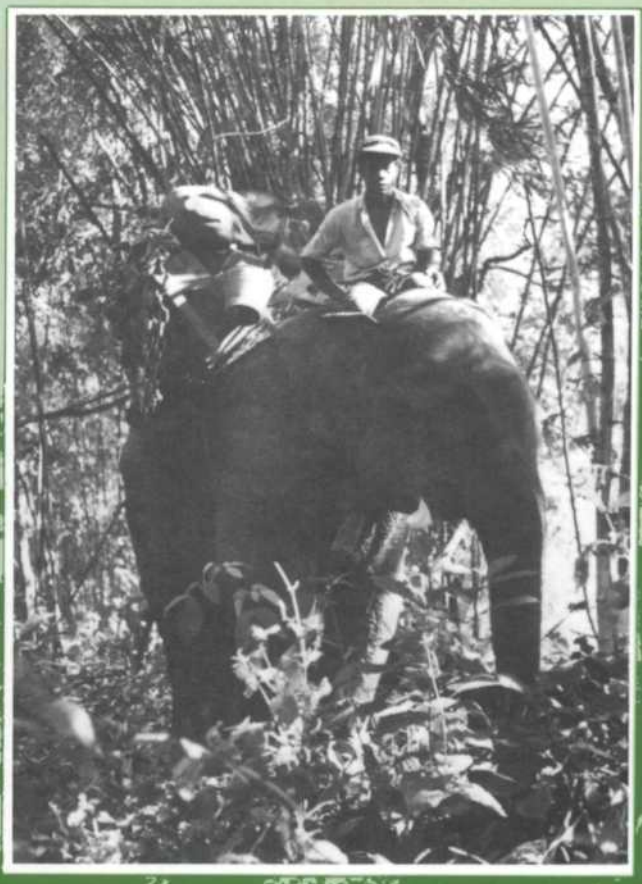
The IUCN Forest Conservation Programme

The Management of Tropical Moist Forest Lands

Ecological Guidelines

Second Edition

DUNCAN POORE and JEFFREY SAYER



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IUCN – THE WORLD CONSERVATION UNION

Founded in 1948, IUCN - the World Conservation Union - is a membership organisation comprising governments, non-governmental organisations (NGOs), research institutions, and conservation agencies in over 100 countries. The Union's objective is to promote and encourage the protection and sustainable utilisation of living resources.

Several thousand scientists and experts from all continents form part of a network supporting the work of its six Commissions: threatened species, protected areas, ecology, strategy and planning, environmental law, and education and communication. Its thematic programmes include forest conservation, wetlands, marine ecosystems, plants, the Sahel, Antarctica, and population and sustainable development. These activities enable IUCN and its members to develop sound policies and programmes for the conservation of biological diversity and sustainable development of natural resources.

THE IUCN COMMISSION ON ECOLOGY

The IUCN Commission on Ecology (COE) serves as the Union's source of technical advice for translating knowledge of ecological processes into practical action for conservation, sustainable management and restoration, in particular of areas degraded by human action. The IUCN programmes on Forest Conservation, Marine Conservation, and Wetlands are under the umbrella of the Commission on Ecology. Commission members serve on advisory committees and in working groups associated with these programmes.

THE IUCN FOREST CONSERVATION PROGRAMME

The IUCN Forest Conservation Programme (formerly the IUCN Tropical Forest Programme) coordinates and reinforces activities of the IUCN members and Secretariat which deal with forests. The Programme focuses on the conservation of species and ecological processes, and on investigating and promoting sustainable use of the resources of these forests.

The Programme includes international and national policy initiatives and strategies as well as field projects addressing selected problems in managing the world's most biologically significant tropical forests. These selected projects put the World Conservation Strategy into action by reconciling the requirements of conservation with national development and the needs of people living in forest areas. Special emphasis is given to the development of compatible uses for buffer zones around national parks and reserves.

IUCN develops its positions and policies on the basis of the concerns and information communicated by members, trends identified by monitoring activities, and the feedback from numerous field projects. Data on species of plants and animals, and on forest sites which are important for biological and ecosystem conservation, are held by the World Conservation Monitoring Centre in Cambridge, UK.

This series of publications from the Forest Conservation Programme, in conjunction with regular meetings, enables IUCN to communicate policies and technical guidance to governments, major international institutions, development planners, and conservation professionals. The Programme works closely with development assistance agencies, governments and NGOs, to ensure that conservation priorities are adequately addressed in their activities.

The Forest Conservation Programme receives generous financial support from the Government of Sweden.

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by

Duncan Poore and Jeffrey Sayer

IUCN - The World Conservation Union

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PREFACE

The original IUCN "guidelines" for the management of moist tropical forest lands arose as the result of workshops held in Caracas, Venezuela in February, 1974 and in Bandung, Indonesia in May and June of the same year. A third workshop, in tropical Africa, was planned but, unfortunately, never took place. The workshops were designed by the then Director-General of IUCN, Dr Gerardo Budowski, the Deputy-Director, Mr Frank Nicholls and by Dr Ray Dasmann, whose book, written in collaboration with John Milton and Peter Freeman, *Ecological Principles for Economic Development* blazed the trail for ecologically sustainable development. After the Caracas workshop, Dr Duncan Poore elaborated a text which was then the subject of detailed discussion and refinement at the Bandung workshop. The final text was completed in 1976, incorporating many helpful comments from Dr Hans Steinlin of FAO and from the MAB team of Unesco.

Seven years later, in 1983, IUCN embarked upon a major programme to strengthen its activities in the field of tropical forest conservation. The guidelines provided the intellectual underpinning and rationale for this programme. In the mid-1980s, however, the advent of the Tropical Forestry Action Plan (TFAP), the International Tropical Timber Agreement (ITTA) and a host of other initiatives aimed at conserving tropical forest resources made it necessary to bring the guidelines and IUCN's policies on tropical forests up to date. *The Management of Tropical Moist Forest Lands: Ecological Guidelines* was published in 1987 and consisted essentially of an updating and rationalisation of the 1976 publication.

The 1987 version of the Guidelines has now been out of print for over two years and numerous requests for copies are still reaching us. We have taken advantage of the reprinting to revise the Guidelines in the light of recent developments and changes of perception. The main changes relate to the issues raised by the evolving TFAP, the work of the International Tropical Timber Organization (ITTO), by new information and ideas about species extinction and deforestation rates and a more critical examination of the timber industry.

Some of the guidelines found in this publication may appear self-evident to those who have been closely involved with the tropical forest debate over the years. It is, however, a matter of considerable concern that, since the tropical deforestation issue has moved into the public arena and has become the subject of attention of political and lobbying groups, there has been a tendency to lose sight of some basic principles. There is a serious danger that well-intentioned but poorly conceived media-driven campaigns will result in the resources available for tropical forest conservation being dissipated on programmes which are inefficient or even counter-productive. We hope that the basic principles and information presented in these Guidelines will help to focus the public debate on those fundamental questions upon whose understanding the future of tropical forests depends.

Duncan Poore, Glenmoriston, Scotland
Jeffrey Sayer, Gland, Switzerland

March, 1991

ACKNOWLEDGEMENTS

Many people have contributed ideas and information to this book. Its contents have been the subject of discussion at numerous IUCN meetings; particularly the meetings of the Tropical Forest Advisory Group. The latter is drawn from IUCN's volunteer network and from representatives of our collaborating organisations. A number of people have made valuable contributions to the text, they include Gerardo Budowski, Steven Bass, Mark Carwardine, Mark Collins, Martin Holdgate, Paul Driver, Stephanie Flanders, Alejandro Imbach, Jose' Flores Rodas, Jeffrey McNeely, Kenton Miller, Jacqueline Sawyer and Tim Whitmore. Our thanks go to all of these people.

INTRODUCTION

WHY THESE GUIDELINES HAVE BEEN PRODUCED

In 1976 IUCN, in collaboration with UNEP, FAO and WWF produced *Ecological Guidelines for Development in Tropical Rain Forests.* At that time it was felt that failure to pay adequate attention to fundamental ecological principles was resulting in forms of development which were unsustainable and were depleting a vitally important natural resource.

The fifteen years that have elapsed since then have seen no easing of the rate at which tropical forests are degraded or transformed to other, often less sustainable, uses. There has, on the other hand, been a considerable growth in our knowledge and understanding of tropical ecosystems and of the causes, and effects, of their degradation and destruction. As a result, there is now much greater awareness at the political level of the serious consequences for human development if these destructive trends are allowed to continue.

Many of the ideas from the 1976 Guidelines and similar IUCN publication dealing with the coast, islands and arid zones, blossomed in 1980 into a comprehensive, reasoned and rational strategy, the *World Conservation Strategy.* For ten years now this has provided the guiding philosophy for IUCN's work. The Strategy made a compelling case for the interdependence of conservation and development, for the need to preserve biological diversity and maintain ecological processes, and to use living natural resources sustainably. It singled out tropical forests as being of special concern. The philosophy of the *World Conservation Strategy* has now become accepted almost universally, and the debate is now concerned less with **what** ought to be done rather than **how** can it be done and what is the best balance between its various objectives.

Since 1980 there have been many other developments: the emergence of the Tropical Forestry Action Plan (TFAP); the negotiation of the International Tropical Timber Agreement (ITTA); changing priorities in the World Bank, in the other international development banks and in bilateral aid; and a much enhanced awareness of the importance and urgency of the issue among the world's political leaders. The latter was signalled by the report of the World Commission on Environment and Development (WCED) and statements by Heads of Government, such as those of the Commonwealth (the Lankawi Declaration) and of the "G7", the nations with the most powerful economies in today's world.

RECENT DEVELOPMENT AFFECTING TROPICAL FOREST CONSERVATION

Since 1980 there has been a great deal of activity on the tropical forest front.

A very significant event was the publication by FAO in 1981 of the report of the Tropical Forest Resource Assessment Project, which gave, for the first time, a reasonably complete and well documented report of the present status of tropical forests and estimates of the rate of deforestation.

Although it was widely recognised that the figures it gave were often best estimates based on very scanty evidence, the report did indicate that, whatever further information might emerge, the tropical forest resource was being depleted at a rate which should give rise to great concern; and that there was a great need for the international community to do something about it.

There were two significant convergent reactions to this report. In 1983 the FAO Committee on Forestry Development in the Tropics (CFDT) instructed FAO to prepare a plan of action for tropical forestry. At much the same time, the World Resources Institute (WRI) organised a Conference on the Global Possible which recommended, among many other actions, that a strong initiative should be taken to slow down or reverse tropical deforestation. As a result the WRI, with the support of the World Bank and the United Nations Development Programme took up the challenge. Their report, "Tropical Forests - A Call for Action", to the preparation of which IUCN contributed, was released together with the FAO Tropical Forestry Action Plan at the World Forestry Congress in Mexico City in June 1985. Both recommended a doubling of international investment in tropical forestry and selected five fields as in special need of support. These were: forestry in land use; forest-based industrial development, fuelwood and energy; conservation of tropical forest ecosystems and institutional strengthening.

At this stage there were already certain concerns that the programme was too firmly based in the forestry sector, that it placed too much stress on the power of external finance and that it failed to recognise the role of NGOs. Nevertheless it produced valuable results, not principally through being a "plan" in any formal sense, but through providing a mechanism. In the next few years, in spite of a number of deficiencies, it brought tropical forestry into the middle of the international forum, it increased investment, it provided a means for countries to review their internal priorities against a wider canvas and it offered a mechanism for the coordination of the aid initiatives of the multilateral and bilateral donors.

In 1986 the World Bank issued its operational policy on "Wildlands, their protection and management in economic development", the world's major development assistance institution thereby recognised the need to invest in preventing the depletion of the resources of natural areas, and particularly their biological diversity and ecological processes. Tropical moist forests were once more singled out for special attention. In the years that have followed the World Bank has greatly strengthened its ability to deal with environmental issues. Conservation specialists now, as a matter of routine, are asked to join Bank project preparation and appraisal missions, and the conservation of natural resources is increasingly seen as a major operational objective of Bank lending. This pattern is being repeated in the African, Asian and Inter-American Development Banks. In 1991 the Bank has been given the responsibility of administering the Global Environment Facility, a very substantial fund, one of the four aims of which is the conservation of biological diversity. A new World Bank Forest Policy is now nearing completion. This will give far greater prominence than previous Bank policies to the conservation of areas of natural forest and for the need to avoid development projects which cannot be guaranteed to lead to sustainable use of forest resources.

During 1986 and 1987 the fate of tropical forests was elevated to the highest levels of political concern. President Mitterand of France convened the "Silva" meeting of heads of state and ministers to stimulate international action for better management of forest resources in the tropics. Twenty seven world leaders met at the Rockefeller conference center in Bellagio, Italy, to promote further international action on tropical forests and particularly the TFAP. Tropical forests have figured in the agenda of the "G7" economic summits which bring together the heads of government of the world's seven most powerful economies. It was a major concern of the last meeting of the Heads of the Commonwealth in Malaysia and was embodied in their Langkawi Declaration. Public concern for the rain forests in northern Queensland is thought to have been a decisive factor in influencing the results of recent Commonwealth elections in Australia.

The level of political awareness of the issue is also exemplified by the prominence given to tropical deforestation in the report of the World Commission on Environment and Development (WCED), in April 1987. The WCED was convened by the United Nations General Assembly to examine environment and development issues. The Commission was composed of leading economists, politicians, scientists and development planners and it based its report on a series of public hearings held throughout the industrialised and developing world. It provides a major endorsement of the philosophy of the World Conservation Strategy and of the Tropical Forestry Action Plan. It reflects the belief that conservation can only occur if the basic needs of poor people in the third world are met by development and that development can only be sustainable if the life support systems upon which it depends are conserved. The WCED report repeatedly stresses the importance of tropical forests for the conservation of biological diversity and ecological processes.

A parallel movement which mirrors this concern had its origins in the timber trade and is now centred in the International Tropical Timber Organization (ITTO). Negotiations for an international agreement to regulate and rationalise the trade in tropical timber began in the last 1970s under the aegis of the United Nations Commission on Trade and Development (UNCTAD). An agreement (the International Tropical Timber Agreement) was drafted in 1983 and came into effect in 1985.

ITTO is in origin a commodity agreement. It has 47 members, 22 from timber producing countries and 25 from consumers. Decisions are taken according to a complex voting formula in which producers and consumers vote separately and their voting power is related to their share of the world timber market and the extent of their forest resources.

The ITlA is unique among commodity agreements in that it includes a provision for the conservation and management of the resource upon which the trade is based. The ITTO has already undertaken several landmark studies on fundamental resource conservation issues. These include the extent to which sustainable forest management for timber is practised anywhere in the tropics, the development of guidelines for sustainable forest management, a study of the way in which incentives could encourage sustainable management, the status of rare timber in trade and the sustainability of the timber industry in Sarawak. Its importance is as a political forum in which the mutual interests of the producer and consumer countries in sustainable timber production can be pursued. ITTO has now set the year 2000 as its target date by which all timber entering the international trade should come from sustainably managed forests. This is taking place against the background of increasing consumer pressure to discourage the purchase of timbers which do not come from a demonstrably sustainable source.

During the last few years there has being growing political concern about global climatic change. There is evidence that deforestation may contribute between 7 and 20 per cent to the total world emission of greenhouse gases and, on the other hand, it is recognised that increasing the standing volume of woody biomass is one known way of withdrawing carbon from the atmosphere. This has added another element to the movement to reverse the trends of tropical deforestation.

The culmination of a decade of growing concern for environmental conservation will be the United Nations sponsored World Conference on Environment and Development which will take place in Brazil in 1992. Tropical forests will be a major issue at that conference. There are already proposals for three international instruments affecting tropical forest: a general Biodiversity Convention, a global forest agreement and a forest protocol to a proposed World Climate Convention.

The WCED report, for example, repeatedly stresses the importance of tropical forests for the conservation of biological diversity and ecological processes:

> *"The link between conservation and development and the need to attack the problem at the source can be seen clearly in the case of tropical forests. Sometimes it is government policy, not economic necessity that drives the overexploitation and destruction of these resources. The direct economic and fiscal costs of this over-exploitation - in addition to those of species extinction - are huge. The result has been wasteful exploitation of tropical forests, the sacrifice of most of their timber and non-timber values, enormous losses of potential revenue to the government, and the destruction of rich biological resources ..."*

> *"Third world governments can stem the destruction of tropical forests and other reservoirs of biological diversity while achieving economic goals. They can conserve valuable species and habitat while reducing their economic and fiscal burdens. Reforming forest revenue systems and concession terms could raise millions of dollars of additional revenues, promote more efficient, long term forest*

> *resource use, and curtail deforestation. Governments could save themselves enormous expense and revenue loss, promote more sustainable land uses, and slow down the destruction of tropical forests by eliminating incentives for livestock ranching."* (WCED, 1987).

In fact, the guidelines produced by IUCN in 1976 had already anticipated many of the issues (and solutions) which have now been given prominence by these later developments. But much is new, both in our knowledge of the extent and functioning of the forests and of the processes determining their future. The guidelines have therefore been thoroughly revised to encompass our increased knowledge and understanding. They now represent IUCN's vision of the future of tropical forest lands, the methods to be followed and the constraints to be considered in turning the idea of conservation with development into a reality for the tropical forest regions of the world.

WHY TROPICAL MOIST FORESTS ARE VALUABLE [1]

The values of tropical moist forests reside in the goods and services they provide if the forests remain as forest. But, there is one exception; the value of the mature soils that have developed under forest cover can also be realised by converting the forest into land for productive, sustainable agriculture. Wherever there is a real need for land to grow food, there is likely to be great pressure to convert forest for this purpose.

A well-managed tropical forest is a constantly self-renewing resource. It produces many benefits. Among these are timbers, including many of high quality; rattan and rubber, wood for domestic use and fuelwood; fruits, nuts, spices and other foods; and numerous other products of high economic value, such as dyes, cosmetics and medicines. These multiple products can sustain the basic needs of local communities as well as providing goods for wider markets and services for the whole country.

The tropical forest contains some of the world's oldest and richest ecosystems, containing more than fifty per cent of all species of plants and animals on some six per cent of the world's surface area. Even with existing knowledge (which is certainly very incomplete) about 15,000 different plants support some kind of non-timber use. Many have medicinal uses (to manufacture drugs for malaria, leukaemia, amoebic dysentery etc) or are being screened for potential use against cancer and AIDS; others are the wild relatives of many important food crops and are therefore essential for breeding disease resistance and other improvements into vulnerable plantations of coffee, cocoa, rice, maize, groundnuts, bananas, pineapples, kiwi fruit, citrus and so on.

Forests are essential for sustaining human life in the tropics. Their function in regulating the flow of water is well known; they lower the intensity of peak floods and maintain the base flow of rivers in periods of low rainfall. This is of great importance for food security because most of the food produced in the tropics comes from the alluvial plains along the lower courses of rivers which originate in forested uplands.

