources agency of the developing country. The international NGO uses money from the donors to purchase the developing country's debt at a discount on the secondary market. The debt is then canceled in return for the debtor nation's commitment to a nature conservation action. Actions might include issuing bonds to produce a stream of funding that can be used for conservation programs implemented by local environmental NGOs, or for establishing and managing nature reserves in forested areas. The approach is flexible, however. Recently, large swaps have been arranged directly between donors and host governments. AID's Natural Resources Management Program in the Philippines combines direct repayment of Philippines' debt with a usual NGO-brokered swap of dollar debt for local currency bonds.

The U.S. Congress has been instrumental in encouraging development of the debt-for-nature swap mechanism. The 1988 Foreign Assistance Appropriations Act ordered the Treasury Department to analyze debt-for-nature arrangements. Treasury issued a ruling that gave U.S. banks a tax incentive to act as private donors in debt swaps [38]. The ruling was modified to increase the incentives after a Senate inquiry. The International Development and Finance Act of 1989 encouraged multilateral development bank involvement in debt-for-nature swaps, authorized AID spending for such swaps, and modified AID practices to allow grantees (e.g., NGOs) to retain the interest on proceeds resulting from the exchanges. Thus, Congress allowed AID funds to be used for exchanges where local currency bonds are issued and where conservation organizations are given endowments rather than just current-year funding. This helps to resolve a significant problem identified in the 1984 OTA assessment: tropical forest conservation needs to be supported by long-term programs, but most develop-

ment assistance funding has been limited to short-term projects.

Debt-for-nature exchanges are a new and politically appealing form of development assistance. However, most analyses of debt-for-nature swaps do not mention from whose pocket the funds come, and few questions have been asked about grantee accountability, the efficiency of investments made through debt-for-nature swaps, or whether the technologies the funds are spent on are effective. With the stakes getting higher, Congress may consider looking into these issues.

Extractive Reserves and Buffer-Zone Development

Tropical country governments commonly do not have sufficient resources to enforce resource-use restrictions on public lands without the willing cooperation of local people. For at least a decade, environmentalists have promoted resource-use zoning in certain areas, using buffer-zone development and extractive reserves as ways to give local people a stake in forest conservation. Both zoning approaches are based on reducing local peoples' need to use resource-degrading practices in areas of high biodiversity or environmental service. For example, some sites particularly vulnerable to human-induced degradation might be restricted from any human use. In other areas where sustainable wood production and nature conservation are not compatible, only controlled harvests (''extraction'') of non-wood products would be allowed. Forests in buffer zones near settled areas would be intensively managed for wood products the local people use. Forests further from settlements would be managed for industrial timber. Extensionists, from forestry departments or from local NGOs, would facilitate local peoples' participation in establishing the restrictions, and the people would enforce the restrictions through social pressure.

Variations of the buffer zone approach are being tried, mostly in small-scale projects developed cooperatively by forest departments and NGOs. An extensive review of these efforts in several tropical countries indicates that most such projects are less than 5 years old, few are large enough in scale to affect a majority of the people living near the subject forest, and most of the NGOs are inexperienced in rural development [65]. Thus, these must be consid-

ered trial efforts and the projects undertaken so far cannot yet be considered successful or replicable.

The only large-scale test of the extractive reserve concept is in Brazil. Rubber tappers and Brazil nut harvesters promoted such reserves as an alternative to timber harvesting and land clearing, and the Brazilian Government has established a legal framework for such reserves. A substantial investment, including development assistance funds, is being made in research and infrastructure, so monitoring and evaluation will probably indicate the degree of success within a decade. This important test of the extractive reserve theory may be undermined, however, by events outside of local or national control, such as low world prices for natural rubber.

Research Reserves and Gene Sanctuaries

Certain tropical forest and other biologically diverse areas have been set aside to advance scientific understanding of ecosystems, and to protect germplasm of economically important species. For example, most biosphere reserves have zones designated for ecological research and management trials. Tropical research stations, such as La Selva (Costa Rica), operated by the Organization for Tropical Studies, and Barro Colorado Island (Panama), managed by the Smithsonian Institution, allow scientists access to undisturbed tropical ecosystems. The United States also has established a system of marine and estuarine sanctuaries which serve as research reserves prohibited from use other than by scientists attempting to understand the dynamics of their ecological systems. The scientific knowledge derived from study of these research reserves likely will provide new insights into ecosystem management.

