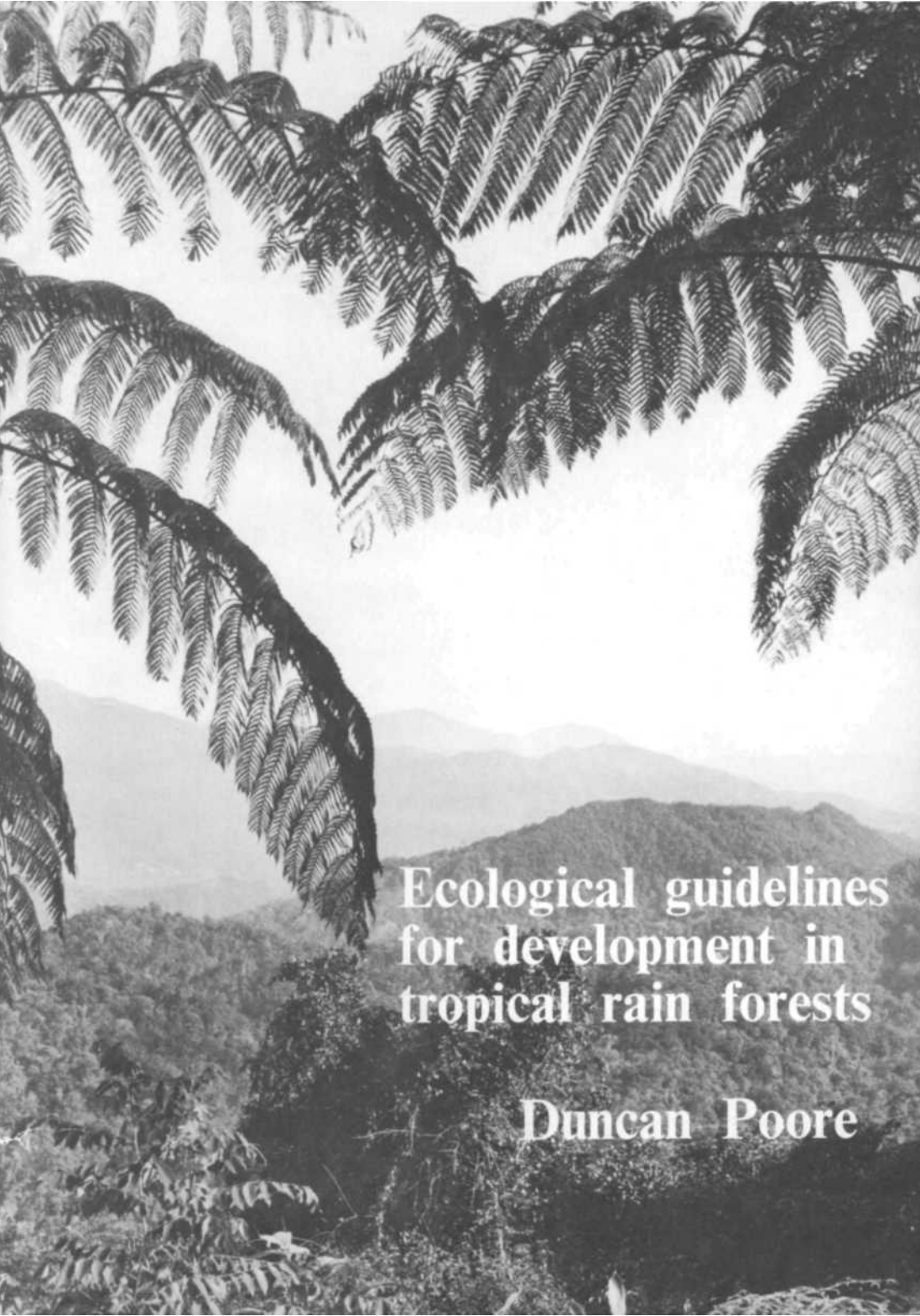

Ecological guidelines for development in tropical rain forests

Duncan Poore

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PREFACE

Many of the problems of the world today can be traced to the pressure of population on resources. These problems can be alleviated, if not entirely solved, by a balanced development which makes the best present use of all resources, while retaining their capacity to provide for mankind in the future. Unfortunately development often follows a different course; in pursuit of short-term advantages, it dissipates the natural capital on which long-term prosperity should be based.