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[1] Although much of the public concern is about tropical forests as a whole and many of the actions are directed at all forests (even including temperate mountain forests) within tropical countries, these Guidelines are concerned mainly with tropical moist forests and very particularly with the rainforests - those occurring in climates which are wet all the year round. Although "tropical forest" is sometimes used as shorthand, the recommendations refer principally to "tropical moist forest". Many of them are, however, of much wider validity.

ESSENTIAL GOODS AND SERVICES PROVIDED BY TROPICAL FORESTS

Maintenance of biological diversity. A comprehensive system of protected natural forest areas would maintain examples of the full diversity of natural communities, landscapes and land forms and would protect the entire range of animal and plant species and their genetic variation.

Regulation of climate. Forests moderate the climate both locally and globally: they influence the composition and heat retaining capacity of the atmosphere and the heat and water exchange characteristics of the earth's surface. They re-evaporate moisture deposited in rain , and much of this is condensed and deposited in fresh rain elsewhere.

Conservation of soil and water. Forests protect catchment areas and ensure an adequate quality and flow of fresh water. They control erosion and sedimentation and are especially important where these effect downstream investments that depend on water for transportation, irrigation, agriculture and fisheries, and recreation.

Production of non-timber products. Natural forests provide a vast range of foods, medicines, fibres, oils, dyes, resins etc; these often play a very significant part in rural economies.

Production of timber. Forests provide a sustainable yield of wood products for domestic use both by local communities and in the country at large. In many cases this is very important for the generation of export earnings.

Maintenance of wildlife. Forests support fish and wildlife which are vital food sources for local communities, and provide a basis for industry, sport and recreation.

Recreation and tourism. Forests provide opportunities for outdoor recreation for local residents and foreign visitors and serve as poles for the development of tourism.

Resources for education and research. Forests provide opportunities for formal and informal education, research and the study and monitoring of the environment in natural areas.

Preservation of cultural heritage. Forests are part of the heritage of the countries where they occur. They contribute to the folklore and traditions of the people and often profoundly influence local culture. They often reflect past human use and may protect historical features. In his inaugural speech at the IUCN General Assembly in Kinshasa in 1975, President Mobutu referred to the forest national parks of Zaire as the "cathedrals" of his country.

Scenic beauty. Forests enhance the quality of the environment near towns and cities, highways and rivers, and provide areas for recreation and tourism.

Reserves of potentially fertile land for agricultural development. Some soils developed under long periods of forest cover can be transformed, with due care, into land for productive, sustainable agriculture.

Support for rural development. Forests play an integral part in the development of rural lands, trees can be used to rehabilitate degraded lands and play a crucial role in ensuring food security.

Options for the future. Lands kept under forest retain natural processes and maximise options for future use of the land.

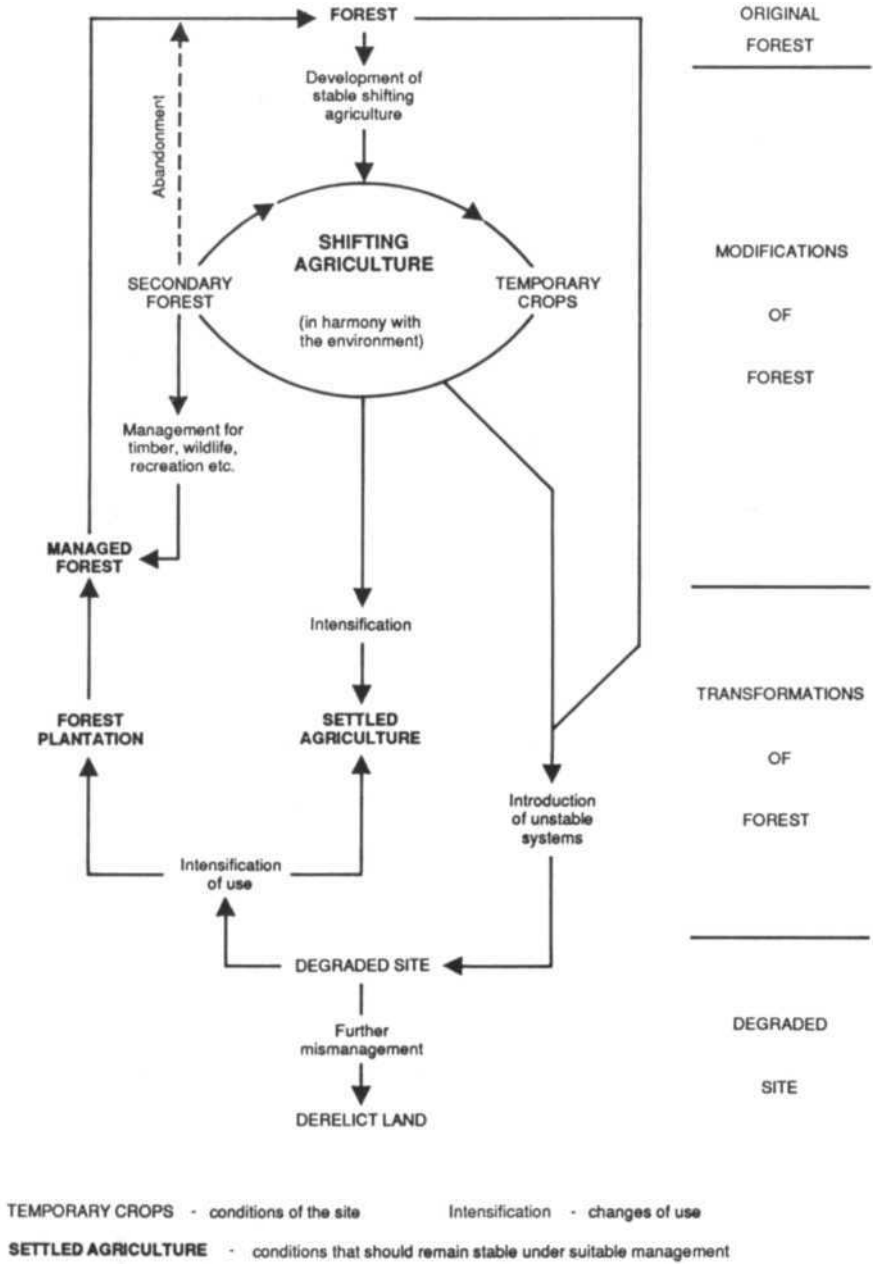


Fig. 1: Interrelationships of shifting agriculture with other uses

DEGREES OF CHANGE TO WHICH FORESTS MAY BE SUBJECTED

Primary, unmodified or virgin forest:

Forest which is essentially unmodified by human activity. In fact many moist tropical forests have at some time in their history been affected by human activity but, after a long period, they can hardly in practice be distinguished from virgin forest except by examination of soil profiles or by very detailed studies of structure and composition. For all practical purposes these forests may be considered as unmodified.

Primary forests are nonetheless subject to constant change. There are internal cycles of regeneration caused by the death of trees and the regeneration of their successors. A range of stages of succession will therefore be found recolonising gaps of different ages in any area of forest. These contribute to the diversity of the ecosystem. In many forests there are also gaps formed by natural causes - lightning strikes, typhoon or hurricane damage, landslips, volcanic activity and, in the drier seasonal forests, periodic fires. Forest composition also fluctuates according to small climatic changes altering the chances of successful regeneration of certain species. We include in this category forests slightly modified by the hunting and gathering activities of indigenous peoples.

Modified forest: Forest managed for the production of timber or other produce, for wildlife or recreation. The more intensive the use, the more the structure and composition are altered from that of the primary forest.

The term *"natural-forest management"* is widely used to describe the silvicultural management of such forests although strictly it would be more accurate to describe them as "near-natural forests"; secondary forests is another term used. The important point is that when well managed these forests do retain most of the biological diversity and ecological values of primary forests; but, unless properly managed, modified forests such as these may progressively decline in value; the process may be rapid, or so slow as to be almost imperceptible.

A special case of *"modified forest"* is land within the cycle of shifting cultivation. In the early stages of each cycle, most trees have been killed; but, if the fallow period is long enough, a secondary forest ecosystem may become established.

Transformations from forest: This is where the natural forest is totally removed and replaced by one of a variety of other uses: other trees (forest plantations, fruit orchards or other cash crops from trees), a combination of trees and herbaceous species (agroforestry), arable or pastoral farming, or structures (roads, towns, reservoirs, mines, etc). Sustainable use of these usually depends on greater inputs of energy, whether mechanical or human. Although transformed land may be more productive than modified forest, it is also more vulnerable to mismanagement or natural disaster.

Sites degraded from forest: Sites where ecological mismanagement has led to the total replacement of forest ecosystems by ecosystems dominated by grasses, low shrubs, creepers etc. This can be caused by progressive over-exploitation of forest for wood, curtailed cycles of shifting cultivation, and over-cultivation followed by soil fertility decline and abandonment. The characteristics are loss of soil fertility and structure, erosion and susceptibility to fire.

Tropical forests in common with all other forests also have a key role in moderating the climate – both the local micro-climate and global weather patterns. They do this through their influence on the proportion of "greenhouse" gases in the atmosphere and on the hydrological cycle - the movement of water and water vapour between the land, the oceans and the atmosphere.

All these benefits are best provided by intact or well-managed forests. The cost of maintaining the crucial ecological services in particular, is low compared with the sums required to rehabilitate the catchment areas, instal the engineering works or plant the new forests required to offset the damage caused by removing the original forest.

It is true that it is quite possible to arrange substitutes for any one of these benefits. Catchments can be protected by tree crops combined with sound soil conservation measures; timber can be provided by plantations; genetic resources can be preserved in gene banks, botanical gardens and zoos. But only the forest provides all of these together. Hence the importance of maintaining the greatest possible area under well-managed forest cover and of protecting substantial areas of intact natural forest.

OPTIMISING THE USE OF TROPICAL FOREST LANDS

Tropical forest lands can be used for many purposes. At one extreme, where they are uninhabited, they can be preserved intact and unused; at the other they can be converted to crop lands, engineering structures or cities. In between there are many gradations - from very light harvesting (such as that practised by hunter-gatherer peoples), through the more intensive but still sustainable collection of jungle produce and game, to commercial timber harvesting at various intensities. The more intensive the use, the more the forest is changed from its original structure and species composition.

A particular form of cyclical use is shifting cultivation, in which the forest is felled and crops are grown for a variable period, after which the site is left to return to secondary forest. There are variations in the degree to which naturally occurring species are left when the forest is felled or are later planted or encouraged.

Both timber harvesting and shifting cultivation can, if carried out unsustainably, lead ultimately to such degradation that tree cover is eliminated and forest can only recolonise the land with difficulty, if at all.

To make the best use of available land, it is therefore necessary to allocate it to various uses. This is generally accomplished by a system of land use planning. This attempts to allocate land to various uses according to its intrinsic properties and the needs of the country. In this process of allocation two points are of cardinal importance:

- Forest management requires a long-term commitment. If the land is to be managed well, the manager, whether government, local community, individual or company, needs to have some guarantee of security - that the land will not suddenly be diverted to some other use.
- Some changes of land use are in practical terms irreversible. An undisturbed natural forest cannot be recreated once it is felled; once turned into a rubber plantation, a managed natural forest can only with great difficulty be recreated; soil which has reached a coastal delta cannot be replaced on a mountain slope. It is axiomatic, therefore, that consideration should be given first to those values that are irreplaceable.

The hierarchy of choice should be:

- **critical sites for biological diversity, for soil and catchment protection and for native peoples;**
- **managed forest;**
- **sites to be transformed to agriculture.**

The key decision to be made is: should the forest remain as forest or should it be transformed to another use? If in any doubt, it should be maintained as forest.

CONSTRAINTS

There are a number of reasons why particular care has to be taken in making decisions about land use in areas covered with tropical moist forests Some of these are connected with the ecology of the tropical forest themselves; others are inherent in the institutional difficulties suffered by most tropical countries.

Because of the large number of species in any tropical forest ecosystem and the complexity of interrelations between them, any artificial manipulation of the forest may have unforseen consequences. For example a single species of fruiting tree may provide food for many birds and mammals during periods when other sources of food are not available. It is therefore vital to observe carefully what the effect of any action may be and correct it if the trend appears to be damaging.

Many soils under tropical forests are inherently infertile and also very easily damaged if they are exposed to the burning tropical sun or the intense impact of tropical rain. Particular care is therefore needed in changing use or and in exposing the soil to the elements. The forest itself has evolved in such a way that it can best utilise these conditions. Artificial replacements are rarely so efficient or so stable.

Because of the very great richness of the forest, many species are very thin on the ground. A large area of forest is necessary to sustain viable populations of such species and fragmentation of the forest can have dangerous consequences for its integrity.

Because of these difficulties and constraints, countries require firm and conservative policies for their forest lands and the forest itself requires sensitive and skilled management. This in its turn necessitates large numbers of skilled and dedicated staff. Few tropical countries have been able to devote the necessary resources to building up the corps of staff that is needed.

MANAGING TROPICAL FOREST SUSTAINABLY

The maintenance of ecological processes: Forest use should not cause the deterioration of the hydrological functions of forested catchments. Hillsides should not be exposed to the erosive effects of rainfall or heavy vehicles. The removal of inorganic nutrients from the system should be minimised by such measures as debarking logs in the forest. The structure of the original forest should be maintained as far as possible.

The maintenance of biological diversity: Sites important for rare or localised species should not be disturbed. Small pockets of undisturbed forest can preserve populations of wildlife species which will subsequently recolonise the forest which regenerates after logging. Forest tracts should not be unnecessarily fragmented as this will result in the loss of species which need to range widely or which exist at low densities.

The satisfaction of the needs of local people: The probability of sustainability will be considerably enhanced if the local people share in the benefits of forest use and if other measures are taken to ensure that their basic needs are met. Attribution of secure tenure to productive farmland, guaranteed access to forest products and provision of employment and shared benefits in forest exploitation will all encourage sustainability. There are numerous examples of indigenous communities being forced into unsustainable use of marginal lands by industrial exploitation of their traditional homes. There are a few examples, mainly from Central and South America, of local cooperatives exploiting forest in ways which are likely to prove sustainable.

The maintenance of the harvest of all products: Full sustainability cannot be considered to have been achieved if the yield of only a single product is sustained. It is highly desirable that yields of all products and services be taken into account. There has been a wide-spread tendency to exclude the so-called minor forest products from assessments of sustainability and to fail to consider the role of upland forests in supplying water for downstream agriculture. Products used by indigenous communities must be considered alongside those supplying distant markets.

The sustainability of timber production: When primary forest is first logged it normally contains a high standing volume of timber, a variable proportion of which, depending upon species composition and market demand, is marketable. This standing volume has accumulated over a long period and contains slow-growing trees and many large diameter specimens. The commercial timber is therefore likely to be of a quality and volume that will probably not be matched in future cuts. In this sense the first crop is, in practical terms, not repeatable.

If the production of timber is to be genuinely sustainable, the single most important condition to be met is that nothing should be done that will irreversibly reduce the potential of the forest to produce future crops of marketable timber - that is, there should be no irreversible loss of soil, soil fertility or genetic potential in the marketable species. It does not necessarily mean that no more timber should be removed in a period of years than is produced by new growth; overcutting in one cycle can be compensated by undercutting in the next cycle or by prolonging the cutting cycle.

Moreover there have been very strong incentives for those in tropical forest countries to plunder the forest, often without realising that this is what they were doing. It has been possible, for example, for governments to build up national reserves of hard currency and equally possible for individuals to become very rich in the process. This trend has been encouraged by the growth of markets (often very unstable markets) in the richer parts of the world for primary tropical produce - timber, rubber, bananas, cocoa, tea, coffee, oil palm, sugar cane etc.

Those who live in or near the forest are in a state of social flux; rising populations, new tools, changing expectations, and exposure to education and to the influence of the media, all tend to make them dissatisfied with their traditional way of life. The younger generation, especially, often see greater advantage in opening up the forest to cultivation than in retaining it as forest.

All these factors are leading to unprecedented pressures on a forest resource that is much more delicate and vulnerable than it appears.

CHANGING THE USE OF TROPICAL MOIST FOREST LAND

Not all tropical forest lands should necessarily remain under forest cover. There are certain legitimate demands - such as some forms of food production, settlement and roads - which can only be fulfilled once the original forest is removed or altered. Perennial tree crops may play an important part in economic development if planted on suitable sites. But such changes should only take place once the capability of the forest lands to meet these demands has been explored.

In deciding whether to alter a tropical forest, a series of questions should be answered:

- What are the dominant ecological and social constraints in the forest area in question? What are the soil characteristics of the site? Many nutrient-poor or wet tropical soils can sustain nothing but an intact forest cover.
- Is there degraded, altered - or at least non-primary - tropical forest available which also could sustain the required enterprise? Such land usually supports fewer species, provides less ecological benefits, is nearer to settlements and infrastructure and can be rehabilitated by development. A notable example would be the development of timber production from old secondary forest, which may often yield a higher proportion of desirable species than primary tropical forest, or the development of plantation forests on unused, degraded grasslands.
- Are there ways in which the enterprise could be sustained within the existing forest - in other words, without drastically altering the forest structure?
- If the tropical forest were to be cleared and a new use established, what would be the net change in costs and benefits of all forest values, including such external benefits as watershed protection?

In deciding whether or not to alter a tropical forest, it is essential to assemble and analyze sufficient ecological, economic and sociological information upon which to base a decision. If large scale or drastic changes are proposed, there should be a legal obligation to provide an Environmental Impact Assessment.

Once the decision to change the use of a tropical forest has been made, the objective must be to ensure the sustainability of the new use and to ensure that the change is made in a way that causes as little damage as possible. It is generally more difficult to ensure the sustainability of non-forest use than that of the forest that it replaced. Primary forest is highly adapted to the site where it grows and makes efficient use of soil and climatic resources. By contrast, an artificial plantation

KEY PRINCIPLES FOR MANAGEMENT

The seven key principles for the management of tropical moist forest lands which are central to these guidelines are:

- Ecological constraints must be considered early and throughout tropical forest land development.
- The allocation of tropical forest land to other uses should be determined only after thorough economic, social and ecological evaluation - by a range of disciplines - and through dialogue with local communities.
- Tropical forest should be converted to uses other than natural forest only if it can be demonstrated that this will produce sustainable benefits in a more desirable form than the tropical forest itself can produce.
- Wherever possible, areas of tropical forest which are already degraded should be selected for uses other than natural forest rather than clearing yet more areas.
- Special efforts should be made to manage carefully those large areas of TMF which are essential for benefits such as the maintenance of watersheds and biological diversity.
- The people who live in and around tropical forests should have a large say in their management.

of only a few species is liable to diseases and pests, drought and nutrient problems. Under these conditions, extra costs - in the form of fertilizers and pesticides (if not soil erosion) - will be incurred. To minimise such costs, a good approach is either to fit small areas of the new enterprise into an intimate matrix with intact forest, or to use agroforestry techniques which mimic forest structure.