Scientists who explore tropical forests for new or specific plants continue to introduce new products to U.S. and other markets. For example, out of 85 fruit and nut crops recently brought to the United States from the Malaysian rain forests, six are expected to be introduced to U.S. markets. The plant material from all of these species will be available for research to the U.S. Agricultural Research Service “regardless of the fate of their native rainforests” [60]. Despite their potential contributions to world markets, few forest areas have been set aside specifically to safeguard the genetic resources of crop species. The Indian Government has established a gene sanctuary for citrus plants in the

northeastern part of the country. Mexico has established a 350,000 acre biosphere reserve near Guadalajara that safeguards *Zea diploperennis*, a perennial corn with genes that provide resistance to several diseases [46].

Development of New Products

The potential that genetic resources hold for the development of new medicines, other new products, and improved agricultural crops is a primary rationale for biodiversity conservation. The OTA assessments reported scientists’ expectation that economic botany and ethnobiology research could reveal this potential and thus motivate improved management and conservation of the natural resource base. That expectation has now been reinforced by substantial improvement in the methods for screening natural products for their potential as medicines. Using biotechnology, scientists have isolated receptors and enzymes involved in certain diseases, and many types of diseased cells can now be cultured for use in screening. With robotics, technicians can now screen thousands of samples in the time it took to test 20 to 50 a decade ago [48].

New investments are being made in biodiversity research, and probably will lead to new conservation efforts as well. Some 200 companies and nearly as many research institutions worldwide are reportedly looking for plants as sources of pharmaceuticals and pesticides. For example, AID, the National Science Foundation, and the National Cancer Institute have proposed a Joint Program on Drug Discovery, Biodiversity Conservation, and Economic Growth that would provide grants for pharmaceutical development from plants [11]. Another innovative program, coordinated by AID, is the United States-Asia Environmental Partnership, a coalition of U.S. Government agencies, NGOs, businesses, and their Asian counterparts. This includes a Regional Biodiversity Conservation Network that is intended to assist local communities to benefit economically from preservation and use of Asian forest and marine genetic resources [54].

In some cases it is possible to synthesize the active component of a plant-derived drug when it has been isolated, but synthesis has not been technically or economically feasible for some promising compounds [59]. For these, cultivation or sustained harvest from natural populations becomes necessary. Taxol, a drug being investigated for treatment

of cancer, is a current example. Taxol is extracted from the bark of slow-growing Pacific yew trees, and it takes six 100-year-old trees to extract enough drug to treat one patient. Removal of the bark kills the trees. Destruction of the trees has become a problem, even though the drug is still in the research and development stage. U.S. Department of Agriculture scientists are investigating extraction of taxol from yew tree cells and propagation of Pacific yews by tissue culture.

Private firms, research organizations, and environmental NGOs have begun cooperating to develop methods for sustainable harvest of plants that produce medicines and chemicals. The same organizations have begun to search for legal arrangements (commonly called intellectual property rights) by which people in tropical countries could benefit financially from conservation and subsequent commercial development of the genetic potential in their biologically diverse ecosystems. One of the first such arrangements is an agreement between Costa Rica and a large U.S.-based pharmaceutical company. Costa Rica will protect its biota in return for granting exclusive rights to screen plants collected by a Costa Rican National Biodiversity Institute for pharmaceutically active substances. Profits from "chemical prospecting" will be shared, and profits accruing to Costa Rica will be devoted to its national conservation program [22]. Similarly, other companies are relying on the knowledge of shamans (native healers) to assist them in their search for natural drugs. Further, compensating indigenous peoples for their knowledge or protection of resources valuable to companies in the developed world is recognized in the draft Biodiversity Convention to be discussed at the 1992 United Nations Conference on Environment and Development [11]

Consumer Campaigns

A number of conservation organizations and private firms have begun to promote "green" products. Some promotions discourage consumer use of products made with materials believed to damage the environment (such as beef raised on cleared tropical forest areas or tuna harvested in ways that kill dolphins). More proactive promotions urge consumers to buy products made with materials that come from locally managed natural resources (such as Brazil nuts from extractive reserves). The approach is new, and its direct impact on resource conservation has not been assessed, but evidence



Photo credit: J. Tinsley, USDA Forest Service

Taxol, an anticancer drug produced from the Pacific yew tree, was only recently discovered. Expanded investigations into the chemical characteristics of marine and terrestrial organisms show promise for development of pharmaceuticals and other products.

exists that the promotions are having indirect beneficial impacts. For example, U.S. consumer preference for "dolphin safe" labeled tuna **may** have induced non-U.S. fishing companies to modify their harvest practices to comply voluntarily with U.S. marine mammal protection laws.