These Guidelines have been produced for those who have to take decisions on development in areas of tropical rain forests. It is hoped they will provide useful guidance in ensuring the very best use of these irreplaceable natural resources. Tropical forests provide a fine opportunity for statesmanship; great expanses of them still remain largely unexploited —unlike forests in other zones of the world. On the other hand, because of their fragility, it is exceptionally easy to make serious mistakes leading to the extinction of species, the irreversible loss of soil and local change of climate.

The Guidelines have been developed by IUCN largely by means of two conferences (one in Caracas, Venezuela, and the other in Bandung, Indonesia). They represent the fruits of a long period of consultation which began with the publication of *Ecological Principles for Economic Development* by Raymond F. Dasmann, John P. Milton and Peter H. Freeman. Great interest and support throughout has been shown by the United Nations Environment Programme, FAO, UNESCO and the World Wildlife Fund, as well as by many individuals associated with IUCN.

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ILLUSTRATIONS

Photo, page 16: Scriven, WWF
All other photos : Poore, IUCN

Introduction

The pressing need of the countries in tropical forest regions is to improve the quality of life of their increasing populations while, at the same time, providing the base for a stable and continuing prosperity. The speed of change presents governments with problems of unusual complexity in planning the best allocation and management of land; and these problems are further complicated by growing shortages of raw materials and rising costs of production throughout the world. It is tempting to make rapid capital out of resources that are readily available or to adopt forms of exploitation or use which have been successful elsewhere but have not been sufficiently tested under local conditions.

Ecological knowledge can help in several ways: in the better identification of opportunities to make the best long-term use of the land; in drawing attention to situations where care must be taken if deterioration or other undesirable side effects are to be avoided; and, thus, in providing the decision-maker with a more complete framework in which the lasting costs and benefits of any policy or action can be accurately estimated.

The earlier, therefore, that ecological knowledge is taken into account, the better the use that will be made of local resources in the process of development and the less the danger of costly mistakes or long delays while projects are assessed and reformulated. Perhaps most important, the ecologist can call attention in advance to courses of action that are likely to lead to any lasting or irreversible deterioration of the resource.

The input of ecological knowledge should, therefore, be early and positive. Ecologists should be intimately associated with the formulation of national objectives and policies as well as during more detailed and technical stages such as drafting legislation, planning the allocation of land to various uses or designing development projects. If the ecological contribution is made at these early and formative stages, its positive and constructive nature will be most evident. If, however, it is delayed until specific actions for development are actually being planned, it is very likely to contain elements of caution and constraint. In such circumstances it is useful to insist that any proposal (whether for new laws or regulations or for a particular development project) should be accompanied by an assessment of its environmental impact so that unforeseen

and damaging consequences may be avoided. The "environmental impact assessment"[1] is a useful means of ensuring that ecological experience is taken into account in the process of development, but it should be recognized that this is only a partial and imperfect substitute for making earlier use of this experience.

In either case public consultation is useful in ensuring that policies and decisions are based on as wide a foundation of knowledge and views as possible, while also making the public aware of the whole range of environmental issues involved. The importance of education in the broadest sense cannot be overestimated; for it is only by having a public fully alert to environmental matters and well informed about them that the operation of ecological guidelines will gain wide acceptance.