The benefits of undisturbed tropical forest are so significant that it is usually worth devoting part of a forest tract to protection. The "buffer zone" approach (developing ecologically sensitive productive activities around a "core" protected forest) can increase total production and protection values.

MANAGING TROPICAL MOIST FORESTS

As indicated above there are a number of purposes for which tropical moist forest may be managed. These fall broadly into three categories: (a) for the conservation of biological diversity; (b) for the protection of critical soils and water catchments; and (c) for the supply of products, whether wood or non-wood. For every one of these purposes the forest may be managed sustainably or not, according to the standards of management applied. Each is dealt with separately in the Guidelines which follow.

The principal agents for the conservation of biological diversity are the protection and management of the various categories of protected areas, especially the IUCN Categories I-IV (Scientific Reserves and Wilderness Areas; National Parks and Equivalent Reserves; Natural Monuments; and Habitat and Wildlife Management Areas) (see Box p. 48). These should also protect the full range of ecological processes. Yet only about four per cent of the world's

remaining tropical forest is legally protected and, in many cases, this protection is not very effective on the ground. A special effort is therefore essential to increase this area - and to strengthen enforcement of legal protection.

Yet it is quite unrealistic to seek to make totally protected areas sufficiently extensive to provide for the conservation of *all* ecological processes and *all* species. Sustainable production of valuable timber from well managed natural forests is potentially one of the most effective ways of ensuring the conservation of very large areas of natural forest while meeting the social and economic needs of the regions concerned. Recent research has shown that well managed forests retain most of the diversity of primary forests, both in terms of the number and the diversity of species they support (Sayer *et al.,* 1990). Managed natural forests can provide employment, generate wealth and supply downstream industries, thus enabling peoples in tropical developing countries to improve their lives without clearing their forest. The conservation of biological diversity can be made even more effective by a carefully planned juxtaposition of protected areas and forests managed for timber. Even greater benefits can be derived if it is possible to link the harvesting of non-timber products to harvesting of valuable timbers.

Areas selected and managed for the protection of fragile soil or water catchments preserve, by definition, the full range of ecological processes and also make a substantial contribution to the conservation of biological diversity.

The key to sustained management is to ensure that the biological "capital" produces significant "interest" (in the form of desirable forest benefits) and to harvest that interest without eating into, or damaging, the capital itself. This idea of sustained yield is, of course, not new to foresters, who have developed a similar system of management for temperate forests.

However, systems have not yet been developed for all tropical forest types - or they have not been practised long enough to be proven - and harvesting and management is relatively expensive. But the greatest limitations to practising sustained yield management are institutional. Inappropriate government land use policies often do not provide the long-term security necessary for sustainable forest management, often favouring land clearance for agriculture. Forest departments are underfunded and the financial structure of the timber business does not provide equitable benefits to all those engaged in it or affected by it Aid programmes which have focused on capital intensive, government-controlled, forest management schemes have exacerbated the problem.

A SHORT HISTORY OF TROPICAL MOIST FOREST USE

Although people have lived in the tropics since the origins of Homo sapiens, it is comparatively recently that they have moved into tropical moist forests on a significant scale: perhaps 25-40,000 years ago in south-east Asia and the Pacific, 10,000 years ago in the Amazon and only even as recently as 3,000 years ago in Africa. For a long time their densities were low and the effects of their occupation small. Although there are traces of silvicultural practices from Java and China which date back 2,000 years, there was little if any harvesting of large trees for timber and extensive clearance for agriculture was a rarity.

The first great changes were brought about by movements of people from China into SE Asia and from Europe into Africa and S America. These inroads have been greatest during the last two hundred years when forests were cleared for plantation agriculture, mainly for cash crops for export (sugar, tobacco, coffee, cocoa, tea, rubber and oil palm) but also for rice.

Forest exploitation for timber started on a small scale in the late 18th century but has become a powerful force for change since the Second World War. Colonial governments established forest departments in the 19th century in Asia and in the early 20th century in Africa. The mandates of these departments, and of their successors in the independent nations that subsequently emerged, included the conservation and management of a wide variety of forest resources. They provided government stewardship of the resource, their senior staff are still often called "Conservators".

Systems for managing the forests began to evolve in parallel with increasing demands for tropical timber in Europe. Large quantities of teak, for example, were needed in the latter half of the 19th century for Britain's Royal Navy. This had considerable influence on the approach to forest management in India and Burma.

As new territories were opened up in the equatorial zone - notably in Central Africa, Malaysia and the West Indies - an increased demand for dark tropical hardwoods, combined with a low demand for forest products within the territories, led to an expansion of the logging of large size timber for export. The equatorial forest trees were tall, straight, columnar and self-pruning and therefore provided excellent timber and veneer. One product - large-sized timber - was given priority. Marketable species over a minimum girth limit were selectively felled.

Until the 1940s, forests had been harvested using axes, handsaws and animal power. These tools caused relatively little damage to the forest and limited the exploitable area. Only forests near rivers could be extensively exploited, as rivers were the only practical routes for getting produce out of the forest. Species with light timbers - "floaters" were the mainstay of the market.

The communities that live within the forest today include some of the oldest surviving cultural groups on earth. Their use of forests for hunting, gathering and cultivation, is based upon a detailed knowledge of the forest and what it can yield. Provided that population densities remain low, these communities can, and often do, live in close harmony with the forest; they often manage the forest deliberately to sustain yields of many products and have a powerful interest in maintaining the integrity of the ecosystems of which they are a pan.

This situation has been transformed both by changes from within and by pressures from outside. Even within the forest the balance has always been delicate, easily disturbed by outside influences. Now, more than ever before, it is under siege. The influence of modem medicine, new tools, better communications, contact with the media and with a wider economic life, all provide the conditions in which even traditional forest dwellers are tempted to use the forest unsustainably.

Added to this have been powerful pressures from outside. There have been massive rises of population in tropical countries and hence demands for new land to grow food. The development policies of governments have led to the clearing of forest to grow crops for export, to the construction of new roads and dams, and to a rapid exploitation of timber to earn foreign exchange, made possible by the advent of the chain saw and new powerful machinery for building roads and handling timber. Exports of tropical timbers to industrialised nations have increased sixteen-fold since 1950 and there has been very great increase in domestic consumption.

These pressures are likely to continue. Populations continue to rise and the expectations of people change as development proceeds. The demand for local timber will follow these trends and much of the new land for growing the additional food that will be required can only come from areas now under forest.

> *"Government policies impinging significantly on the forest sector include tax and trade regimes, industrialization incentives, laws governing land tenure, and agricultural resettlement and development policies. These frequently are biased against the preservation of standing forests and towards their exploitation or conversion to other land uses. Often they tip the balance of incentives facing private parties; to exploit or convert forest resources far faster and further than market forces would otherwise allow."* (Repetto and Gillis, 1988).

In the past years industrial logging has become a focal point for public concern over the fate of tropical forests. Newly logged forests look as though they are devastated and the intrusion into tranquil, pristine natural forests of bulldozers and chainsaws offends the sensibilities of many people. In addition it is common knowledge that the forest industry has often taken an irresponsible attitude towards the husbandry of the resource. Cut-out and get-out has been the motto. But it is important not to be swayed by emotional reactions. In spite of the finding of an ITTO study that substantially less than one per cent of tropical forest is demonstrably sustainably managed at an operational scale (Poore et al, 1989), there are very large areas of forest in Central Africa and Southeast Asia which show little sign of long term damage even after several cycles of logging. In contrast there are vast areas in Indo-China, Borneo and Amazonia where forests have been utterly devastated by agricultural encroachment in the past few decades without a single log entering the trade.

The vexed question of the potential role of industrial forestry in the conservation of forest resources is the subject of an intense debate within the conservation community. A major forum for this debate has been the International Tropical Timber Organization which has now adopted the target date of 2000 by which all timber entering international trade should be from sustainably managed forests. ITTO is steadily putting into place various steps by which forest management should move rapidly in this direction.

REACHING A BALANCE

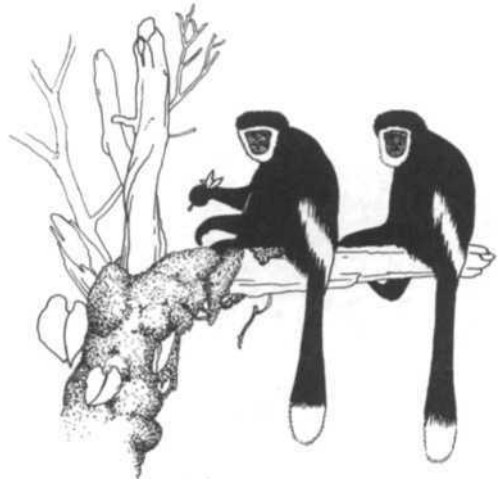
In the final analysis, land, resources and people will reach a balance; this is an ecological certainty. They may reach this equilibrium in a planned, humane manner and in such a way that relatively rich resources remain at the disposal of humanity, or they may reach it by a series of cataclysmic plunges that cause untold hardship and leave an impoverished world. The first is the only sensible course to follow.

In economic terms there are two extreme options: one which reflects the cost of including ecological considerations in tropical forest use, so that the forest continues to serve people indefinitely; or one which reflects the great cost of wasted resources, land degradation, and the associated hardship of millions of inhabitants in tropical forest-dependent countries.

THE INTERNATIONAL DIMENSION

One final point: this balance cannot be achieved by the nations of the tropical forest area alone. International commodity markets and debt scheduling - which are major factors in TMF degradation -continue to be dominated by the industrialised nations. This influence has at times forced developing country governments to pursue short-term destructive exploitation of natural resources against their own wishes and better judgement.

The authorities in the developed nations have a responsibility to adjust their policies so as to help tropical countries to achieve the pattern of sustainable development they seek. An immediate opportunity exists to increase the use of grants and loans to support sustainable use of forests by rural communities - rather than continuing to support projects which radically alter these ecosystems. Recent initiatives to transform international debt into credits to pay for conservation programmes in debtor nations are a constructive way to tackle both the economic and environmental problems of tropical developing nations.



GOVERNMENT POLICIES

"Soundforest policies can be based only on an analysis ofthe capacity ofthe forests and the land under them to perform various functions. Such an analysis might lead to some forests being cleared for intensive cultivation, others for livestock; some forest land might be managed for increased timber production or agroforestry use and some left intact for watershed protection, recreation or species conservation ..." (WCED, 1987).

The state of tropical forests is not determined by national forestry policy alone. Every policy in tropical developing countries - in particular, agriculture, energy and industry - has an impact upon tropical forest resources; and the effects of all these sectors are, in turn, greatly influenced by national economic, financial and social policies. In addition, the fate of tropical forests can be determined by policies set in other countries, through the often dominant effects of trade, aid and debt. Indeed, more tropical forest degradation is caused by the direct or indirect effects of poor policy outside the forestry sector than by forestry policy itself.

Much useful work on analysing and developing these policies has recently been carried out by the International Institute for Environment and Development (IIED), the World Resources Institute (WRI) and others. Therefore, in this document, we attempt only to draw general conclusions about the ways that governments might evaluate their own policies, to emphasise some new IUCN perspectives on these issues and, in particular, to draw attention to some major misconceptions which cloud the present policy debate. The guidelines cannot be specific about the content of such policies, which should be highly dependent on national characteristics as well as on the types, areas and present use of tropical forests.

As a first step it is of fundamental importance that governments thoroughly examine their development objectives. It is generally recognised that development should be a process by which the quality of peoples' lives is improved. However, development planning decisions continue to be made upon the uninformed view that this process requires simply an increase in national economic product. We would prefer to see development defined as an improvement in the human environment.

POLICY REVIEW AND FORMULATION

Background

Countries where considerable areas of intact tropical forest remain have a tremendous opportunity to retain their unique values. Policies should emphasise the protection of those areas best suited for maintaining biological diversity and watershed functions. In countries having much degraded land, or where there are many competing demands on tropical forests, policies should emphasise land-use planning and the rebuilding of land capabilities through afforestation, fuelwood production and very strict protection of critical watersheds. In all cases forestry policy must be fully integrated and compatible with agricultural, regional development and economic policies. Even then, policies will only be effective to the extent that they are supported by adequate institutions, and resources, for implementation.

Guidelines

1. **Policies must encourage the sustainable development of tropical forest as a national asset. The review and formulation of all policies which have a bearing, direct or indirect, upon tropical forest must therefore take into account:**
   - **an evaluation of all the benefits which tropical forest can produce;**
   - **the need to treat tropical forest as a capital resource and to invest accordingly in preventing its depletion;**
   - **the need to ensure that the objectives of sustainable development are met;**
   - **the need to maintain essential ecological processes, especially where these influence hydrological systems and local climate;**
   - **the need to maintain overall biological diversity;**
   - **the need to ensure that harvests do not exceed sustainable levels; and**
   - **the necessity to maintain the basic spiritual needs of people living in and around the area in question.**
2. **The review and formulation of all policies which have a bearing on tropical forest should be carried out by representatives from the whole range of sectors who use or otherwise affect the state of tropical forest lands.**
3. **Policies must be backed up by effective tools and procedures for implementation. It is essential to have a capability for practical land-use planning and to be able to control and supervise operations effectively. The ecological and social implications of any proposal affecting tropical forest must be considered at the earliest stages of the proposal and throughout project development.**
4. **The National Constitution should reflect the nation's determination to ensure the sustainable use of the whole range of tropical forest benefits.**

NATIONAL CONSERVATION STRATEGIES

"A useful tool in promoting this approach is the preparation of National Conservation Strategies (NCS), which bring the processes of conservation and development together. Preparing an NCS involves government agencies,

non-governmental organizations, private interests, and the community at large in analysis of natural resource issues and assessment of priority actions. In this way, it is hoped that sectoral interests will better perceive their interrelationships with other sectors and new potentials for conservation and development will be revealed. (WCED, 1987).

Background

In practice, there are limits to how significantly - and how soon - policies can be changed to encourage the sustainable development of natural resources such as tropical forest. The essential element is to promote an inter-sectoral review of government policies in order that they may be appraised against environmental standards. IUCN has found the development of National Conservation Strategies (NCSs) to be a useful method of bringing about the redefinition of national priorities. In many countries, this has already provided an excellent forum - and its product a useful reference - for policy change. The inter-sectoral reviews of policies affecting forest lands promoted by HED have similar but somewhat more focussed objectives, while the policy reviews carried out as part of the TFAP process have tended to concentrate excessively on the forestry sector.

NCSs have proved valuable in demonstrating that conservation and development are intimately linked; ultimately the objective of both is to achieve the optimal environment for mankind. NCSs promote debate on the real objectives of development and make environmental issues more prominent in the national planning process.

The preparation of an NCS is a process of review and the building of consensus on sustainable development issues. It requires that all parties who derive benefits, or incur costs, should be involved in the decision-making process. This is important because government policies will only be implementable as far as they reflect the genuine needs and aspirations of the people concerned. Governments cannot influence resource use exclusively by regulations and repression, especially not in remote areas or where the local populations have considerable autonomy. NCSs must therefore be based upon a genuine dialogue with the people whose day-to-day lives depend upon the sound management of tropical forest resources. Responsibility for resource management must ultimately be placed in the hands of these people.

NCS preparation is undertaken by people representing all sectors and interest. It defines who is (or should be) responsible for specific policies affecting tropical forests and other resources. Ecological considerations must be included at an early stage of, and throughout, the development of the NCS and all economic and social costs and benefits must be included in the analysis. Long-term costs and benefits should not be excessively discounted.

An NCS provides a more appropriate mechanism for making decisions than the simple financial analysis at the "project" level that has dominated decision making by both governments and development assistance agencies in the past.

Guidelines

5. **The process of developing a National Conservation Strategy or comparable policy review is an excellent way of beginning and maintaining the kind of multi-sectoral dialogue required for the formulation, and implementation of effective sustainable development policies. It also plays an important educative role.**

6. **A national land-use policy is an essential requirement. It must encourage the optimal use of each land resource; but it should balance this with the requirement to retain**

flexibility and ensure sustainability. Special care should therefore be taken to minimise irreversible land-use changes. An effective land-use policy would include a provision for controlling and monitoring the effects of changes in land-use.

ECONOMIC, FINANCIAL AND FISCAL POLICIES

"In Central and South America, many governments have encouraged the large-scale conversion of tropical forests to livestock ranches. Many of these ranches have proved ecologically and economically unsound, as the underlying soils are soon depleted of nutrients; weed species replace planted grasses, and pasture productivity declines abruptly. Yet tens of millions of hectares of tropical forest have been lost to such ranches, largely because governments have underwritten the conversions with large land grants, tax credits and tax holidays, subsidized loans, and other inducements." (WCED, 1987).

Background

History has demonstrated that:

- forest benefits are of value at all stages of economic development;
- forests can provide an important and sustainable resource base for rural development;
- a well-managed forest (that is not restricted to the intensive production of only a few products) can respond to changing demands.

It is also generally accepted that:

- the direct financial costs of many environmental problems caused by deforestation (such as flooding and soil erosion) are high; and
- the values of non-marketed ecological benefits, such as climate regulation and the protection of downstream agriculture, are significant.

Since these costs and benefits are increasingly being investigated by economists, it is becoming more practical, as well as more necessary, to incorporate such considerations into national economic and financial policies.

However, whilst it is now possible to develop economic and financial theories to accommodate the requirements of sustainable tropical forest development, these are still very seldom incorporated in economic and financial policies and are even more rarely implemented. For example, it is widely accepted that low discount rates should be applied to the financial analysis of forestry operations. This compensates for the forest's production of non-market benefits and the considerable delay in realising financial returns on investments. It therefore favours the sustained yield of a variety of forest benefits. But other government policies often go against this principle. They encourage, through tax concessions and credit schemes, the exploitation of one product alone - often at an unsustainable rate - or otherwise the undue exposure of forest owners and tenants to short-term economic fluctuations.

The result is that usually only a few people gain from forest use and these are rarely local people with traditional dependence on the forest.

In addition, governments capture only a proportion of forest rents. The "rent" available from logging is the value of the wood products that can be derived from the standing trees minus all

the costs of harvesting, transportation to the mill and processing. Timber concessionaires should be able to make profits similar to those that they could expect from similar levels of investment in other activities. The balance of the rent should accrue to the government. In many countries the timber industry has brought great profits to some parts of the chain of intermediaries and the government has not captured a sufficient proportion of the rent, because stumpage fees or other taxes are too low. The potential for large windfall profits has resulted in a rush to invest in timber exploitation with little regard for the future of the forest.