Numerous European governments have directly restricted use of tropical wood products. The International Tropical Timber Organization is developing a system for rating tropical timber production according to sustainability. The results will be publicized; wood from well-managed tropical forests may be labeled as environmentally "green." Similarly, the Ecological Trading Company (ETC) is negotiating with the World Wide Fund for Nature to "setup an independent monitoring agency which could give a seal of approval to 'acceptable sources' [69]. ETC is a tropical timber company that negotiates agreements directly with forest communities, selects individual high-value trees for harvest rather

than clear-cutting, and uses portable sawmills and horse-drawn timber removal. Although definition of “well-managed” forests and “acceptable sources” of tropical timber is problematic, certainly consumer campaigns have potential to raise general awareness about conservation.

Ecotourism

Tourism is a potential source of income, including foreign exchange, that can be generated by tropical forest and biodiversity protection. The game parks in East Africa are the best-known example of nature-or ecotourism, but tropical forest parks also are attracting many visitors. Tropical countries worldwide contain some 1,420 individual national parks and other protected areas [6], many of which regularly appear on ecotourism itineraries, and the majority of which were relatively recently designated. Globally, protected acreage now stands at some 175 million hectares; in some countries protected area growth has been particularly dramatic. Costa Rica’s network of 55 national and private wildlife reserves cover nearly 20 percent of the country’s total land area [6]. Few of these existed before 1973.

By one estimate, nature tourism accounted for between \$2 and \$12 billion of the \$55 billion tourism generated for developing countries in 1988 [25]. Many developing countries, perceiving ecotourism as a more environmentally benign and sustainable alternative to mass tourism, and a potentially lucrative industry, have developed institutions and programs to attract ecotourists. In many Latin American and Caribbean countries, newly passed legislation encourages investment in ecotourism infrastructure [6]. Besides increasing foreign exchange earnings, tourism generates employment and attracts capital for infrastructure development; through this and other “multiplier effects” it can contribute to economic diversification as well as growth [6,15].

Some parks in Thailand generate income that totals 3 to 10 times the cost of park management [12]. Most tourism income does not become available for conservation, however, as it accrues to private sector service providers (e.g., hoteliers). Still, that income can influence politicians to provide larger budgets and increased political protection for parks. At numerous tropical parks, NGOs are experimenting with ways to make ecotourism benefits accrue to local people. AID is sponsoring such efforts in Costa Rica, Indonesia, and other countries.



Photo credit: Alison L. Hess, Office of Technology Assessment

Tourism revenues may provide economic justification for protection of species and habitats. The Kenyan “visitor attraction value” of a single lion has been estimated at \$27,000/year; that of a herd of elephants at \$81 0,000/year [25].

Despite sparse data, conservationists and economic planners are finding that ecotourism and the revenues it generates, can, in fact, provide an economic rationale for natural resource conservation and wildlife protection policies [49]. This rationale may be the only broadly accepted means of counter-ing efforts to develop these resources for near-term profits—that is, “economic value must be assigned to ecological resources if these are to be conserved” [10]. Further, ecotourism can be an important part of a more comprehensive conservation and development strategy by “helping to build a constituency necessary for effective policy and action” [23]. As first-hand contacts with a wild area and its inhabitants increase, so grows the group of advocates for its protection.