Ecological predictions can only be made on the basis of facts and these are often incompletely or imperfectly known. Research and survey are certainly necessary in some instances to provide the information necessary to take wise decisions. But there is often a temptation to collect information for its own sake and to be reluctant to take decisions on knowledge already available. The guidelines frequently stress the need for facts and the assessment of facts before taking action; this should be interpreted as meaning *sufficient* facts for the kind of decision to be made. This is a matter of fine judgement which can only be resolved by discussion between those who have to make the decisions and the appropriate specialists—and will vary from case to case.

Each development is in itself a form of experiment. As far as possible, therefore, each project should include provision for "monitoring"—checking at periodic intervals the way in which the development is affecting the environment and the extent to which the predictions made beforehand are justified. This process is invaluable in assembling the facts that are necessary to improve the quality of future decisions. The same considerations apply to monitoring as to research; it can become an activity with its own momentum, collecting information which is unnecessarily detailed. While it is an essential ingredient in improving the development process, the objective should constantly be kept in mind when designing programmes. More is not necessarily better; the best is to collect enough but not too much.

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[1] Munn, R. E. (Ed.). 1975. *Environmental impact assessment—principles and procedures.* Scope 5. ICSU.

The cardinal rules are:

WISE ALLOCATION TO VARIOUS USES

HIGH STANDARDS IN CHANGING
FROM ONE USE TO ANOTHER

HIGH STANDARDS OF MANAGEMENT

Important textual note

The Guidelines are set out as follows:

The principle: in *italics*.

An explanation of the principle—where necessary.

The specific guidelines derived from the above. These are numbered.

Land-use policy and allocation of land to various uses

The natural vegetation of the humid tropical regions is forest. Except for small areas, the uppermost slopes of the highest mountains, for example, and swamps and landslips, the whole land has been covered with trees. This forest is both the richest and has had the longest period of continuous development of any in the world; and much of it, especially in South East Asia and Amazonia, has remained almost undisturbed until very recently.

Previously Man had settled widely in the seasonally drier areas but his inroads into the rain forest itself had been limited, and usually confined to tracts near the coast or accessible up the large rivers. Although many parts of the humid tropical regions are apparently unsuitable for them, stable and productive forms of agriculture were developed, for example in Java and Thailand, which have retained the fertility of the original forest soil.

In these fortunate areas where much of the forest cover remains intact, there is still considerable freedom of choice in planning land utilization and the approach can be more flexible because more alternatives are open. These are advantages of immeasurable value and every care should be taken to retain them. A most important characteristic of this forest is that it is self-perpetuating. Undisturbed it will protect soil, water, timber, wildlife and scenery without deterioration or need for any management. It is both the most protective and the least expensive use of land.

But the reserve of untouched forest has rapidly decreased in the last decade and the process is accelerating. This is partly due to the large-scale opening up of new land for agriculture, and partly because the best standing timber has been looked upon as a resource to provide investment.

In any well planned development, the allocation of land for particular uses is basic. It should attempt to match objectives to the resources available; and avoid using resource capital as a substitute for income. If well done, such allocation assigns to each desirable use a proper share of the most appropriate lands available, the end result being potentially more valuable than any known alternative. A prerequisite to this is an

evaluation to determine the degree to which different land areas are suited for and will tolerate the various potential uses. This may do much to prevent conflicting claims for the use of land.

Once land has been allocated and used for certain purposes, it is often, though 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. The wise allocation of land is therefore of the highest importance for it will ensure the best immediate use and the least possible restriction of future use.

In this connection it may be helpful to consider the degrees of change to which the forest (or other natural ecosystems) may be subjected—as follows:

Primary, unmodified forest.

Modifications of forest, e.g. forest managed for production of timber or other produce, for wildlife, recreation, etc. Cycles of shifting cultivation in balance with their environment.

Transformations from forest in which the natural forest is totally removed and replaced by trees (forest plantations, fruit or cash crops), arable or pastoral farming, or structures (roads, towns, reservoirs, mines, etc.).

Degradation of site by erosion, invasion of weed species, etc.