There are a number of other possible financial measures which would favour sustainability of the forest but are rarely applied, in particular:

- taxes which discriminate between species;
- taxes based on the area of forest harvested;
- licences based on merchantable timber in the tract rather than on volumes removed;
- incentives payable to logging crews who meet, within narrow limits, the planned harvest rate and protection prescriptions; and
- leases to logging companies which are at least as long as the cutting cycle.

Present practices tend to encourage loggers to abuse the resource, the real losers, of course, being the taxpayers in society at large and the forest dwelling peoples in particular, who bear the costs of environmental degradation without reaping the benefits of timber bonanzas.

Guidelines

7. Economic policies should aim to balance short-term production from tropical forest lands with the need to ensure the long-term flexibility of tropical forest use.

8. Special attention should be given to valuing non-market forest benefits in economic terms, but more especially to using such valuation in making economic decisions affecting tropical forest. Where this valuation cannot be made realistically, other methods such as Environmental Impact Assessment, should be used to ensure that ecological considerations are included in decision-making.

9. The sustainable levels of production of forest benefits should be determined and, where possible, demand controlled so as to fall within these limits. This should be assisted by setting appropriate prices for forest products.

10. In economic development generally, the intention should be to add value to forest products; experience has shown that forest industries in tropical forest countries can only add value if efficiency in processing, and competition between forest industries, are encouraged.

11. An analysis should be made of incentives for any activity which affects tropical forest lands e.g. tax concessions, credit, grants or indirect incentives such as provision of infrastructure. Future incentives should be very carefully designed to ensure optimum, sustained production of a range of benefits and their equitable distribution.

12. Where concessions are given for forest use, governments must ensure that they capture a significant proportion of forest rents and that a sufficient proportion of this rent is reinvested in the maintenance of the forest. Realistic stumpage fees should be charged, land rents set by competitive bidding, taxes on timber exports levied and longer-term leases given where these would encourage more sustainable utilisation.

In general, the extra direct costs incurred through adopting sustained yield practices should be borne by the user, and not by governments.

TRADE AND INTERNATIONAL RELATIONS

"The promotion of tropical timber imports into certain industrial countries through low tariffs and favourable trade incentives, combined with weak domestic forest policies in tropical countries and with high costs and disincentives to harvesting in industrial countries, also drives deforestation. Some industrial countries typically import unprocessed logs either duty-free or at minimal tariff rates. This encourages developed country industries to use logs from tropical forests rather than their own, a pattern that is reinforced by domestic restrictions on the amounts that can be cut in domestic forests ..." (WCED, 1987).

Background

Almost all tropical forest-dependent nations are "developing" countries. Their present economic dependency on industrialised nations, and the lack of stability in the markets of the primary products of tropical forest lands - timber and plantation crops - make it difficult for them to ensure the sustainable utilisation of tropical forest.

Yet, while tropical forests are major national assets for the countries to which they belong, they also have global importance because of their influence on world climate, their biological diversity and the value of the traded products they supply. Significant changes in the trade and international relations policies of industrialised nations are needed in order to favour their long-term conservation.

Progress is already evident. At the request of recipient governments, aid agencies from industrialised countries are beginning to channel support into various conservation and sustainable development activities. But the effect of this support may be diminished by the trade and foreign policies of these same countries.

The International Tropical Timber Organization has set the year 2000 as the target date by which all tropical timber entering international trade should come from sustainably managed forest. It produced in 1990 "Guidelines for the Sustainable Management of Natural Tropical Forests" and is working towards incentives which may be used at all levels to favour sustainable management. Its measures in the fields of forest industries and market intelligence are designed to stabilise and add value to tropical timber entering the market.

Finally, there is clearly a value attached to tropical forests by people who may only wish to have the option of visiting the forest, or who even attach value to the existence of forests that they have no intention of ever visiting or using. People attach value to the fact that their children may derive some benefit from the existence of forests. The magnitude of these values is demonstrated by the sizeable voluntary contributions to private conservation agencies in the developed world. An accurate estimate of such values is clearly impossible, but they could have an important part to play in certain trade and foreign policies.

Guidelines

13. Industrialised countries should formally recognise their dependence upon tropical forests by ensuring that trade and foreign relations policies help tropical forest countries to develop and manage tropical forest lands in a sustainable way.

Specifically, they should apply tariffs and quotas to discriminate in favour of timber and other products harvested sustainably and timber products processed within the country of origin.

The International Tropical Timber Agreement provides a mechanism for developing and applying such practices.

14. **Commodity agreements should be formulated with the participation of producer and consumer nations on equal terms. They should help sustained-yield practices to be economically viable for producer nations in both the short - and long-term.**

15. **Tropical forest should not be exploited for short-term gains to repay foreign debts. Rather, it is important, in all negotiations between debtor countries and financial institutions, to balance debt repayment with the sustainable income-generating capacity of tropical forests. And, if it is true that the debt burden leads to environmental costs, then these should be reflected in lower interest rates or debt cancellation.**

16. **Aid-assisted projects in tropical forest land should only go ahead after thorough economic, social and environmental analysis, preferably as part of a national strategy formulated by the recipient government, and with the assurance that their implementation will be sustainable. In general, aid for securing the long-term viability of tropical forest ecosystems (protected areas, sustainable forest management, rehabilitation of degraded land, watershed management etc.) should be increased. Aid agencies should support organisations working on the ground with local peoples. While such action must have government encouragement, these will not always be government institutions.**

SECTORAL POLICIES

Background

Economic analysis shows that the management of forest resources is far too important to be the responsibility of the forestry sector alone. Timber and other forest products are only some of the many benefits derived from forests; and they may not ultimately be the most valuable, although they are likely to be the most substantial sources of direct revenue.

Experience also shows that there can be no sustainable management of forest resources unless there is a permanent forest estate in which the operator, whether government or private, may invest with long term security. In addition the government forest department must be in a position to set standards and exercise control over the quality of implementation. Therefore, in tropical forest-dependent nations, the forestry sector must be accorded high priority for government support.

Government policy for the private forestry sector should encourage the sustainable production of a wide range of forest benefits, while ensuring the optimum social value from that production. Particular areas for attention are general rural development and community and farm forestry. Incentives should be provided for private and community forestry.

Guidelines

17. **Forestry policy should cover the whole range of forest values, and not merely timber. There may be merit in designing two-fold forest policies, one concerned with wood**

production (including both state forests and private lands, including wood from agricultural land) and the other concerned with the environmentally sound management of the country's forests for all their values. Greater co-ordination with other sectors will be essential in order to maintain careful balances between:

- **land retained as forest and land to be transferred to agricultural use;**
- **production of different products and protection for different purposes;**
- **natural forest and plantations; and**
- **short- and long-term returns on investment.**

The major aim of state forest policy should be to maintain the forest resource base. This will necessitate the establishment of a state-owned forest estate, for the total protection of critical forest lands as watersheds and reserves for biological diversity. Powers of protection must be vested in a government forestry authority and/or wildlife conservation authority, as appropriate. The objectives of forest management, and timber utilisation and processing should be clearly expressed, realistic and achievable, and be consistent with these Guidelines.

18. **Agricultural policy should reflect the role of forests as the source of environmental services essential for maintaining food security, and as the living environment for certain communities of people. Agricultural development should not interfere with these services; and, in particular, it should not unnecessarily involve clearing forest land unless such land is of high fertility and the change in land-use produces an overall increase in sustainable benefits. No clearance should ever take place in critical watersheds, on critical soils or in areas of exceptional biological diversity. Agricultural development should incorporate agroforestry/forestry/gardening systems wherever possible. Permissible population densities of shifting cultivators should be defined for major forest types and action taken to intensify and stabilise agriculture if higher densities are likely to be reached.**

19. **As the industrial sector grows in tropical forest-dependent nations, policies for the control of pollution should be developed in order to avert possible disastrous ecological and economic effects on tropical forest such as those caused by acid rain and other pollutants in some European and North American forests.**

20. **Energy policies should recognise the often considerable dependence on fuelwood; policies for the sustainable development of wood fuel supplies should be formulated in conjunction with forestry authorities. Fuel efficiency and alternative energy sources should be promoted.**

21. **Major infrastructure development represents a considerable commitment of resources in tropical forest-dependent nations; policies should be based upon a careful analysis of environmental issues, beginning when ideas are first being formulated.**

SOCIAL AND SETTLEMENT POLICIES

Background

Many tropical countries have excellent policies and legislation but, because they are not a product of dialogue with the people, they are not perceived to be relevant and are not socially

acceptable. Power over resources does not necessarily lie with governments. It may lie with local shifting cultivators, big business in the capital city, the military, logging companies or sometimes with international corporations. Therefore, it is often better to start with the people rather than with the trees.

There has been a tendency in some countries to view huge areas of luxuriant forests as a vast unexploited resource for agricultural development. This has led to government-sponsored transmigration schemes. These, while yielding relatively few development benefits, have often caused great environmental harm. Sometimes the problems of overcrowding and resource depletion in dry areas have been approached by moving people to wetter areas. This tendency must be treated with great caution. Areas of abundant rainfall rarely have soils suitable for annual cropping and the people who are moved are generally inexperienced in the farming systems which should be are appropriate for new environment

Guidelines

22. All tropical forest development should be planned with the full participation of communities already living in the area, and be responsive to their needs. Particular attention should be paid to the interests and values of indigenous communities long established in the forest. As a general principle, these communities should retain the maximum autonomy in the use of their traditional lands, except in rare instances of land of exceptional national importance or where an already diminished forest area can no longer support their requirements.

23. Land title should not generally be given in areas which have critical value for catchment management, biological diversity, or where unique or distinctive ecosystems occur. But security of tenure and management agreements are desirable for farmers living around a protected area, in order to discourage encroachment on the area. The common requirement that land be cleared to obtain title often encourages land speculation and should be avoided.

24. General education on natural resource values should be incorporated in the school syllabus. Training in sustainable development of tropical forest resources should form a distinct part of professional and technical training for all disciplines involved in tropical forest development.

25. Unplanned and uncontrolled settlement by new colonists in tropical forest should be discouraged. Demands for such settlement should be anticipated and viable alternatives sought. Incentives and infrastructure should be provided to encourage colonisation only of areas demonstrated to have the necessary potential for sustainable agriculture. Investments in creating industrial employment may be used to relieve pressure on forest lands.

26. Planned resettlement or the development of new centres of population should take into account the present social, cultural, economic and health conditions of those to be settled and their future needs. Settlement plans should be developed with the full participation of the persons to be resettled.

More detailed guidance on the planning of resettlement schemes is provided in two publications of the IUCN Tropical Forest Programme: Transmigration and the Environment in Indonesia (Whitten *et al.,* 1987) and Resettlement Planning in Indonesia's Transmigration Programme (Davidson, 1987).

GLOBAL EXTENT OF TROPICAL FORESTS AND WOODLANDS

Various problems are encountered in any attempt to quantify forest cover and its change over time. First, it is necessary to define what is meant by forest, and which particular types of forest are to be considered. Second, forests change either due to complete clearance (which reduces their area), or because of various forms of disturbance (which change their species composition, biomass and structure). The latter are very hard to quantify or even to define accurately. It is necessary to specify whether destruction, disturbance or both have occurred and what the nature of this disturbance has beea Third, until the recent advent of satellites it was impossible to achieve an extensive objective record of forest cover at a single moment in time and even with them it is impossible to identify certain kinds of damage which may be of great significance.

Differences between published figures for tropical deforestation arise largely because these problems are ignored or dealt with in different ways. The only comprehensive survey which dealt with these issues consistently for almost all tropical countries was published in 1981 by FAO to a 1980 dateline (FAO/UNEP, 1981). This was updated by FAO in 1988 to correct errors and extend the cover to some small countries omitted in 1981, but still to a 1980 dateline.

FAO established a global nomenclature of forest types, which includes three main divisions: *closed forests* (with a continuous interlocking canopy), *openforest* (open canopy broadleaved forest with a continuous grass layer under a tree canopy that covers more than 10 per cent of the ground) and *shrublands* (in which the woody plants are predominantly shrubs more than 50cm high but less than 7m high). In addition FAO distinguished *forest fallow* derived from the clearing of forests for shifting cultivation. This is typically a mosaic of various woody regenerative stages. Closed and open forests can be distinguished on aerial photographs and satellite images.

Since the last century it has been common to recognise three major kinds of closed tropical forests, *rainforests, monsoon (or seasonal) forests* and *thorn forests,* the occurrence of these categories being largely determined by climate. The different closed forest formations are seldom distinguishable in national statistics and are difficult to tell apart by remote sensing, especially in the wet season when seasonal forest trees are in leaf. The convenient term *tropical moist forest* has been widely used to include both tropical rain and seasonal forests.

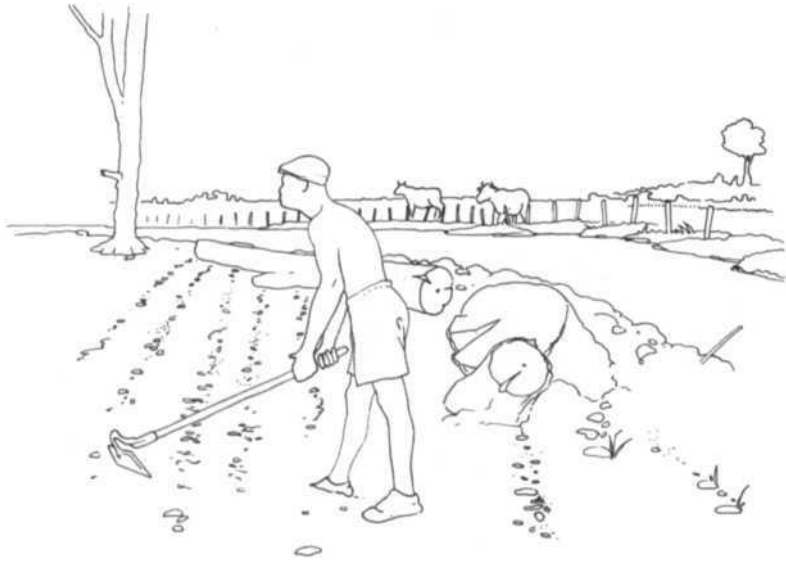
A more detailed discussion of the problems associated with the various estimates of forest cover is given in Sayer and Whitmore (1990).

FAO are now completing a new survey of the world's forests to a 1990 dateline. The results are expected to be published in 1992 but the preliminary indications are that forest areas will prove to be less than previously estimated and the rates of loss higher.

The FAO/UNEP assessment of the global extent of tropical forests remaining in 1980 was as follows:

	The Americas		**Africa**		**Asia**		**World**
	Area in '000 ha	**% of world**	**Area in '000 ha**	**% of world**	**Area in '000 ha**	**% of world**	**Area in world**
Closed forest	678,655	56.5	216,634	18.0	305,510	25.4	1,200,799
Open forest	(216,977)	29.5	486,445	66.2	30,948	4.2	734,390
Fallow of closed forest	108,612	45.3	61,646	25.7	69,225	28.9	239,483
Fallow of open forest	(61,650)	36.2	104,335	61.4	3,990	2.3	169,975
Shrubland	145,881	23.4	442,740	71.0	35,503	5.7	624,124
Total							**2,968,771**

LAND ALLOCATION



The satisfactory allocation of land should be absolutely central to the development planning of any nation. Unless the right decisions are made at this stage there is little chance of development that can be sustained.

The land resource in tropical forest countries varies greatly. Certain areas arc critical for the maintenance of water supplies; others are of unique importance for preserving genetic resources and the full range of plant and animal species. Some have the potential to yield large quantities of timber or other forest produce. Some contain soils that are suitable for productive, sustained agriculture; others are totally unsuitable for cultivation.

Over and above these physical and biological characteristics, some areas are occupied by local peoples while others belong to the government and are consequently free from local land rights.

The allocation of land should attempt, therefore, to match objectives to the resources available. Except in cases of compelling national necessity, it should avoid using resource capital as a substitute for income. If well done, this allocation assigns to each desirable use a proper share of the most appropriate lands available. The end result is potentially more valuable than any alternative.

A prerequisite for satisfactory allocation is an evaluation to determine the degree to which different land areas are suited for, and will tolerate, each of the various potential uses. This may do much to prevent conflicting claims for the use of the land, though it cannot always eliminate them.

Once land has been used for certain purposes, it is often, although not always, impossible to reverse the process and restore it to its earlier state. This may be because we do not know how to do so (even with all our present knowledge of science, the smallest area of tropical forest cannot be reconstructed) or because it is too expensive. Misallocation may lead to such extreme

degradation that the value of the site for all purposes is permanently impaired. The wise allocation of land is therefore of the highest importance - and the greatest care should be taken over any decision that will lead to irreversible change - for it will ensure the best immediate use and the least possible restriction of future use. This is crucial because the needs and skills of future generations may be different from our own, and conditions may change. For example, agricultural land may prove to be more valuable than a reservoir, or a unique example of natural forest more valuable than degraded grassland.

LAND EVALUATION AND SURVEY

Background

Wise and successful allocation of land depends on facts. Any decisions regarding its designation and allocation should be based on as much relevant environmental, social and economic information as possible. This is essential in order that the merits of alternative patterns of development may be compared. These facts may best be supplied by environmental resource surveys, sensitive analysis of the needs and desires of people who will be affected and a careful assessment of demand and markets.

The kind of information required inevitably varies according to the land-use envisaged. For example:

- for agriculture and plantation forestry, the main environmental prerequisites are a knowledge of climate and soil; the relative importance of these varies according to circumstances. Other important factors are the levels of technology and capital that are likely to be available, the farming systems likely to be introduced, the technical skills of the farmers, accessibility to markets and availability of labour.
- for the management of natural forests for timber production, accessibility to markets and availability of labour also need to be considered, but the present composition of the forest and its potential for adequate regeneration and production are particularly important; and
- for natural areas (which are to be retained and managed as such) the important features are their present flora and fauna, the extent to which they are either unique or representative of important ecosystems, and intrinsic characteristics such as species diversity and endemism. Of special significance are the homelands and customary rights of indigenous peoples.

Each area may also have environmental features which make it suitable for other forms of development, such as mineral extraction, dam or road construction, the siting of new towns, etc. The ecological effects of any such developments should be examined closely before proceeding further - the process known as "Environmental Impact Assessment".

Where detailed surveys of climate, soils, flora and fauna, mineral resources, topography and hydrology, land ownership and social preferences are available, these may, with suitable interpretation, supply the required information. If such surveys have not already been carried out, they should be started as soon as is feasible. Of particular importance are the early preparation of topographical base maps, the establishment of a regional meteorological network and the systematic collection of relevant statistical information on population, health, hydrology, soils, etc.