Conversely, tourism may deprive indigenous people access to the resource areas they traditionally have used for hunting, fishing, and foraging [15], potentially driving them farther into vulnerable

ecosystems or into resource-degrading employment. Tourism also is an unstable source of income, subject to widely fluctuating demand scenarios; local economies that rely heavily on tourist dollars can be severely disrupted by a sudden decline in tourist arrivals. More radically, certain terrorist groups have harassed or killed tourists in an effort to destabilize government regimes in countries highly dependent on ecotourism revenues. This has happened, for example, in Kenya, Papua New Guinea, and Peru [43]. Decline in tourism revenues for any of these reasons eventually is likely to reduce the protection afforded to habitats and species.

NEW POLICIES AND PROGRAMS

New information, new concerns, and experimental approaches are surfacing in international efforts to sustain tropical forests and biodiversity. Proposals range from reorienting research, to sweeping changes in international organizations and new, widescale international agreements. Some of the more immediate and far-reaching of these proposals follow.

Endangered Species and Endangered Ecosystems

The 1973 Endangered Species Act (ESA) established a regulatory program specifically designed to protect U.S. species from extinction. Under ESA, species are listed as endangered or threatened solely on the basis of their population and range trends. The act restrains Federal agencies from funding, authorizing, or carrying out any activity that may imperil a species officially listed as endangered and prohibits all citizens from harming, killing, or uprooting such species on public or private kind. Finally, ESA requires the Fish and Wildlife Service or National Marine Fisheries Service, as appropriate, to develop and implement recovery plans for species in danger of extinction. Despite four congressional amendments, ESA has not lost its reputation as the United States' most powerful and rigorous piece of environmental legislation.

ESA comes before Congress for reauthorization in 1992, and undoubtedly will be the focal point for heated debate. Listing of the northern spotted owl, native to old-growth forests in the Pacific Northwest, and subsequent restrictions on logging those forests, has spurred intense debate over regulatory demands affecting land use and property rights. A

coalition of agricultural, mining, forest products, and other industrial interest groups is devoting its attention to reducing ESA's power over land-use decisions.

Since 1973, at least 550 species of animals and plants have been listed as endangered or threatened—of these, six are considered recovered and at least seven have been declared extinct [33]. Six-hundred other species are considered endangered, but are not yet formally listed as such. At current staff and funding levels, the Department of Interior's Inspector General estimates it will take 38 to 48 years to move these species through the listing process [61]; another 3,500 species suspected of endangerment but awaiting analysis will not be dealt with for decades. Consequently, numerous conservation biologists and some members of Congress are advocating an ecosystem protection approach that would protect regionally dispersed, ecologically representative communities of species,

The most far-reaching of these proposals is to develop an "Integrated National Biodiversity Policy" within which ESA would function as a "law of last resort" [39]. Another proposal is to devise a national biodiversity strategy based on representative ecosystems and subsequently to establish a National Center for Biological Diversity [33]. A counterproposal is to require that the values of continuing a species' existence be compared to the economic values of the activities that endanger it, and thereby determine a winner.

Forestry Research

Forestry, agroforestry, and related environmental issues are being incorporated in the mandate of the Consultative Group for International Agricultural Research (CGIAR), the major network of research institutions funded by bilateral and multilateral donors to support development in tropical regions. The International Center for Research in Agroforestry and one other tropical forestry research institution not yet identified will be brought into the system. A new strategic agenda for forestry research will be shared by these 2 institutions and 10 other CGIAR centers that include forestry projects in their research programs. Other progress in forestry research includes establishment of a Special Program for Developing Countries within the International Union for Forestry Research Organizations, and international donor support to the forestry research



Photo credit: Alison L. Hess, Office of Technology Assessment

Forestry and agroforestry have been incorporated in the mandate of the major network of international agricultural research institutions with the addition of the International Center for Research in Agroforestry in Nairobi, Kenya, and one other institution not yet identified.

capacity of national agencies in the developing countries.

It is likely that much of this new activity will continue the pattern of tropical forestry research conducted over the past 30 years, which has been to downplay natural forest management and to focus instead on forest plantations and, more recently, on agroforestry. Several systems for management of natural tropical forests were developed between 1900 to 1960, but little has occurred since then. Meanwhile, research and technology development for tropical forest plantations have achieved wood yields that are now about 10 times the yields from natural forests. High yielding plantations often are mentioned as a means to offset pressure on natural forests. However, this claim is dubious, because forest plantation establishment commonly begins with razing a natural forest [36].