If areas are suitably chosen with proper respect for their ecological characteristics, modifications and transformations can be carried out with no loss of fertility; and indeed the capacity of a site for a chosen use may be greatly enhanced—for example by terracing and irrigation. But it is either impossible or very expensive to return to an earlier use. It should, therefore, be recognized that many decisions to transform or modify are for practical purposes irreversible. Misallocation or mismanagement may, of course, lead to such degradation that the value of the site for all uses is permanently impaired.

Wise and successful allocation of land depends on facts which may best be supplied by environmental resource surveys.

For *agriculture and plantation forestry,* the main prerequisites are a knowledge of the climate and soil, the relative importance of these varying according to circumstances. For the *management of natural forests for timber production* the present composition of the forest and

its potential for adequate regeneration are important. In both accessibility to markets and availability of labour have to be taken into account. For *natural areas which are to be retained and managed as such* it is their present vegetation and fauna, the extent to which they are either unique or representative of important ecosystems, and their intrinsic characteristics that are important. Each area may also have environmental characteristics which makes it suitable for other forms of development such as mineral extraction, dam or road construction, the siting of new towns, etc.

Where detailed surveys of climate, soils, vegetation and fauna, mineral resources, topography and hydrology are available, these may, with suitable interpretation, supply the required information. If such surveys are not already being carried out, they should be started as soon as is feasible. Of particular importance is the early setting up of a regional meteorological network and the systematic collection of relevant statistical information (on population, health, hydrology, etc.).

But, where such detailed surveys are not available, there are short cuts which will provide very valuable information. Much can be accomplished by the use of remote sensing or by air photography, such as the extensive surveys carried out in Kalimantan, W. Malaysia and Sarawak. Vegetation surveys can also be valuable for regional planning. These proceed from the premise that vegetation, especially undisturbed vegetation, gives a good general measure of climatic conditions and thus of the potentialities and limitations of an average site for various kinds of land use. Within each zone there are of course extreme sites where the nature of the soil overrides or compensates for the influence of climate, and offers special potentialities or imposes special constraints. In most circumstances knowledge of both climate and soil is necessary to assess capability reliably.

Because the majority of the nutrients on a site covered by tropical forest are in the vegetation at any time, 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, others infertile. If intended for agriculture, soils must be surveyed according to their potential for agriculture and the findings of surveys should be supplemented by crop trials before large areas of forest are opened up. Unless these are promising, land should be left as unmodified or as managed forest.

Guidelines

Decisions on the designation and allocation of land for various uses should be based on as much relevant information as possible.

A proper understanding of each different kind of land—its separate "capability" for different uses and the constraints which must be observed when it is manipulated for productive purposes—is necessary in order that the merits of alternative patterns of development may be compared.

1. When they are not already available, national and regional resource surveys should be undertaken as soon as possible to provide the facts. For example: on social structure, climate topography and land form, soils, vegetation and fauna, mineral resources and hydrology.

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

3. Capability should be assessed separately for each possible use or value of the land. For example: potential for mineral extraction, agriculture, timber production; suitability of settlements, roads, dams, 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.

4. Existing surveys may need to be supplemented or reinterpreted in the light of new knowledge and changing social priorities.

The development of any region should be planned as a whole in order to make the best present and future use of available resources through a comprehensive and integrated approach to development.

5. A total catchment area is recommended as an appropriate unit for planning, which should include the infrastructure of settlements, roads, dams, water supply, siting of saw-mills, processing plants for agricultural produce and other industry.

Planning should provide for foreseeable requirements and should be based on the present and likely future needs of the community as determined by its chosen life style.

Decisions which are damaging to the lasting potential of natural resources are often taken under conditions of stress.

6. Any action contrary to the inherent capability of the land should be resisted.

7. 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 proper phasing and planning for development.

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.

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

9. 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.

Planning should be undertaken as far as possible in consultation with those likely to be affected. This may have to be done gradually and by stages.

10. Local consultations should be initiated at each stage of planning in order that the full social costs and benefits of alternatives may be evaluated.