There are also certain short cuts - for use in the absence of such information. Much can be accomplished by the use of remote sensing or aerial photography, for example. Surveys of vegetation can also be valuable for regional planning. These provide good general measures of climatic conditions and thus of the potentialities and limitations of an average site for various kinds of land-use. Within each vegetation zone there are, of course, extreme sites where the nature of the soil overrides or compensates for the influence of climate, and offers special potential or imposes special constraints. In most circumstances, knowledge of both climate and soil is necessary to reliably assess a site's capability.

The majority of nutrients on a site covered by tropical forest are stored in the vegetation or surface layers of the soil, the luxuriance of the forest is no measure of the fertility of the soil on which it stands. If cleared carefully, so that the structure of the soil and its nutrients are retained, some forest soils are fertile. But many are infertile. If intended for agriculture, soils must therefore be carefully surveyed with this in mind, and there should be crop trials before large areas of forest are opened up. Unless these are promising, land should be left unmodified or used for forestry. The same conditions apply to plantations of single species of trees for timber or fuelwood. In contrast, the luxuriance of a forest is often a good measure of its potential for timber production. But even this it is not always so. Areas destined for sustainable timber production should therefore be chosen on the basis of surveys that have confirmed their potential for this use.

Guidelines

27. When they are not already available, national and regional surveys should be undertaken as soon as possible to provide the information on social structure, climate, topography and land form, soils, flora and fauna, mineral resources and hydrology. Special attention should be paid to fragile or sensitive areas and those where there is intense pressure of people on resources.

28. Until detailed surveys are available, the greatest use should be made of the results of remote sensing, and of vegetation surveys, as a measure of climatic and soil characteristics.

29. Capability should be assessed separately for each possible use, or value, of the land. Land-uses or values include: potential for mineral extraction, agriculture and timber production; suitability for settlements, roads, dams and tourism; intrinsic value for conservation as examples of ecosystems, to preserve genetic resources of plants and animals; as beautiful landscapes, or as sites of historical or archaeological value.

30. Existing surveys may need to be supplemented or reinterpreted in the light of new knowledge, improved technology or changing social priorities.

31. A total catchment area is recommended as an appropriate unit for planning; and plans should include all elements of the infrastructure needed - settlements, roads, dams, water supply, siting of sawmills, processing plants for agricultural produce, and other industry.

32. Measures for conservation of the national heritage (natural protected areas and cultural sites) should be planned nationally and all local decisions should take account of this national plan.

33. Before felling, or major harvesting of forest produce, an assessment of the possible final use of the land should be made in order to enable a proper phasing and planning for development.

34. The environmental effects of alternative courses of action and legislative proposals should be assessed in advance in order to ensure that long-term costs do not outweigh short-term benefits.

35. National interests must be balanced against the interests of any special groups in the community.

36. Once forest lands have been transformed or extensively modified the change is for practical purposes irreversible. Modifications which cause least disruption to soils and the physical structure of the vegetation are likely to be the most stable and sustainable.

37. The effects of alternative courses of action on the region in question, its surroundings and, in particular, on the whole catchment area of any affected river system, must be evaluated through an "Environmental Impact Assessment" or other appropriate means.

38. Local peoples' participation should be encouraged at each stage of planning in order to find out local wishes and preferences and evaluate the full social costs and benefits of alternatives.

39. In the course of land-use planning, it may be decided to leave forest untouched in order to have a reserve of unallocated land. But in the case of protected forest, national parks and nature reserves, land should be allocated specifically for these purposes and not looked upon as a reserve which is available for future conversion.

40. Before deciding to modify or transform untouched areas, every consideration should be given to alternatives. This may include adapting areas that have already been changed to more productive uses, for example using grasslands for pine plantations. Alternatively, it may involve the intensification of existing uses or using areas for more than one compatible purpose.

41. The effects of any major development should be monitored and evaluated; the results of this evaluation may be used, if necessary, to modify the course of development and will provide experience to guide future development schemes.

ALLOCATION, CONFLICTS AND MULTIPLE USE

In the previous section it has been emphasised that society has a number of possible uses for areas covered with tropical forest, and that firm allocation of forest areas to such uses is of the highest importance if optimal use is to be attained. Yet there are often strong differences of opinion and conflicts about the best ways to manage the land in the national interest. The choices are not easy.

Broadly, there are three main alternatives:

- to keep the forest as it is because of its intrinsic value;
- to manage it as a source of raw material; or
- to remove the trees and use the soil for other purposes.

The choice between these is essentially a political one, which snould be governed by national priorities. Governments frequently depend, in making these decisions, on calculations of costs and benefits in economic terms. This is a useful guide provided that the methodology employed places a true value on the natural resource and allows effectively for inter-temporal comparison. Unfortunately many evaluations have not adequately reflected either the influence of special interest groups or the cost of making decisions which are ecologically flawed.

The difficulty is caused by those values of a tropical forest - and there are many - that are difficult or impossible to quantify in monetary terms. Such values include their importance:

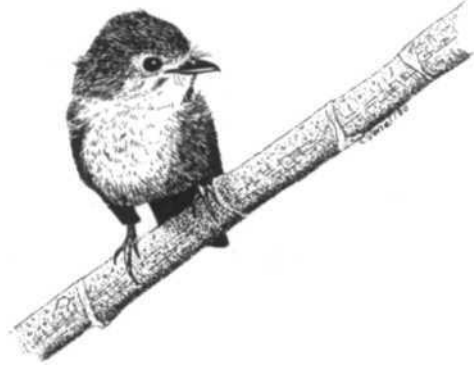
- as part of the world's reserve of forested land and bank of stored carbon;
- as part of global biological diversity
- as the living space of indigenous peoples;
- for the preservation of particular species, ecosystems or landscapes; and
- because the forest acts as a guardian of soil fertility, prevents erosion, regulates the run-off of water and has a moderating influence on climate.

These are often known as the protection and the conservation functions of the forest They contrast with the production function, as a source of forest products, and the conversion value, once the area has been converted into agricultural land, reservoirs etc.

It is difficult to give any hard and fast guidelines to govern such national, political choices; but certain questions should always be asked:

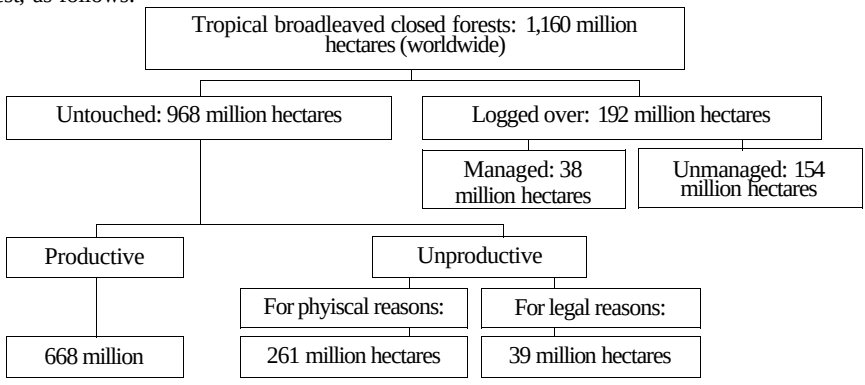
- Is the proposed change of use irreversible?
- Does it destroy an important protective function of the forest?
- Does it remove the only (or best) example of a natural ecosystem or area which is a significant part of the nation's natural or cultural heritage?
- Will the benefits foregone by those who might use the forest in the future, and the future costs likely to be incurred for land restoration or social support to communities affected by the change, be likely to exceed the benefits derived by forest conversion?

If the answer to any of these questions is affirmative, every effort should be made to find an alternative. Failing this, the development should only be permitted if it is overwhelmingly in the national interest.



THE LOSS OF TROPICAL FORESTS

The FAO/UNEP Tropical Forest Resource Assessment concluded that in 1980 the world resource of tropical closed forests covered 1,200 million hectares, of which 1,160 million hectares were broadleaved. A further 240 million hectares of closed forest was in fallow following clearing for shifting agriculture. The uncleared area was broadly divided into untouched and logged-over forest, as follows:



According to these figures 83 per cent of the present extent of broadleaved closed forest is in a natural or near-natural state. 69 per cent is productive in the sense that it is accessible and available for exploitation for its timber.

For the period 1980-1985, FAO estimated that 5,8 million hectares of productive closed forest were being cleared every year, as was a further 1.3 million hectares of commercially unproductive forest, some of which was in national parks and reserves. The total annual rate of clearance of closed broadleaved forest was therefore estimated at 7.1 million hectares. A further 0.4 million hectares of bamboo or conifer forest and 3.8 million hectares of open forest were estimated to be cleared. This gives a total of 11.3 million hectares of all tropical forests; a figure which has come to be widely quoted. Over half of this was forest land that had already been logged-over; the proportion was higher for Africa (77%) and Asia (70%) than for tropical America (43%).

Expansion of agriculture was the single greatest cause of deforestation. It was estimated that shifting agriculture accounted for 70 per cent of deforestation in Africa, 50 per cent in Asia and 35 per cent in Latin America.

During the latter years of the 1980s, as new forest cover estimates based on satellite imagery have become available, it has become clear that in many countries the rate of deforestation is higher than that estimated by FAO. However, many of the more extravagant published claims have been based on uncritical examination of the data and considerable extrapolation.

The biggest documented increase in deforestation over the FAO 1980 estimate is in Brazil and Indonesia and is due to fire. Drought in 1982-83, followed in 1983 by the Great Fire of Borneo burned 4 million hectares of forest. It is debatable whether this should be classed as deforestation, or as disturbance from which the forest, if not further disturbed, will eventually recover. It has been widely reported that fires set by farmers in Brazil burned 20 million hectares of forest in 1987 and a similar amount in 1988. But it is likely that these figures are over-estimates because of the coarse resolution of the satellite imagery used. A more probable figure for total deforestation in the Brazilian Amazon in these years is 3.5 million hectares (Feamside 1990). There are many other countries where deforestation rates are now thought to be somewhat higher than those estimated by FAO. *In 1990 both FAO and the World Resources Institute in Washington released new estimates of total tropical deforestation of 17 million hectares a year.*

ECOLOGICAL CONSTRAINTS TO DEVELOPMENT

Certain features of tropical ecosystems impose fundamental constraints upon the use to which tropical forest lands can be put The natural ecosystems that have evolved in situ are highly adapted to make optimum use of the resources available, but artificial systems that replace them are often less efficient

The following general principles about ecological constraints to development can be drawn:

Tropical soils are highly susceptible to physical degradation particularly if they are mechanically disturbed, exposed to the sun or exposed to the direct impact of heavy tropical rainfall. Highly adapted biological cycles and interactions are equally susceptible to disruption, with results that are difficult to predict.

Many tropical rainforests have existed in their present form for long periods of geological time. High rainfall over these long periods has washed many water soluble mineral nutrients out of the soil. This process is known as leaching. High temperatures and the high level of biological activity have resulted in this process being more pronounced in the tropics than in the temperate zones. Where they have not been enriched by minerals transported to the site by volcanic, mountain building or alluvial forces, tropical soils are often very poor and nutrient availability is a major factor limiting biological productivity. Many decision makers underestimate the extent to which the leaching of mineral nutrients limits the options for development in areas of tropical moist forest

Natural ecosystems have evolved to make efficient use of available nutrients; and complex mechanisms exist to recycle nutrients within the ecosystem. The high biological diversity of tropical forests, and particularly of their soil fauna and flora, results in part from evolution to optimise nutrient use. Physical disturbance of the ecosystem disrupts the nutrient cycling mechanisms and results in nutrients being lost to the locality either by leaching or through removal in exploited products. Plantations, agricultural lands, pastures and secondary forests often make less efficient use of the nutrients present in the soil and this may accelerate nutrient loss to the system through leaching. Even when they are more productive in the short term, the loss of nutrients that they cause may lead to declines in yields in the long term. The higher the rainfall, the more susceptible the soil is to leaching and the more powerful this constraint becomes.

In the various biogeographical regions of the world different nutrients tend to be in short supply. In many temperate regions calcium is limiting; in the dry tropics nitrates are critical; and in the humid tropics phosphates and potassium are more frequently the critical nutrients. Many trees of the moist forest have evolved complex symbiotic relationships with mycorrhizal fungi, which enable them to make more efficient use of these and other nutrients. Plantation and agricultural crops which lack these symbionts are not efficient producers in tropical moist forest lands.

In some tropical regions soils have been greatly enriched by recent volcanic activity or alluvial deposition. The island of Java, the Rift Valley and adjacent highlands in central Africa, and several floodplains in south-east Asia are notable examples. Nutrient poverty is less of a constraint to development in these areas.

Tropical moist forests are notable for their great richness in species of animals and plants. The reasons for this species richness are still not fully understood. In some regions species richness increases with increasing rainfall and, especially, with longer duration of the rainy season; but this is not true of biomass which is highest in areas receiving between 2000 and 3000 mm of rainfall and with a distinct dry season. The richest forests are usually found in the lowlands on soils of medium fertility. The number of species usually decreases sharply in extreme conditions, of drainage, altitude or soil nutrients.

Moist forests are characterised by a high level of species interaction. There are many examples of species whose life cycles are so intimately interrelated with those of other species that they cannot survive in isolation. Notable examples are the various root symbionts which promote the movement of nutrients from the soil to above-ground vegetation. Efficiency of nutrient use is also an important force in the evolution of strategies for reproduction, dispersal, activity patterns, growth form and foliage replacement of plants or animals of the tropical moist forest. Many decomposer animals enter into symbiotic relationships with protozoa, bacteria and fungi that enable them to utilise nutrient-poor diets. Termites, leaf-cutting ants and wood boring beetles are examples. Apart from these nutrient relationships there are many other examples of interdependence, for example between plants and their pollinating animals and those which disperse their fruits.

Disruption of the ecosystem, resulting in loss or significant decline of one species, may impair the reproductive or dispersal efficiency of other species. The interrelations may be so pervasive that small disturbances could result in a domino-like sequence of extinctions of mutually interdependent organisms. The term "keystone species" has been used to describe species which occupy a particularly important place in the ecosystem and whose loss would result in especially dramatic ecological disruption and loss of interacting species.

The relative stability of the physical environment of tropical forests for long periods of time - and the selection against dispersal mechanisms which might incur nutrient costs - have resulted in the evolution of a high degree of localised endemism and of species with highly disjunct distributions.

Some localities have particularly high species diversity and/or endemism. This results from the evolutionary history of these areas. Sites of high diversity are sometimes, for example, thought to have been refuges where species survived past periods of climatic change.

The plant and animal species at one site may be significantly different from those found in another apparendy similar site nearby.

Natural forest ecosystems are highly adapted to physical constraints imposed by local climates. Even in high rainfall areas, drought may seriously restrict plant growth at certain seasons. Waterlogging of soils may also restrict their productivity. In very high rainfall areas the foliage

of tropical plants is adapted to shed water efficiently; in drier areas mechanisms exist to store water or reduce water loss. In some tropical areas cloud cover is so heavy and persistent that lack of sunshine restricts productivity. Options for plantation and agricultural crops are limited by these climatic constraints.

Guidelines

42. Serious constraints are imposed on tropical land use by soils poor in nutrients. The long-term stability and productivity of natural ecosystems results from their highly evolved adaptation to deal with local nutrient constraints. The possibility of gradual decline in productivity of plantations, agricultural crops, pastures and managed forests through soil nutrient depletion must be recognised.

43. Because of the low prices commanded by products, and because of remoteness and transport problems, it is rarely economically or logistically possible to use inorganic fertilisers on a large scale on lands cleared from moist tropical forest. The use of crops or trees with nitrogen fixing symbiotic bacteria and various other agroforestry systems can enhance the availability of nutrients and the efficiency of their use.

44. The interactions between species are much more complex in tropical than temperate ecosystems. The impact of relatively minor disturbance to the ecosystem may be far reaching and hard to predict Loss of one species may lead to the extinction of many others which depend upon it at some stage of their life cycle.

45. Local variations in soils and climates, and in the ecological history of sites, results in a large number of distinct ecosystems in tropical moist forests. As much as possible of this variation must be conserved if the full potential of tropical lands is to be realised.

46. The higher the total rainfall and the longer the rainy season, the more difficult it is to grow plantation or agricultural crops in the tropics.

BIOLOGICAL DIVERSITY IN TROPICAL FORESTS

Biologists around the world are increasingly vociferous in their warnings that the earth is on the brink of a "mass extinction". Ecologists have found that there is a direct relationship between the area of a natural habitat and the number of species it can sustain. Experiments have confirmed that reducing habitat size increases the risk of species extinctions.

About 1.4 million species of animals and plants are known to science - but there are believed to be at least three times this number waiting to be discovered, and possibly many millions more. The richest environment of all, the canopy of the tropical rain forest, is only now beginning to yield some of its secrets to scientists. But species are disappearing before they have even been found and described.

Tropical forest species are especially prone to extinctions. The ideal ambient conditions for organic life, the struggle for nutrients, competition between predators and prey, and between herbivores and plants, have led to astonishing levels of species diversity and biological specialisation - each species with a very narrow set of ecological requirements. Most species of tropical trees, birds, mammals and even invertebrates, occur at low densities, and once a tract of forest is reduced to isolated pockets, the fragments begin to lose species.

The Atlantic rain forest along the east coast of Brazil, once covering several thousand square kilometres, is now reduced to 15 or so tiny fragments. Less than two per cent of the original area can be protected, but each forest island is packed with endemic species. Numerous other cases of fragmented forests could be cited from Ecuador to India, Cote d'lvoire to Malaysia.

The still extensive forests of Brazil, Zaire and Indonesia will, at present rates of deforestation, last well into the next millenium. Yet even in these great expanses of trees, species distribution is patchy. Distribution has been affected by vagaries of the Earth's climate over geological time: the boundaries between tropical forests, woodlands and deserts have undergone great expansions and contractions. The richest areas - those forests that have remained intact since before the Pleistocene Ice Ages - act as centres from which recolonisation of geologically younger adjacent forests is even now taking place, although slowly. Our knowledge of the location of these forest refugia is incomplete, but the richness of reserves such as Tambopata in Peru and Korup in Cameroon have become legendary. But these too are subject to the laws of biogeography and susceptible to extinctions.

BIOLOGICAL DIVERSITY IN TROPICAL FORESTS

Known and Estimated Diversity of Life on Earth

Form of Life	Known Species	Estimated Total Species
Insects and other Arthropods	874,161	30 million insect species, extrapolated from arthropods surveys in forest canopy in Panama; most believed unique to tropical forests.
Higher Plants	248,400	Estimates of total plant species range from 275,000 to as many as 400,000; at least 10-15% of all plants are believed undiscovered.
Invertebrates[1]	116,873	True invertebrate species may number in the millions; nematodes, eelworms, and roundworms each may comprise more than 1 million species.
Lower Plants[2]	73,900	Not available.
Microorganisms	36,600	Not available.
Fish	19,056	21,000 assuming that 10 percent of fish remain undiscovered; the Amazon and Orinoco rivers alone may account for 2,000 additional species.
Birds	9,040	Known species probably account for 98 percent of all birds.
Reptiles and Amphibians	8,962	Known species of reptiles, amphibians, and mammals probably comprise over 95 percent of total diversity.
Mammals	4,000	
Total	1,390,992	10 million species considered a conservative estimate; if insect estimates are accurate the total exceeds 30 million.