Existing natural forest management systems were developed at least 30 years ago, and only piecemeal information has been gathered on natural forests since then. Several systems are thought to be sustainable, but implementation and monitoring to confirm this is lacking. The comprehensive review of tropical forest management commissioned by the International Tropical Timber Organization (ITTO) states that:

...it is not yet possible to demonstrate conclusively that any natural tropical forest anywhere has been successfully managed for the sustainable production of timber [36].

Existing systems, if rigorously followed, produce low yields of high-value timber over very long rotations. Low yields and low economic returns may be one reason why only about 800,000 hectares of tropical moist forest is being deliberately managed for sustainable production of timber (0.1 percent of tropical moist forest in ITTO countries), whereas about 40 million hectares have been designated as protected areas where timber production is excluded [36].

Multilateral Development Bank Policies

The pace of multilateral bank lending and the nature of bank-sponsored forestry projects have changed dramatically since 1980. Most forestry lending until the 1970s was for extraction of raw materials and development of wood-based industries. World Bank projects in the 1970s reflected the Bank's broadening social goals; many forestry projects were oriented to tree planting for rural development and other longer term purposes. The World Bank's 1978 policy paper articulated the link between social needs and forestry development and became an important model for policy at other multilateral banks. The pace of project startups accelerated in the 1980s, with a larger share of the projects aimed at reforestation, farm forestry, watershed protection, and similar social and environmental purposes (see table 1). Forestry at other multilateral banks evolved similarly: few loans now are made for direct support of wood industries, but many are made to establish plantations. The banks have begun in the past 2 years to develop projects with explicit biodiversity conservation objectives.

Some agriculture and infrastructure development projects financed by the banks have caused destruction of tropical forests and other natural habitat for

Table I—Number of Forestry Projects Financed (Initiated) by the World Bank by Time Period and Type of Project

Period	Type of Forestry Project		
	Industrial	Social	Environmental
1949 -1969	6	0	0
1970 -1979	18	6	0
1980 -1985	11	16	4
1986 -1990	10	15	7

SOURCE: World Bank Environment Department, *Forest Policy Paper* (Washington DC: World Bank, 1991).

biodiversity. Largely because of congressional insistence, development banks have implemented environmental impact assessment procedures that should help to avoid such damage in future projects. Most recently, the U.S. executive directors of all multi-lateral banks have been directed by Congress not to vote in favor of any action that:

. . . would have a significant impact on the environment, unless a summary of the environmental impact of the action has been made available to the director 120 days prior to the vote. Each director, in turn, has the responsibility to make that information available to the public [32].

The effect of these new directives for environmental impact assessment of development bank projects bears monitoring; implementation of these procedures is just beginning, and the motivation for this reform of bank practices has been mainly external.

The World Bank's new Forest Policy Paper [67] heralds continued evolution in the nature of the forestry projects. Effects on forests and biodiversity will apparently be given increased consideration when the Bank undertakes interventions outside of the forestry sector. Within the forestry sector, Bank interventions will emphasize policy reform and institutional strengthening to support forest and biodiversity conservation. The Bank plans to give increased support to international programs, such as the Global Environment Facility,² that provide grants or low-interest financing for biodiversity projects. The Bank's forest plantation projects will avoid razing natural forests or usurping farmland. The new policy paper makes a strong commitment

to buffer-zone development, support for parks and reserves, and rigorous environmental impact assessment. Political pressure on the World Bank to commit itself to conservation-oriented forestry has come from the U.S. Congress and, more recently, from the governments of Germany and other European nations. The Asian Development Bank has adopted similar policies, focusing much of its forestry lending on reforestation and social forestry programs.

International Tropical Timber Trade

International organizations concerned with tropical forests and biodiversity commonly focus on establishment and management of protected areas. Many tropical country forestry departments and research organizations concentrate development efforts on forest plantations. ITTO, however, is the one international organization that concentrates on trade and commodities coming from all forests in tropical nations.

The main outcome of the International Tropical Timber Agreement, which became effective in 1985, was a framework for cooperation between nations that produce tropical timber and those that import it. The agreement set up the International Tropical Timber Organization. ITTO has objectives typical of a commodity trade group (e.g., regulation of prices and supplies), but a growing focus of its activities has been analyzing the sustainability of tropical forest use and promoting policy and program changes that would extend sustainable forest management and would develop technical improvements in management systems. Unlike other commodity organizations, meetings to set ITTO policy include representatives from conservation organizations and academia in addition to government and industry representatives.

ITTO's producer members control roughly 70 percent of the world's tropical moist forests [36]. The organization commissioned a major review of forest management for timber production in its member nations, and concluded that the conditions necessary for successful management to sustain production forests are:

² The Global Environment Facility (GEF) is operated by the World Bank on behalf of its founders, the U.N. Development Programme and U.N. Environment Programme. GEF is expected to provide "several hundred million dollars" for biodiversity research and protection over the next 3 years [27].

- government resolve;
- a sound political and social case for the decision to maintain a permanent forest estate;
- long-term security for the forest estate, once chosen;
- stable markets for forest products;
- adequate information for selection, planning, and management of the forest estate;
- flexible, predictive systems for planning and control;
- the resources needed for control; and
- the will needed by all concerned for effective control [36].

International Environmental Security

Since the 1980s, the concept of environmental or ecological security, based on the premise that threats to the environment are as serious to human quality of life as military threats [16], has been the focus of considerable discussion related to international environmental law. In a 1989 letter to the United Nations, international ecological security was described as:

[A] state of affairs in international relations within which a system of . . . broad co-operation on the basis of international law will safeguard preservation of the environment and improvement of its quality with a view to creating appropriate conditions for a life worthy of human beings and securing sustainable and safe development of all States [44].

An international legal basis for establishing environmental security as a guiding principle was established in the World Charter for Nature [53]. This document states that:

. . . nature shall be respected and its essential processes . . . not . . . impaired [Article 1]; living resources shall not be utilized in excess of their natural capacity for regeneration, the productivity of soils shall be maintained or enhanced, [and] non-renewable resources . . . shall be exploited with restraint [Article X; and] nature shall be secured against degradation caused by warfare or other hostile activities [Article V; and] military activities damaging to nature shall be avoided [Article XX] [66].

Recognition of international environmental security as a guiding concept for intergovernmental relations, however, likely would require codification of international environmental laws. One framework for codification would be to establish two primary categories of environmental management problems.

1. Problems associated with *protection* of the environment: a) avoidance of vandalism (war-time or other non-remunerative destruction); b) avoidance of pollution (of air, water, or soil) that is in excess of the natural renewal or cleansing processes; and c) avoidance of permanent anthropogenic intrusion in specially designated protected areas; and
2. Problems associated with *utilization* of the environment: a) avoidance of resource use rates that exceed estimated maximum sustained yield or maximum sustained absorption; and b) avoidance of resource use at rates that will prevent recovery of degraded environments (and potentially provision of human assistance to aid that recovery) [66].

Creation of such a state of affairs would require the “espousal of obligatory principles and norms of conduct for governments” [50] and, thus, likely would require reconsideration of the realms of national sovereignty and international cooperation. Because of the acknowledged “globalization” in areas such as production, trade, investment, communications, and tourism, this type of redefinition already is occurring [40]:

In many crucial respects, nations are no longer the sole masters of their destinies. . . . What happens in practically any part of the world can affect remote areas elsewhere. This interdependence in economic, military, and environmental affairs has already begun to erode traditional notions of security and even national sovereignty itself.

Regional and international mechanisms to progress toward international environmental security already exist, and have shown progress towards international environmental accords. Regional mechanisms take such forms as multilateral and bilateral agreements, international commissions, or licensing arrangements. One prominent example is the United Nations Regional Seas Program, which brokers agreements among countries sharing ocean basins such as the Mediterranean and Caribbean Seas (e.g., Convention on Land-Based Sources of Pollution in the Caribbean).

International mechanisms are likely to be conventions, agreements, charters, or guiding principles promulgated by such institutions as the United Nations and the former Warsaw Treaty Organization. International legal principles address and define international environmental problems and

solutions; international agreements legally bind parties, creating rights and obligations concerning the regulated resources [42].³ Such efforts already have brought us the World Charter for Nature, the Convention on Trade in Endangered Species, and the unfinished Convention on the Law of the Sea. The latter exemplifies the difficulties in reaching such accords. Further, international organizations that deal with environmental issues commonly lack the capability, or the authority, to ensure adherence with international agreements [44]. For example, the Governing Council of the United Nations Environment Programme (UNEP) has only the powers of recommendation, and not of enforcement. Proposals to remedy this range from enhancing development of regional environmental agreements and organizations [66], to strengthening coordination of environmental concerns at the United Nations and directing UNEP to spearhead codification of international environmental law, to establishing a U.N. Environmental Security Council (requiring amendment of the U.N. Charter) [44].