[1] Excludes arthropods, includes 1,273 miscellaneous chordates.
[2] Fungi and algae.

Source: *On the Brink of Extinction: Conserving the Diversity of Life*, E.C. Wolf, Worldwatch Paper 78, 1987.

FORESTS FOR NATURE CONSERVATION AND ENVIRONMENTAL PROTECTION

Lands for forest conservation and protection fall into three basic categories:

- **protection forests,** where the forest is used to protect soils from erosion and to preserve the water flow and regulation functions of river catchments;
- **nature conservation forests,** which are established for the conservation of natural ecosystems and the full diversity of species which they contain; and
- **genetic resource forests,** which are established to preserve genetic resources of special value which are not adequately represented in conventional protected areas. They aim to include not only species but also the range of genetic variation within species by preserving distinct populations as well as the species as a whole.

Many of the functions of protection, conservation, genetic resources and even production forests may be complementary to one another. For example, it is usually possible to allow areas in protection forests to be used for scientific research, education and recreational tourism, provided that certain conditions are met Normally, this means that one part (often known as the "core") remains completely protected, while use of the rest is regulated to be consistent with the primary aim of protection.

Conservation forests also, incidentally, protect soils and water supplies, while protection forests contribute to nature conservation. Similarly, the conservation of genetic resources is promoted by both these kinds of forest, though additional measures may be necessary.

It may even be possible to permit carefully controlled cropping of timber and other products without interfering with the protective function of these three categories, but all interests will suffer if this protective function is damaged.

Proper allocation is not enough; there must also be clear and explicit objectives of management and these objectives must be effectively met In other words, where it has been decided that an area should be allocated for a protective use, this use should in all cases take priority over all others, because other uses might irreversibly damage the protective value of the forest.

Guidelines

47. For each conservation or protection area, a primary objective of management should be determined and other uses should be permitted only if they do not conflict with this primary use.

48. Those forests which are of critical importance for the conservation of biological diversity or which fulfil critical environmental functions should be legally gazetted by the highest competent authority of the country and should in no circumstances be modified or cleared.

49. It must however be recognized that many kinds of careful extractive use can be compatible with species protection and the maintenance of hydrological functions. In these circumstances management regimes which permit controlled exploitation by, and under a degree of control of, local communities may be more viable than attempts to impose total protection in the face of possible resentment and hostility on the part of traditional users of the area. The extractive reserves in Amazonia and certain forests managed for the controlled extraction of small volumes of timber for local use, fall into this category.

PROTECTION FORESTS

Background

Most natural forests protect soil fertility, prevent erosion, regulate water run-off and have a moderating influence on climate. The purpose of protection forests is to maintain these values, in particular to maintain soil depth and quality in the catchment and to regulate the quantity and quality of the water yield from it Erosion, siltation and excessive fluctuations in water flow will thus be avoided. Protection forest is therefore essential for preserving the agricultural productivity of rich valley lands and for ensuring reliable water supplies for domestic use, irrigation and industry.

Other kinds of vegetation cover and land uses besides natural forest can sometimes protect catchments. Thus shrublands and grasslands may provide adequate protection even on quite steep slopes but, if these areas are trampled by domestic livestock or are burned, serious erosion may occur. Selectively logged forest can provide adequate catchment protection but, if heavy vehicles are used on slopes, logging roads are not properly constructed or skid trails run straight up and down slopes, erosion may be serious. Natural forest is always the safest choice, and it is better to retain the original cover unless there are compelling reasons to do otherwise.

If forests are removed without ensuring that the alternative use will conserve both soil and water, there can be untold damage to downstream agricultural production, as well as to property, creating conditions for disease and rendering rivers and estuaries unnavigable. The cost of remedial measures, if indeed they are feasible, may be extremely high.

Guidelines

50. Catchment protection in the tropics is so important for ensuring food security and protecting water supplies that the designation of catchment protection areas must have very high priority.

51. The conditions under which it is necessary to maintain intact forest cover vary according to slope, soil erodability and climate. General specifications for protection forest cannot therefore be laid down, but should be determined individually for each country or region.

52. If they have not already done so, governments should draw up specifications (covering soil type, erodability, climatic conditions etc) for areas that must be scheduled as protection forests and should ensure that these are respected.

53. Specifications should also be drawn up, based on the necessary research, to determine what kinds of exploitation may be permitted in protection forests. Permissible exploitation may include: the harvesting of medicinal herbs, extraction of carefully selected trees, the collection of genetic material, and so on. The specifications should ensure that such activities are carefully licensed and controlled and do not interfere in any way with the forests' protective function.

54. Governments should identify all deforested catchment areas which are contributing to soil erosion and irregular river flow. As a matter of urgency, every effort should be made to restore a stable cover of trees or other vegetation which will protect the soil and regulate water flow to the same extent as the original forest.

55. Critical catchment areas of this kind should only be used for food production when there is no other acceptable alternative. Where this is the case, agroforestry systems should be adopted which copy as closely as possible the protective structure of the natural vegetation, and which will continue to protect the soil even if they are abandoned or neglected.

NATURE CONSERVATION FORESTS

> *"The total expanse of protected areas needs to be at least tripled if it is to constitute a representative sample of earth's ecosystems."* (WCED, 1987)

Background

Within tropical forest regions there are a great number of forest types and other natural ecosystems. It is critical to preserve sufficiently large samples of each of these, to be self-perpetuating. It is particularly important to conserve samples of the various types of lowland rain forest on fertile soil, for these are under the greatest pressure for conversion to agriculture and often support ecosystems and species not found elsewhere.

It is often argued that conservation forests take up land that could be used for productive purposes and that a nation cannot afford to make this apparent sacrifice. It is true that a complete cover of conservation forests does compete with other uses, but the extent of that competition is often exaggerated. If samples of the various types of forest are chosen well and early (which implies a survey of the resource) the percentage of the total land area devoted to them need not compete unduly with other forms of land use; and, by careful planning and management, it may

BUFFER ZONES

Buffer zones are areas peripheral to national parks or reserves which have use restrictions to give added protection to the reserve, and to compensate local people for the loss of access to the resources of strict reserve areas. They provide the following benefits:

Biological benefits. Buffer zones provide a physical barrier to human encroachment into the strictly protected core zone. In small isolated reserves they provide extra protection against storm damage and micro-climate variation. They enlarge the effective area of natural habitat of the reserve and reduce species loss through edge effects. They extend the habitat and thus the population size of large wide-ranging species. They enhance the environmental services provided by the reserve, for instance by protecting watersheds and contributing to climatic regulation.

Social benefits. Buffer zones promote sustainability of use of wild plant and animal species by local communities. They can thus safeguard supplies of medicinal plants and hunted wildlife which might otherwise disappear under intensive agricultural land use. They provide a mechanism by which local people can genuinely benefit from the existence of a protected area and will thus foster local interest in supporting conservation programmes. Local people are compensated for loss of access to the resources of the core area.

To achieve these benefits the following criteria must be observed:

- The structure and species composition of the vegetation cover in the buffer zone should be as close to that of the strict reserve area as possible.
- The biological diversity of the buffer zone should be as high as possible.
- The vegetation of the buffer zone should be as heterogeneous and stratified as possible.
- The capacity of the ecosystem in the buffer zone to retain and recycle soil nutrients should be preserved as far as possible.
- Buffer zone activities should not have negative impacts on the physical structure of the soil or on its water regulating capacity.
- As far as possible, exploitation of buffer zones should be based upon traditional, locally adapted lifestyles and resource management practices.

Techniques for managing buffer zones are reviewed in the 1991 IUCN Forest Conservation Programme publication *Rainforest Buffer Zones: Guidelines for protected area management,* and in the 1988 IUCN Tropical Forest Programme publication *Buffer Zone Management in Tropical Moist Forests: Case studies and guidelines.*

be possible to combine protection, sustained production and other socially and economically valuable uses, such as recreation, education, research and tourism.

More important, the justification for nature conservation is that it provides an insurance policy for the future in addition to these present benefits. It preserves a reservoir of continually evolving genetic material representative of the natural ecosystems being protected; it provides a vast

source of knowledge of potential use to the scientific community; it preserves a reservoir of wild animals and plants which may enable them to be cropped in surrounding areas; and it maintains samples of unchanged communities, thus providing controls against which the changes brought about by other forms of land-use may be measured and assessed. It is therefore important to establish conservation forests even on potentially rich agricultural soils.

In addition to these protected areas, there is great scope for managing other land in such a way that it retains a high diversity of species. Wherever possible, this should be made a supplementary objective of management of such areas. With the careful application of ecological knowledge it is frequently possible, for example, to maintain substantial populations of wild plants and animals in areas of forest that are being managed for an economic crop - indeed the wildlife may itself be part of the crop. Where land has been transformed for intensive agriculture, the maintenance of wild populations is, of course, sometimes more difficult. But the application of ecological knowledge to maintaining a high diversity of species in such areas, may diminish the risk of epidemic outbreaks of pests.

Guidelines

56. A survey and assessment should be made (at an early stage in planning) of the intrinsic value of land for the conservation of flora, fauna and natural ecosystems; and legal and administrative action should be taken to permanently secure large, typical samples of all the country's ecosystems together with any areas of exceptional interest.

57. In specific situations, where there are areas of outstanding and possibly of unique value, high priority should be given to their protection. This should be given preference over other forms of land-use and is particularly urgent in lowland rain forest.

58. Safeguarded areas should be as large and as varied as possible. It is impossible to make universally valid recommendations about these matters, for often, in practice, there is very little choice. However, the size and characteristics of the protected areas should be related to the needs of the plant and animal communities that they are intended to protect; and, wherever possible, the areas chosen should be large and should include examples of different ecosystems, representing, for example, the different altitudinal zones on a mountain or gradations of wetness. (This will provide some insurance against climatic change).

When the land surrounding protected areas becomes intensively used, these are left as "islands". Their edges become altered for some hundreds of metres and the areas become very vulnerable to such external factors as climatic extremes. The danger of losing species can be lessened by making reserves larger and more varied, or by regulating land-use in the areas between them so that migration is possible.

59. The larger and more varied the area, and the more sympathetic the land-use surrounding it, the less active management is likely to be required to maintain its value.

60. In planning the overall development of any area, provision should be made for the migration of animals and dispersal of plants between protected areas, for example by leaving corridors between reserves.

61. Wherever possible, areas set aside to safeguard samples of natural ecosystems should be surrounded by buffer zones, taking advantage of physiographic and other natural protective features. These should be maintained under natural vegetation or, if this is impossible, under protective tree cover; but they can be used for any form of economic land-use that does not interfere with the integrity of the protected area.

When a protected area is established in an inhabited region, various supporting measures may be necessary to withdraw pressure from the protected area and to make it acceptable to local people. Unless there is local sympathy and understanding for a protected area among the people who live around it, it is unlikely to survive.

62. Protected areas should only be established after close consultation with the people living in or near them.

63. Measures should be taken to ensure that the people benefit economically from the protected area.

64. Where these measures are not enough to prevent continuing damage to the protected area, steps should be taken to attract the population to new and less harmful forms of economic activities: more intensive agriculture, the managing of community forest, agroforestry systems or small-scale industry. Pressure may be reduced still further if these are sited at some distance from the protected area.

65. The objectives of management for such a protected area should be carefully defined and adhered to. They should include maintaining part of the area completely undisturbed, as a standard for comparison; but in the remainder, uses for scientific study, for education and for recreation should be encouraged, provided that these uses do not conflict with the primary purpose of protection.

66. There should be a management plan for each protected area, and the course of management should be monitored to assess whether the original objectives were reasonable and the management has been successful.

67. By the careful manipulation of controls and financial incentives it may be possible to maintain "protected landscapes" which combine the function of nature conservation with those of a thriving and developing local community.

68. Management of land outside protected areas should be carried out in such a way that reasonable populations of wild plants and animals can survive in them. By maintaining variety, this may often prevent any of these species from becoming pests. Sometimes also, wild species play an important part in the life cycle of cultivated plants. Their disappearance may prove to be serious.

GENETIC RESOURCE FORESTS

"Species and their genetic materials promise to play an expanding role in development, and a powerful economic rationale is emerging to bolster the ethical, aesthetic, and scientific cases for preserving them. The genetic variability and germ plasm material of species make contributions to agriculture, medicine, and industry worth many billions of dollars per year." (WCED, 1987).

Background

For practical reasons, the term "genetic resources" is usually confined to the wild relatives of plants and animals that are already known to be of economic importance. The reasons for conserving these resources are clear and the economic benefits direct and immediate.

By implication, an important feature of genetic conservation is that the material preserved should be available for use. People should have access to the seed or germ plasm for use in improving the productivity, quality or resistance to pests and diseases of plant or animal crops that are already domesticated.

The objective, for any species, is to preserve its whole range of variation. As this is frequently unknown, and it is impracticable to include all species, it is necessary first to choose certain species on which to concentrate and to survey this range of variation. Where this is also impracticable, the next best alternative is to protect the populations of any species within the whole range of climatic and soil conditions in which it is found. In each separate location it is necessary to protect a population of at least 50 to 500 individuals - the number in each case depending upon the breeding system of the species in question. For some species the area needed may be quite small, for others fairly large.

If the system of nature conservation forests of a country is comprehensive, populations of all species of plants and animals will be preserved. In reality this is rarely the case and complementary measures are required to ensure the conservation of the full range of species and the genetic variation that they contain. In temperate lands many species are preserved only in small intensively managed modified ecosystems (nature reserves). Regrettably, in the future, this will increasingly be necessary in the tropics. To compliment the function of genetic resource reserves special management prescriptions may be applicable in production forests. This will enable them to serve the additional function of genetic resource conservation.

Guideline

69. National surveys and conservation programmes for genetic resources should be undertaken to:

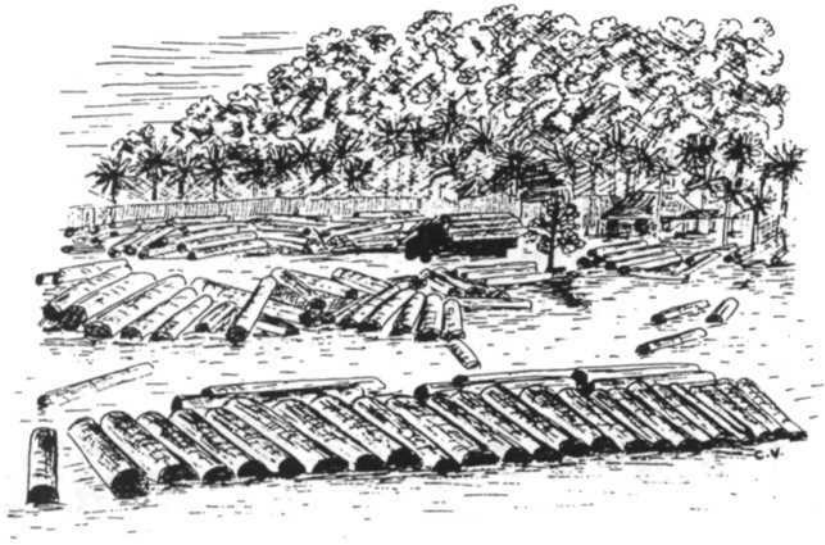
- **identify species of actual or potential economic importance;**
- **determine the extent to which the varieties of each species are preserved in existing protected areas;**
- **establish additional protected areas as necessary;**
- **apply additional management, both in protected areas and in production forest, to preserve genetic resources and make them available for use.**

CATEGORIES AND MANAGEMENT OBJECTIVES OF PROTECTED AREAS

1. **Scientific reserve/strict nature reserve.** To protect nature and maintain natural processes in an undisturbed state in order to have ecologically representative examples of the natural environment available for scientific study, environmental monitoring and education, and for the maintenance of genetic resources in an evolutionary state.
2. **National park.** To protect relatively large natural and scenic areas of national or international significance for scientific, educational and recreational use, under management by the highest competent authority of a nation.
3. **Natural monument/natural landmark.** To protect and preserve nationally significant natural features because of their specific interest or unique characteristics.
4. **Managed nature reserve/wildlife sanctuary.** To ensure the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment when these require specific human manipulation for their perpetuation.
5. **Protected landscapes.** To maintain nationally significant natural landscapes characteristic of the harmonious interaction of man and land while providing opportunities for public enjoyment through recreation and tourism.
6. **Resource reserve.** To protect the natural resources of the area for future use and prevent or contain development activities that could affect those resources.
7. **Natural biotic area/anthropological reserve.** To allow the way of life of societies living in harmony with the environment to continue undisturbed by modern technology.
8. **Multiple-use management area/managed resource area.** To provide for the sustained production of water, timber, wildlife, pasture and outdoor recreation, with the conservation of nature primarily oriented to the support of these economic activities.
9. **Biosphere reserve.** To conserve for present and future use the diversity and integrity of representative biotic communities of plants and animals within natural ecosystems and to safeguard the genetic diversity of species on which their continuing evolution depends.
10. **World Heritage site.** To protected the natural features for which the area was considered to be of world heritage quality and to provide information for worldwide public enlightenment.

The IUCN publication *Managing Protected Areas in the Tropics (1986)* gives much useful information on approaches to the management of these different protected area categories.

FORESTS FOR WOOD



Background

Timber generally comes from four main sources: as a first cut from indigenous natural forest; from the later management of those forests; from man-made plantations; and from trees felled during the conversion of natural forest to other land-uses. Policies for the allocation of land should have determined which areas will be used in each of these ways.

In many countries, production of timber and other wood products remains a most important economic use of natural forests. The "production forests" from which this timber is obtained can also provide numerous other products, which often play an important part in the economy of local communities. In most situations, carefully controlled timber extraction and effective protection (with or without subsequent silvicultural treatment) will allow these forests to go on providing a continuous supply of high-quality timber and other products indefinitely. If, however, the forest is badly logged, relogged after too short an interval or invaded by shifting cultivators, it can become rapidly degraded to less productive secondary growth or grassland.

The rate of timber extraction in tropical forest areas grew rapidly in the 1960s and 70s, most of it from the first cut of primary forest. As the reserves of unexploited forest decline, it is likely that the present situation of surplus will move to one of scarcity; and the supply from primary forest will be replaced by that from secondary forest or plantations. The "mining" of wood from the forest will therefore be replaced by management of the modified forest for a sustainable yield, or by "tree farming".

Logging leads to changes in the composition and structure of the forest; the more intensive it is, the greater the change. Later crops will be different from the first cut taken from the original forest Management will cause forest to become more uniform in structure and the crop will probably consist of fewer species of a higher growth rate and more uniform wood of lower density. There is therefore always a trade-off between intensity of timber production and the conservation of biological diversity.

Carefully planned extraction and later management can be used to change the composition and structure in desired directions, for example to give preference to timbers of the highest value, or to leave large individual trees or species which are important for wildlife, such as figs. If, however, the objectives of management are not confined to producing a crop of timber but are expanded to include other plant products and wild animals, these aims can usually be met most satisfactorily if the forest is managed in such a way that its structure and composition remains close to that of the natural forest. Such a structure also tends to be more stable under local conditions and provides the best security against epidemics etc. It is not therefore advisable to go further than is necessary in changing species and structure.

Specifications for management differ from one forest type to another. In some areas there is already sufficient knowledge for good management. Elsewhere, there should be more research to provide the necessary information; and, until reliable facts are available, it is well to exercise caution. But there seems little doubt that management of tropical moist forest for the sustainable production of timber is technically possible in most regions, if the other necessary conditions for sustainability are met (see Poore *et al.,* 1990).

As a result of land pressures, many lowland forest areas are being converted to agriculture, and forestry production is being pushed onto poorer soils or hilly areas where many of the silvicultural problems of forestry are yet to be resolved and road building and extraction are more difficult and expensive. This unfortunate tendency should be resisted by the proper allocation of forest land to production forestry.

Where a country still has substantial areas of forest left, it should set aside a "forest estate", chosen for its potential quality and productivity. This estate should be chosen, as far as possible, to meet predicted future timber needs. Managed natural forest offers several advantages over plantations: the product is more varied and will give more options in unpredictable future markets; the cost of forest management is lower, the natural forest is less liable to damage from pests, diseases and natural disasters; and it provides more environmental services. In the very humid tropics, especially, plantations of single species have often encountered serious disease and management problems and thus constitute a higher risk than natural forests.

Government investments in forestry, particularly those supported by aid agencies, have often been based on simple financial analysis of the value of timber produced per dollar invested. The predominance of this aid money in the budgets of many tropical country forest departments has resulted in a bias away from natural forest management towards plantation forestry. But, when a broader economic analysis is applied, and the various costs and benefits incurred by both local and distant users are included, the case for investing in natural forest management becomes much stronger.

ITTO has recently carried out a survey of the status of tropical forest management for the sustainable production of timber (Poore *et al.,* 1990). It has also, as has already been mentioned, set the goal of the year 2000 as the date by which time all timber entering international trade should come from sustainably managed forests. As a part of the process which is designed to lead to this highly desirable state of affairs, ITTO has also prepared and published "ITTO Guidelines for the Sustainable Management of Natural Tropical Forests" (ITTO, 1990).

Guidelines

70. Natural forests which are managed for a sustainable production of timber will also provide numerous other benefits to society (watershed protection, biological diversity conservation, a variety of minor forest products). Although timber needs could often

be met from plantations for similar levels of investment, the multiple benefits of the forest would not then be safeguarded against competing land uses. Where options still exist countries should attempt to derive the maximum of their timber needs from a managed "natural forest estate".

71. Such forests should be managed according to the best available principles of silviculture, and in such a way that the natural composition and structure are altered no further than is necessary.

72. Management should be directed at getting the best total return from all forest products, consistent with ensuring that the forest resource base is not depleted.

73. Efforts should be made to widen the range of products that can be used or marketed. The relative values of the various products may change from time to time and new uses may be discovered. A forest which still retains its varied potential can best respond to changes in demand.

74. Good management depends upon a knowledge of the ecology of the principal economic species in any particular forest; this should be given priority in research.

75. Incentives should be provided to those harvesting the forest, whether concessionaires or others, to encourage them to maintain the potential productivity of the forest.

76. Management plans should be prepared for each area of production forest. It should be the responsibility of the Forest Authority to ensure that these are followed.

77. Timber extraction and road building should be carried out in ways that least damage soil, vegetation and watercourses.

78. Predicted timber requirements should take account of local needs for fuelwood. When the viability of the forest is threatened by fuelwood collection, special plantations should be established near the site of demand - but outside the forest - to reduce pressure and preserve areas of forest for future allocation. Alternative sources of fuel (e.g. biogas) should also be developed.

79. When tree plantations are needed to meet demands for wood, they should be placed in non-forested areas wherever there are suitable sites. Such are often provided by waste and degraded lands or abandoned agriculture. Plantations need not be in blocks; they may be more appropriate in and around villages, along roads and canals or in association with agricultural crops. Multi-purpose trees (for fuel, fodder, timber for local construction) can often best serve the needs of local communities, and much can be accomplished by encouraging the recovery of natural vegetation. In densely populated regions, plantation forests can provide effective buffer zones around nature conservation forests.

SYNOPSIS OF ITTO GUIDELINES FOR SUSTAINABLE FOREST MANAGEMENT

The following Guidelines have been adopted by ITTO to promote sustainability of forest management. A number of these are concerned with policy and land allocation but are repeated here for the sake of completeness.

- A strong and continued political commitment at the highest level is indispensable for sustainable forest management to succeed.
- An agreed forest policy should be supported by appropriate legislation which should, in turn, be in harmony with laws concerning related sectors.
- There should be a mechanism for regular revision of policy in the light of new circumstances and/or availability of new information.
- A national forest inventory should establish the importance of all forests, independent of their ownership status, for the purposes of both conservation and production.
- There should be flexible provisions for such inventories to be broadened to include information not previously covered, if and when the need and opportunity for such additional information arises.
- Certain categories of land, whether public or private, need to be kept under permanent forest cover to secure their optimal contribution to national development
- The different categories of land to be kept under permanent forest are: land to be protected; land for nature conservation; land for production of timber and other forest products; land intended to fulfil combinations of these objectives.
- Land destined for conversion to other uses (agriculture, mines etc.) and any land for which the final use is uncertain, should be kept under managed forest until the need for clearing arises.
- The principles and recommendations for implementation of these guidelines apply equally strictly to national forests and privately owned or customarily held forests.
- There should be a national agency capable of managing the government forest estate, and assisting in the management of private and customarily held forests, according to the objectives laid down in the national forest policy.
- Forests set aside for timber production are able to fulfil other important objectives, such as environmental protection and, to a varying extent, conservation of species and ecosystems. These multiple uses should be safeguarded by the application of the environmental standards, spelled out below, to all forest operations.
- Proper planning, at national, forest management unit and operational levels reduces economic and environmental costs and is therefore an essential component of long-term sustainable forest management.
- The forest set aside for timber production should be the subject of a more detailed inventory to allow for planning of forest management and timber harvesting operations. The question of type and quantity of data to be gathered should be the subject of cost-benefit analysis.
- Management objectives should be set rationally for each forest management unit. Formulation of objectives should allow the forest manager to respond flexibly to present and future variations in physical, biological and socio-economic circumstances, keeping in mind the overall objectives of sustainability.
- The size of each production forest management unit should preferably be a function of felling cycle, the average harvested volume per ha and annual timber outturn target of the operating agency (state forest agency, concessionaire etc.)
- The choice of silvicultural concept should be aimed at sustained yield at minimum cost, enabling harvesting now and in the future, while respecting recognised secondary objectives.
- In order to ensure sustained production of timber from each forest management unit, a reliable method for controlling timber yield should be adopted.
- A management inventory supported by a detailed map is indispensable to the preparation of working plans for each forest management unit.
- Working plans should guarantee the respect of environmental standards in field operations.
- Forest management operations can have important positive or negative environmental consequences, both in the forest itself and outside (transboundary effects). These consequences should be assessed in advance of operations to ensure overall sustainability.
- Harvesting operations should fit into the silvicultural concept, and may, if they are well planned and executed, help to provide conditions for increased increment and for successful regeneration.

- Efficiency and sustainability of forest management depend to a large extent on the quality of harvesting operations. Inadequately executed harvesting operations can have far-reaching negative impacts on the environment, such as erosion, pollution, habitat disruption and reduction of biological diversity, and may jeopardise the implementation of the silvicultural concept.
- Pre-harvest prescriptions are important to minimise logging damage to the residual stand, to increase safety for logging personnel and to attune harvesting with the silvicultural concept.
- Planning, location, design and construction of roads, bridges, causeways and fords should be done so as to minimise environmental damage.
- Extraction frequently involves the use of heavy machinery and, therefore, precautions must be taken to avoid damage to residual vegetation, soils and watercourses.
- Post-harvest operations are necessary to assess logging damage, the state of forest regeneration, [and] the need for silvicultural operations to assure the future timber crop.
- Permanent production forest should be protected from activities that are incompatible with sustainable timber production, such as the encroachment of shifting cultivators often associated with the opening up of the forest.
- Fire is a serious threat to future productivity and environmental quality of the forest. Increased fire risk during logging, and even more so following logging, demands stringent safety measures.
- Chemicals, such as those used in silvicultural treatment, constitute risks both in terms of personnel safety and environmental pollution.
- There should be incentives to support long-term sustainable forest management for all parties involved. Concessionaires should have the long-term viability of their concession provided for (mainly by government controlling access to the forest); local populations should benefit from forest management (see below); government forest departments should receive sufficient revenue to continue their forest management operations.
- For private or customarily held forests the basic approach to sustainability is the same as for government forests.
- The national forest service should provide assistance to customary rights holders and private forest owners to manage their forests sustainably.
- Timber from forest land to be converted to other uses, and from forests damaged by hurricanes and other disasters, should be optimally utilised. At the same time, disruption of management of the permanent production forest should be avoided.
- Monitoring and research should provide feedback about the compatibility of forest management operations with the objectives of sustainable timber production and other forest uses.
- Sustained timber production depends upon an equitable distribution of incentives, costs and benefits, associated with forest management, between the principal participants, namely the forest authority, forest owners, concessionaires and local communities.
- The success of forest management for sustained timber production depends to a considerable degree on its compatibility with the interests of local populations.
- Timber permits for areas inhabited by indigenous peoples should take into consideration the conditions recommended by the World Bank and the ILO for work in such areas.
- Management for timber production can only be sustained in the long-term if it is economically viable (taking full account in the economic value of all costs and benefits from the conservation of the forest and its ecological and environmental influences).
- A share of the financial benefits accruing from timber harvesting should be considered and used for maintaining the productive capacity of the forest resource.
- Forest fees and taxes should be considered as incentives to encourage more rational and less wasteful forest utilisation and the establishment of an efficient processing industry, and to discourage logging of forests which are marginal for timber production. They should be and remain directly related to the real cost of forest management. Taxation procedures should be as simple as possible and clear to all parties involved.
- In order to achieve the main principle of good and sustainable management, forest fees and taxes may need to be revised at relatively short notice, due to circumstances outside the control of loggers and the forest agency (e.g. fluctuations in international timber markets and currency values). The national forest agency should be granted the authority to carry out such revisions.
- Continuity of operations is essential for sustainable forest management.

The ITTO publication goes into considerably greater detail in proposing possible actions for implementation of these guidelines and has a number of appendices dealing with such matters as national forest inventories, roads and harvesting and concession legislation.

FORESTS FOR AGRICULTURE AND PLANTATIONS

Although highly successful systems of agriculture, for both food and cash crops, have been developed in some regions (in parts of south-east Asia, for example) the humid tropics are not an easy environment in which to conduct stable and profitable agriculture. Large areas of scrub and secondary grassland bear witness to efforts that have been less than successful. Soils are often infertile and have poor structure; they are readily damaged by exposure to solar radiation and the impact of rain; many areas with high rainfall suffer from occasional periods of intense drought; and conditions favour the rapid growth of weeds and serious infestation by pests.

Most of these difficulties can be overcome, on fertile soils, by careful choice of site and crops, and suitable techniques for clearing the land and subsequent management. It should be recognised, however, that the greater the specialisation or tendency towards monoculture, the more likely the dependence on imported energy and fertiliser. Agricultural systems which do not require high energy and fertiliser inputs will have the advantage of stability, especially if energy becomes scarcer or more expensive. It is possible to intensify agriculture without either of these and intensification based upon locally available resources should be favoured.

TRANSFORMATION OF NATURAL FOREST INTO FIELD AND PLANTATION CROPS

Background

In general, every effort should be made to intensify production on fertile soils, or to raise the status of areas which have already been cleared, before deciding to open up new areas of forest to agriculture.

When after careful assessment, it has been decided that a forest should be transformed for some other use, all possible ecological knowledge should be brought to bear on:

- the choice of its future use;

- the methods to be used in implementing the change; and
- possible incidental effects.

It is easy, by neglecting such precautions, to reduce the potential of a site permanently or to cause serious incidental damage elsewhere.

Guidelines

80. Land should only be used for cultivation or plantation crops when sufficient survey of the ecological conditions has shown that the area is suitable for such crops and when field trials or observations have confirmed this assessment

81. Farming systems must be selected which are suited to local conditions and which can be managed effectively by the people expected to use them.

82. Any modification or transformation of existing vegetation must be carried out in such a way that the least possible harm is done to the soil by radiation and rainfall, in order to retain organic matter, fertility and adequate soil structure. Hand methods are often preferable to using heavy machinery, which can cause serious damage to the soil if used under the wrong conditions.

83. Careful studies should be made of traditional and indigenous systems of agriculture which have produced a sustained yield under these conditions. Every attempt should be made to extend such stable and productive indigenous systems, or suitable aspects of them.

84. Particular attention should be paid to the public health problems that may arise from forest clearing.

85. Special attention is drawn to the danger of introducing species of animals for domestic purposes, under range conditions, where there is any opportunity for escape into the wild. Animals such as buffalo and goat, for example, have caused considerable ecological and economic damage after escape from domestic control.

86. Careful studies should be made before the transformation of mangrove swamp forest to agriculture or fisheries so as to avoid long-term and irreversible side effects from the loss of these ecosystems.

87. New agroforestry and livestock management systems should be developed, both to improve animal production and to prevent unnecessary forest destruction.

88. Improvements in ruminant livestock production can most suitably be obtained by:

- **developing new and suitable breeds;**
- **increasing the productivity (and hence the carrying capacity) of existing pastures by the use of multi-species forage and improvements in management;**
- **integration with field and tree crop production; and**
- **utilising all available by-product feeds.**

89. The improvement of non-ruminant livestock can probably best be accomplished by ensuring the continuous and economic supply of suitable feeds, which should include as many locally-produced by-product feeds as possible. There are also possibilities for integrating pig, chicken and duck production with fish production.

90. Wherever possible, tree crops should be integrated into systems that include the raising of animals and production of food crops.

91. Every effort should be made to improve the productivity of existing grasslands by the introduction and testing of new forage species, the solution of dry season feeding problems and overall improvements in management.

92. Further efforts should be made to domesticate, or bring under extensive management, indigenous animals, such as deer, banteng and crocodile.

INDIGENOUS COMMUNITIES AND SHIFTING AGRICULTURE

> *"Programmes to preserve forest resources must start with local people, who are both the victims and agents of destruction, and who will bear the burden of any new management scheme. They should be at the centre of integrated forest management, which is the basis for sustainable agriculture. Such an approach would entail changes in the way governments set development priorities, as well as the devolution of greater responsibility to local governments and communities..."* (WCED, 1987).

Background

Indigenous local communities still inhabit many areas of tropical forests; some are hunter-gatherers, others practice various forms of "shifting agriculture" or "swidden cultivation".

These terms refer to systems of field rotation, rather than crop rotation. Short periods of cropping (one to three years) alternate with generally longer fallow periods of up to twenty years or more, though more often only four to eight years. The system is characterised by slash and burn clearing and the almost exclusive use of human energy, employing the parang, digging stick or hoe. But within this category there are many kinds of agriculture which reflect the adaptation of man to many different ecological conditions and various circumstances of technology and availability of labour.

It is important to recognise the distinction between those livelihood systems which provide all of a society's subsistence needs and those in which the cultivators derive some of their income from cash cropping or other sources. There is also an important distinction between those systems which are, and those which are not, in balance with the environment.

Those which are in balance, usually only in areas where population density is low, are in harmony with local ecological conditions. They do not lead even to a slow loss of fertility. However, many forces are at work - notably increases in population, the spread of technology and contact with the market economy - which tend to upset this harmonious relationship, where it still exists. When such changes are considered likely, it is important to plan in advance for inevitable agricultural and social adjustments.

Those livelihood systems which are not in harmony with prevailing conditions arise when the balance of a stable system is upset. This leads to the deterioration of the areas where they are practised.

All measures should be designed with the greatest possible consideration for the interests and values of the indigenous community and in full consultation and collaboration with them.

Unless prevailing practices are damaging the environment, or the indigenous communities wish to change them, there is no reason why they should be altered. But, because of growing

MANAGEMENT MEASURES TO MINIMISE ENVIRONMENTAL IMPACTS OF FOREST CLEARANCE FOR AGRICULTURE

General measures:

- identify areas which should not be cleared because of special physical, cultural or biological values or sensitivity, flag these areas for protection;
- provide clear instructions to field staff and contractors on performance standards, including penalty provisions for non-observance;
- provide sufficient well-trained supervisory staff to ensure observance of environmental protection measures;
- limit clearing operations to seasons without predictable high-intensity or long-duration rainstorms, provide for temporary cessation of operations in the event of unseasonal rainfall;
- plan road and track network to minimise erosion and optimise access;
- establish pasture, crop cover, mulch, or soil conservation works, where needed, as soon as possible after clearing;
- if clearing is for grazing, leave tree stumps so as to retain root shear strength as long as possible and to avoid unnecessary soil disturbance;
- use clearance and road equipment appropriate to the task and avoid mechanisation overkill. Manual or low technology methods generally cause less erosion;
- use earth moving equipment while on-site to construct off-stream water supplies (stock ponds, dams) for livestock, contour banks, grassed waterways, and other soil conservation works.

If the area is to be used for grazing livestock:

- maintain buffer-strips for protection against surface and streambank erosion along permanent streams and other erosion prone water courses, exclude livestock from these buffer strips;
- establish grasses or non-palatable shrubs along small, ephemeral drainage lines;
- develop distinct watering points for livestock away from streams and define proper stream-crossing points;
- determine appropriate husbandry practices to maintain ground cover of soil, especially during the dry season; e.g. contour strip grazing, manual grass harvesting and stall feeding etc;
- leave or plant trees to create a silvopastoral system, low shade, deep-rooted, nitrogen fixing tree species are particularly valuable in enhancing soil nutrient levels;
- leave shelter belts to reduce wind erosion;
- exclude or minimise fire on pasture lands to avoid exposing soil surface, losing nutrients and damaging residual forest areas;
- establish contour banks on long slopes with poorly permeable soils to minimise overland flow, ensuring that ponded water can be disposed of without causing seepage erosion.

populations, rising expectations and other social pressures, change is inevitable. It is an unfortunate reality that shifting cultivation will soon cease to be a sustainable use of forest anywhere.