Expanding International Environmental Accord

The arena for current negotiations on international law related to biodiversity, climate change, and tropical forests is the United Nations Conference on Environment and Development (UNCED or 'Earth Summit' to be held in Rio de Janeiro, Brazil in June 1992. Government negotiators representing developed and developing countries have been meeting for over a year to determine the content and wording of new international charters, statements of principles, and agreements. In addition, and unlike previous international environmental summits, nongovernmental organizations have played a significant role in preparation of documents and introduction of issues into negotiations. The negotiations have been fraught with controversy, largely over "North-South" responsibility for financing conservation efforts [cf:35]; the United States' position currently is unclear.

The UNCED Intergovernmental Negotiating Committee (INC) on Biodiversity is working toward reaching an agreement that would be signed at the June 1992 "Earth Summit." Topics of particular concern to the negotiating parties are financing of biodiversity conservation in developing countries,



Photo credit: A. Fullerton, USDA Forest Service

The search for medicines from plant and animal sources is most cost-effective when scientists focus on traditional medicines, such as those sold by traditional medicine vendors in China. With the surge in "chemical prospecting," however, UNCED negotiators have faced increasing controversy surrounding access to genetic materials, product patenting and distribution of royalties, and "intellectual property rights."

biotechnology and intellectual property rights, and the potential for a sweeping international treaty to "interfere with individual nations' authority to manage resources or protect domestic biodiversity. The INC on Climate Change also has faced considerable controversy about provision of "new and additional" resources to assist developing countries to meet the objectives of the treaty, which specifies targets and timetables for reduction in carbon dioxide and other greenhouse gases.

A nonbinding statement of "Principles on World Forests" is in preparation for UNCED, but is not presently under negotiation in the form of an international agreement. Instead, it is one component of Agenda 21, an overall environment and development agenda for the future. Still, negotiations on world forest principles have led to agreement on some basic points, that may in the future become the basis for a legally binding convention. As currently agreed, the principles should:

- cover all types of forests;
- establish sustainable management as the goal of forest management;

³In the absence of international agreements, global resource regulation is based on the rules and principles of international customary law.

- identify “social, ecological, cultural and spiritual needs, as well as economic” goals of management;
- strengthen national-level forest management institutions;
- recognize the value of environmental services of forests, including protecting biodiversity and regulating watersheds and water resources;
- respect sustainable use by “forest dwellers, indigenous peoples, and local communities;
- foster forest management plans based on complete cost and benefit accounting; and encourage development of an international economic climate that supports sustainable forest development in all countries [47].

Discussion of a Forest Convention is expected to be reopened, likely during the 1992 renegotiation of the International Tropical Timber Agreement, potentially leading to a single international legal instrument on forests [20].

Partly in preparation for development of the UNCED Principles on World Forests, the Tenth World Forestry Congress, involving forestry decision-

makers from 136 countries, passed The Paris Declaration (box B) and produced a set of detailed conclusions and recommendations [51]. The principles stated in the Paris Declaration are intended to contribute to the debate leading to UNCED and beyond.

CONCLUSIONS

Significant progress has been made in mobilizing international assistance finding and in coordinating and focusing international conservation efforts in the years since OTA assessed technologies to maintain biological diversity and to sustain tropical forest resources. The stage for forest conservation is being set at high government levels with development of national action plans that set new priorities and call for new programs, institutional development, and major policy reforms. Conservationists behind the planning process are learning to develop necessary links to policies and programs in other sectors, such as population, agriculture, and rural development.

Box B—Excerpts From the Paris Declaration

The Tenth World Forestry Congress, having assembled more than 2,500 participants from 136 countries from 17 to 26 September 1991;

addressees] the public, political leaders and international, intergovernmental and non-governmental organizations throughout the world

reminds them

- of the importance of the renewable goods and services provided by trees and forests in the face of growing demand for construction materials, fuel, animals, food, fodder, recreation areas. . . ;
- of the wealth and diversity of forest environments, and of their positive role in water and carbon cycles, soil protection and the conservation of biodiversity;
- . of the availability, too often ignored, of techniques for the sustainable management of trees and forests, which can ensure their permanence and even increase their capacity for providing goods and services;
- . that it is essential to avoid irreversible damage to the biosphere; and
- . of the advantages of long-term planning in the management of natural resources;

asserts

- . that the real challenge is to reconcile the economic use of natural resources with protection of the environment through integrated and sustainable development;
- that the solution of forest problems requires common efforts to reduce poverty; increase agricultural productivity; guarantee food security and energy supplies; and promote development;
- that forest management plans can be used as comprehensive tool for managing the economic, ecological, social and cultural functions of the resource, thus enlarging the concept of sustain yield;
- that the preservation of specific forest areas in order to protect biodiversity constitutes a particular objective of forest management policy;

(Continued on next page)

Box B—Excerpts From the Paris Declaration-(Continued)

and recommends

- that all people be involved in the integrated development of their region, and that they be provided with the institutional technical and financial means to do so;
- that land-management planning be based on the land's potential and on long-term priorities in order to determine sites that are best suited to be forest@ and that the needs of all people concern~ particularly those who depend on forests for their livelihood should be carefully taken into consideration at the planning stage;
- that the continuity of tree and forest management policies be guarant~ given the need to manage forests on a long-term basis;
- that the designation of certain representative or endangered forests as protected zones continue, and that these areas be integrated into national or international networks;
- that appropriate silvicultural techniques, the extension of woodlands and the long-term use of wood be used to contribute to the absorption of atmospheric carbon dioxide;
- that agroforestry systems, afforestation and reforestation be developed more actively.

The Tenth World Forestry Congress aware of the seriousness, the urgency and the universality of development and environmental problems; emphasizing the renewable nature of forest resources and convinced of the soundness of solutions afforded by sustainable management of all the world's forests, within the context of national forestry policies,

solemnly calls upon decision-makers to:

- *commit* themselves to the "Greening of the World" through afforestation, reforestation and sustainable management of the multiple functions of trees and forests; and to actions in the form of integrated programming, involving the participation of all people concerned, in the context of national land management policies;
- assess developments in the forest heritage at a national and international level, drawing on the global Forest Resources Assessment 1990 Project carried out by FAO;
- limit all emissions of pollutants that damage forests;
- *contain* emissions of greenhouse gases, including those produced by power generation;
- adapt economic and financial mechanisms to the long-term approach required for forest management, and *increase* national and international financial provisions, particularly in favour of developing countries;
- *work* toward the harmonious development of international trade in forest products through the prohibition of any unilateral restriction that is inconsistent with GAIT; and promote the utilization of forest products;
- develop cooperative initiatives at the political level and on clearly identified forestry issues of regional importance, such as the fight against desertification the protection of forests, the management of major watersheds, etc.;
- *strengthen and coordinate* research and field trials, training and the exchange of information, as well as cooperation in all disciplines that contribute to sustainable management of forest ecosystems;
- *strengthen the activities* of and coordination among the relevant international organizations;
- *integrate its* conclusions and recommendations into the planning process of the United Nations Conference on Environment and Development (UNCED), to be held in Rio de Janeiro in 1992, in order to define a non-legally authoritative statement of principles for a global consensus on the management, conservation and sustainable development of all types of forests;

and, in the context of the current negotiations on biodiversity and climate change being conducted under the auspices of the United Nations;

- *strengthen* international cooperation, particularly in the context of the Tropical Forestry Action Programme (TFAP), of a Mediterranean FAP and of other future programmes;
- *raise* awareness of the public, and more particularly of young generations, and disseminate information on forest issues so they will be better appreciated by all people;
- *envisage* ways of following up its recommendations and invite FAO to advise the appropriate intergovernmental bodies and the Eleventh World Forest Congress of them.

SOURCE: *Unasylva*, "Tenth World Forestry Congress—Dossier," vol. 43, No. 1, Winter 1992, pp. 3-9.