The stabilisation of these systems or the resettlement of the people concerned should then be planned in a sensitive and orderly way.

Guidelines

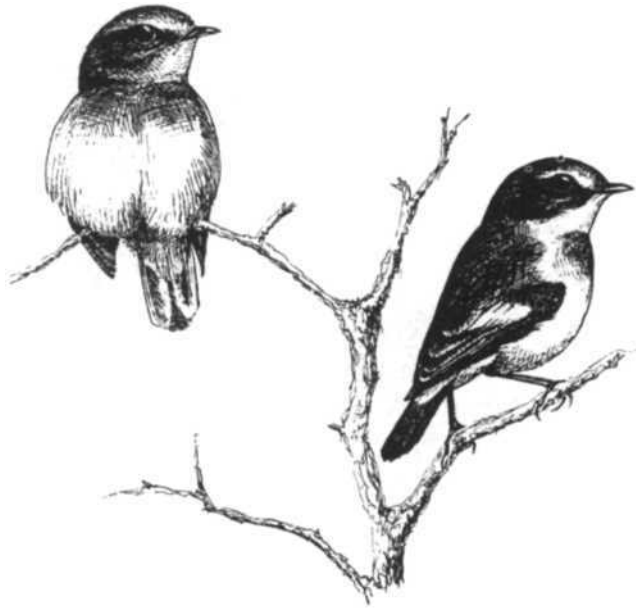
93. When the present practice of shifting agriculture by indigenous peoples is in harmony with the environment and is not leading to slow degradation, there is no ecological reason to change it.

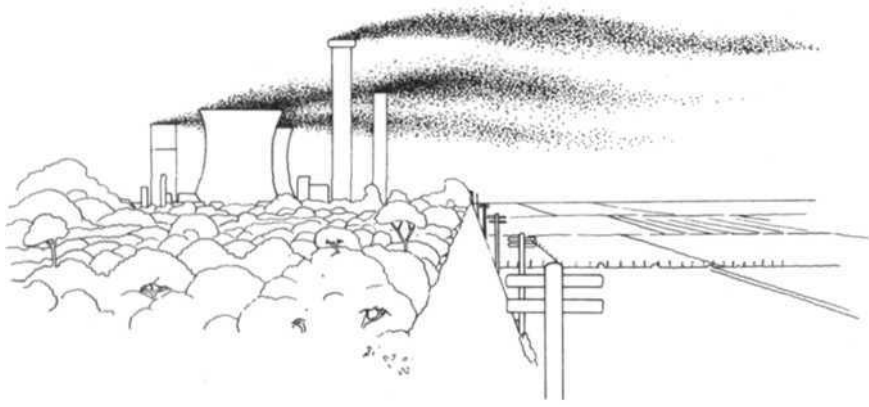
94. There should be regular monitoring to detect when shifting cultivation is beginning to surpass the capacity of the local environment to support it Measures should then be taken to render local systems more productive or facilitate the introduction of more intensive forms of sustainable agriculture, such as new agroforestry systems. If alternative employment can be provided this may divert pressure from the land.

95. Careful note should be taken of the techniques used by local peoples, the plant species and varieties that they use and the systems of agriculture they practise. Much of value may be learned which may be incorporated in new and more intensive systems.

Much forest destruction is caused by new settlers (sometimes landless, sometimes stimulated by entrepreneurs) who move into the forest from outside. They usually follow the line of new roads.

96. Every effort should be made to discourage the unplanned and uncontrolled movement of new colonists into the forest, and the destructive forms of migratory agriculture that they practice. This can be done through well-planned and sustainable land settlement or by the provision of other opportunities for employment





Large capital projects are difficult to alter once begun, even if alterations seem desirable. This is because they require a long period for planning, with considerable investment of money and manpower. As they represent a large social commitment they also develop their own political momentum. For these reasons the possible harmful effects require attention at an early stage of planning and design.

SETTLEMENTS, ENGINEERING WORKS AND INDUSTRIES

Background

Environmental considerations should be fundamental to any decisions on the location of new settlements, engineering works, industries, mines and other such developments. A proper understanding of ecological constraints will enable such developments to be sited most advantageously, minimising the risk of environmental damage.

In addition, any proposed resettlement or development of a new centre of population should take into account the present social, cultural, economic and health conditions of those to be resettled and their future needs. Resettlement should be carried out in consultation with them and should be carefully planned and timed.

Guidelines

97. As far as possible, infrastructure developments should be sited in areas where (a) environmental conditions are most favourable for them; and (b) their local effects can be successfully absorbed.

98. As well as the socio-economic effects, probable ecological impacts should be assessed in advance, and subsequently monitored and evaluated.

99. It must be recognised that the population in new settlements is certain to grow. The infrastructure and allocation of suitable of land for agriculture must be planned accordingly.

100. The planning, design, construction and operation of industries should take into account the possible adverse effects of industrial pollution (physical, thermal, chemical, biological) and other harmful ecological consequences. Standards of quality for water, soil and air should be based on proper ecological criteria.

The following section deals with communication and mining. They can be considered as examples of principles which should also apply to other kinds of development. The same kinds of precautions should also be applied to them. Dams are considered under "River systems and Wetlands".

MEANS OF TRANSPORT AND COMMUNICATIONS

Background

Planning for transport and communications should be an integral part of any regional development plan, taking into account the capacity of the environment and, especially, any long-term or incidental effects.

The effects of opening up communication into hitherto remote regions are far-reaching. Roads, for example, can result in developments which lead to forest destruction, the misuse of resources and badly situated human settlements. They can promote an influx of squatters who clear land for cultivation and create rural slums lacking clean water supplies and other services, and therefore prone to disease.

Guidelines

101. Careful consideration should be given to a choice of mode of transport which will minimise damage to the environment and best enable the course of development to be regulated.

102. Allocation of land and land management along new axes of communication should be in accordance with land capability and a regional development plan.

103. All land clearing and other activities which are not consistent with these should be strictly prevented.

104. If possible, no roads should be routed through sensitive areas, especially those designated as parks or reserves; but, if other considerations make this unavoidable, plans to mitigate any potentially harmful impacts should be drawn up before the roads are built; no activity should be permitted which is not in accordance with these.

EXPLOITATION OF MINERAL AND HYDROCARBONS

Background

Mineral extraction and oil development can result in the destruction of forests which might not be under threat from any other human activity.

Minerals and hydrocarbons have such a high monetary value compared with timber values that the pressure for extraction is usually irresistible. But the broader value of forests is seldom taken into consideration in making such decisions.

Environmental problems can arise at all stages of mineral development:

- **Exploration.** Cutting of new paths can provide access to poachers, settlers and illegal loggers. Poorly constructed tracks on steep land can initiate soil erosion.
- **Extraction.** This can cause the displacement of forest peoples or destruction of their resource, distortion of the local economy, chronic pollution of watercourses, acute pollution from toxic chemicals or oils, air pollution and noise from extraction, crushing and transport and risk of forest fires.
- **Secondary development.** The mine and camp may become a focus for new settlement and colonisation, leading to further clearing of forest for housing, farming etc.
- **Abandonment.** Mine sites may continue to pollute the environment after closure.

Clearly, therefore, it is necessary to consider the environmental acceptability of a possible mining enterprise even before granting permission for exploration.

Extensive mining for relatively low value minerals such as iron ore or bauxite is rarely consistent with the conservation and sustainable management of forests. On the other hand, in some instances, the intensive exploitation for high value materials such as oil or precious metals can be accommodated. But it is necessary to beware of extensive prospecting for precious stones and gold, which may lead to the degradation of water courses and the opening of a network of tracks.

All forms of mining are capable of causing serious pollution but the effects of this can, with care, be mitigated.

The keys to accommodating mineral development within forests are planning and control. Since control is difficult to achieve, planning becomes of even greater importance.

Guidelines

105. Every exploration, development or production initiative should be preceded by an Environmental Impact Assessment (EIA) covering the ecological and social conditions at the site, the likely course of the industry and its effects, recommendations to mitigate any damage and a scheme of monitoring.

106. If a decision is taken to go ahead, any adverse effects can be minimised by good design and environmental management at all stages according to the management measures on the following page.

MANAGEMENT MEASURES TO MINIMISE ENVIRONMENTAL IMPACTS OF MINERAL OPERATIONS IN FOREST

Exploration:

- the appointment of a liaison officer to plan exploration in consultation with local communities;
- the exploration base camp to be as small as possible and, if practicable, established outside the forest;
- cutting of new tracks to be avoided e.g. by using helicopters for seismic studies and for the delivery of equipment;
- any new roads should follow the contours and be constructed to proper standards;
- roads used for exploration should either not be connected to existing roads or the connection should be permanently blocked after use;
- organic effluents should be properly treated and toxic chemicals and oil and drilling muds contained and exported from the site;
- exploration sites should be fully restored including removal of all equipment and wastes, restitution of natural drainage and revegetation.

Extraction:

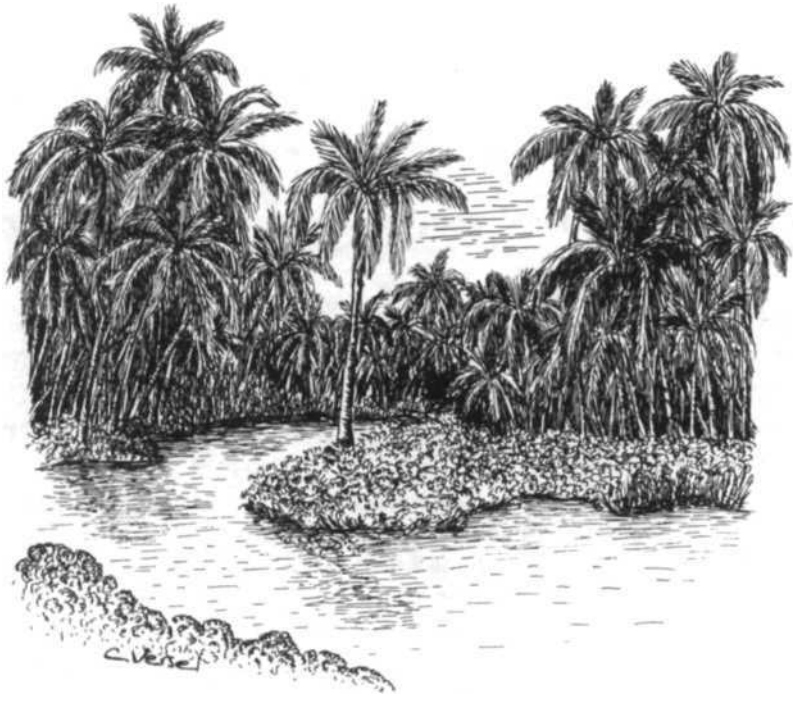
Measures should include the following:

- mine camp and processing to be outside the forest;
- restriction of new access routes, using aerial cableways for evacuating ore if possible;
- restriction of dust and of use of land for the disposal of solid waste;
- landscape restoration and revegetation;
- construction of a tailings lagoon to take and settle all liquid effluents;
- establishment of fire breaks; and
- provision safety, accident and emergency measures.

Abandonment:

This should include the following:

- all equipment and toxic wastes to be removed from the site;
- final stabilisation and landscaping of solid waste dumps;
- revegetation of all disturbed ground;
- capping of tailings dam with an impervious layer, adequately sloped, drained and revegetated; and
- continued monitoring of water quality in watercourses adjacent to the mine site.



WATER CATCHMENT AREAS

> *"Despite their critical importance, an estimated 160 million hectares of upland watersheds in the tropical developing countries have been seriously degraded . . . This has caused unnecessary poverty in the hills and unnecessary damage to the lowlands. More than one billion people in the developing world are hurt by this process."* (WCED, 1987).

Background

In addition to any other use, all areas of land discharge a function in the collection and release of water. The rate at which this water is released - and its quality - are of crucial importance for many human activities.

Generally speaking, land with natural vegetation provides water of higher quality and with a more even discharge than areas which have been modified or transformed. There are therefore strong reasons for maintaining natural vegetation cover, particularly on steep slopes liable to erosion and accelerated run-off.

In considering any change of land-use or management within a water catchment area, prime consideration should be given to its effect on the quality and quantity of water, and the periodicity of discharge. Other uses of land may interfere with, or reduce, the capacity of the land to deliver a regular and plentiful supply of pure water.

Adequate provision must always be made for safeguarding and perpetuating water supplies for domestic use, irrigation and industrial requirements.

Guidelines

107. The catchment should be managed in such a way as to ensure water delivery of the required, and preferably high, quality.

108. The utilisation of the water resource should be based on the needs of the people, first consideration being given to domestic needs and food production.

109. As far as possible, natural vegetation cover should be maintained on upland catchments. The cost of water development projects should include the cost of actively protecting catchment forests.

110. If the land pressures are so great that it is not possible to retain natural forest cover, then systems maximising tree crops and agroforestry should be used which approximate to the multi-layered structure of the natural forest.

111. National parks and strict nature reserves often provide the best possible protection for upland catchments.

112. Catchment forest could be exploited for timber, but this would require much more careful logging practices than are presently found in most of the tropics. Selective logging with sawing in the forest and the use of animal traction to transport timber to roads or waterways has worked well in the past and should be retained as a management technique in sensitive catchment areas.

113. Natural vegetation should be used wherever possible to rehabilitate degraded catchments. If this is not possible, then agricultural or forestry uses which maximise woody vegetation should be used. Stabilisation of steep slopes with irrigated terraces is only worthwhile on relatively fertile soils such as those found in parts of Java.

114. Multiple use of catchments can be consistent with the above objectives and should include provision for sustainable use of wildlife and the greatest possible variety of other forest products

WATERWAYS, DAMS, AND WEIRS

Background

There is already considerable experience in dam building in the tropics. High costs and serious problems of management, affecting both the reservoirs and lower river courses may be caused by damming waters with heavy loads of sediment or a high content of nutrients. The problems of sedimentation are greater in small rather than in large darns. Daily or seasonal variations in water level which expose large areas of shoreline can cause problems for river and lake side settlements, for farming and for fisheries. No resettlement has yet been totally successful around any tropical impoundment. The social and financial costs of these projects have often been grossly underestimated because the data to assess their effects have been inadequate or lacking. Benefits have often been less than anticipated.

Guidelines

115. When planning and executing improvements to existing waterways, canals, etc, special attention should be paid to the total effect of these works on water and living conditions of the people living nearby. Public health and environmental problems that might be solved by any such improvement should be given special attention.

116. When planning any dam or significant change of river regime, special attention should be paid to its effect (or the effect of alternatives) on flow and on physical, chemical and biological characteristics of the water at and below the intended works. This is necessary to assess possible consequences for human health, fisheries and wildlife. It is also necessary to assess the risk of infestation by water weeds. These should include advance studies, of at least one year, on:

- **stream flow, sediment load and bed load;**
- **water chemistry, precipitation and the chemical content of rainfall;**
- **aquatic vegetation and its dynamics;**
- **aquatic fauna, especially fish of economic importance, their life histories, food and feeding habits, reproductive patterns, spawning and migration;**
- **groundwater in the neighbourhood of the proposed reservoir; and**
- **the sedimentation patterns and water regime of flood plains, estuaries and deltas downstream.**

117. Arrangements should be made to monitor these variables and the cost of doing so should be included in the project.

118. The cost of protecting the catchments of new dams, usually by maintaining natural forest cover on slopes, must be included in the overall investment programme. Enormously expensive catchment rehabilitation projects are now becoming necessary where settlers, displaced by or attracted to new impoundments, have damaged catchment forests.

119. Public health problems that may be caused by, or associated with, an impoundment must be anticipated, and their management needs and costs included in the cost-benefit analysis and future management plan. The problems of mosquito and snail-borne human diseases require special attention. If resettlement schemes or spontaneous population movements near any proposed reservoir are likely to bring new populations in contact with disease, this risk must be assessed in order to design appropriate public heath programmes.

120. Preparations should be made in advance to manage the fisheries in the period following impoundment and to provide for the resettlement of displaced animal populations.

THE MANAGEMENT OF FISHERIES

Background

The water bodies of the humid tropics are characterised by great diversity in hydrology and biology, seasonal variation of water level and a locally high potential for producing fish protein.

There is often close inter-dependence between the wetlands and forests. It is impossible to interfere with one, without altering the other.

The complexity of these ecosystems is reflected in the large number of species present. Although the numerous interactions between species are not yet well known, a reduction in quantity, and especially the local extinction, of abundant or important elements of the aquatic fauna may have disastrous side-effects for the whole system. The exact nature of these effects cannot be foreseen.

Every effort should therefore be made to retain the species diversity in natural water bodies, unless these are allocated for intensive fish cultivation purposes. This is to insure against unpredicted and harmful changes in the river systems which might be caused by reducing the number of species. It is also to buffer the fish fauna against changes of environment and to provide for possible future changes in demand for products.

The introduction of exotic or alien species into these water systems is dangerous and, in some instances, has proved disastrous. Experience in the American tropics shows that the resulting improvement of fisheries has been disappointing and the introduced species, once established, have proved almost impossible to eliminate.

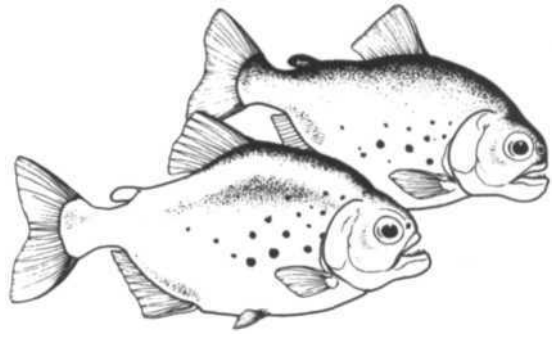
In large river systems, management of the fisheries or regulation of the water regime on one part of the system may have effects in other distant parts, by modifying the migration and spawning of fish species. The situation is different in enclosed water bodies under direct human control, where monocultures can be highly productive and exotic species can be most successful.

Guidelines

121. The introduction of exotic species into water systems should only be considered after all other possibilities of increasing production, such as the encouragement of selected native species, have been exhausted. Even then, it should only be carried out after careful trials and with stringent precautions.

122. In large river systems, regulations for fisheries management must take into account the riverine spawning migrations of many species. Protective legislation designed to maintain a breeding population of such species may need to apply to large portions of a river system and its estuaries.

123. In flood plains (which have high seasonal potential for fish production and are also farmed at low water) farming methods should be avoided which may damage aquatic life. Special care should be taken in the use of pesticides, and persistent chemicals toxic to aquatic life should not be employed. Artificial breeding of important species should be developed for the deliberate stocking of suitable waters.



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