Land which is capable of many uses should be retained as far as possible in order to maintain the widest possible choice for future generations whose needs and skills may be different.

The greatest care must be taken over any decision that will lead to irreversible change.

Conditions may change in such a way that the original resource would have proved more valuable than that which has replaced it. For example: agricultural land rather than a reservoir; a unique example of natural forest rather than degraded grassland.

11. 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 protection forest, national parks and nature reserves, land should be allocated specifically for these purposes.

12. Before deciding to modify or transform untouched areas, every consideration should be given to alternatives. For example: adapting to more productive uses areas that have already been changed (e.g. using savannas for pine plantations); intensification of existing uses; using areas for more than one purpose if these are compatible.

Arrangements should be made, as part of the planning process, to monitor and evaluate the effects of any major development.

The result of this evaluation may be used, if necessary, to modify the course of development and will provide experience to guide future ventures.

13. Significant variables, including those listed in guideline 3, should be observed and the effects of development evaluated.

Allocation, conflicts and multiple use

In the previous section it has been emphasized that society has a number of possible uses for areas covered with tropical forest, and that the allocation of forest areas to such uses is of the highest importance if they are to be used wisely. It may be decided to keep the forest as it is because of its intrinsic values, to manage it as a source of raw material or to remove the forest and use the soil for other purposes.

The next sections (pages 13-21) deal with areas which have been allocated for protection or for management as a source of raw material.

Apart from their importance as a significant part of the world's reserve of forested land, areas of tropical forest are valuable:

a) as sources of forest products, both plant and animal—timber, fruit, latex, drugs, bamboo, rattan, honey, fish, animal skins, etc.;

b) because the forest acts as a guardian of soil fertility, prevents erosion, regulates the runoff of water and possibly has a moderating influence on climate (protection forest);

c) as samples of forest ecosystems containing the genetic resources of the plant and animal species (and the varieties of these)—many of which are likely to have economic potential—in the region; or as examples of untouched natural landscapes (national parks and nature reserves), retained for cultural, scientific, educational and recreational values and as controls against which the effects of changes to similar areas can be assessed.

Forest will normally, therefore, be allocated:

a) for the preservation of species, ecosystems or landscape;

b) for protection of soils and water catchments; and

c) for yielding forest produce.

These uses may be complementary to one another but they also often compete. For example, it is usually possible to allow areas in protection forests to be used for scientific research, education and recreational tourism provided that part remains completely protected and the use of the rest is regulated so that it is consistent with the primary aim of protection. Indeed as well as being a reserve of genetic material, these

areas must serve the interests of science, education and recreation. But these interests will suffer if the protective function is neglected.

In addition to allocation, therefore, it is crucial to be clear and explicit about objectives of managment.

Guidelines

Where it has been decided that an area should be allocated for a protective use, this should in all cases take priority over other uses.

Other uses—for example extraction of timber or excessive use by the public—can easily damage irreversibly the protective value of the forest.

14. For each area a primary objective of management should be stated and any other uses which are inconsistent with the primary use should not be allowed.

15. Within the constraints set above, the use of areas in the fullest interest of the community should be encouraged and imaginative ways of "multiple use" should be devised.

Preservation of natural ecosystems and genetic resources

Within the tropical forest regions there are a great number of forest types, and other natural ecosystems, each containing its own combination of species according to local differences of climate, soil, altitude and geological history. It is highly important to conserve samples of each of these, sufficiently large to be self-perpetuating and to encompass the range of the larger mammals and migratory species. Particularly important is the conservation of samples of lowland rain forest on fertile soil, for these contain ecosystems of the greatest richness and luxuriance.

If samples of the various types of forest are chosen well and chosen 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 be possible to combine their protection with other socially and economically valuable uses (e.g. recreation, education and tourism).

The conservation of natural ecosystems will provide a reservoir of populations of wild plants and animals and of the variation within them under conditions which will enable evolution to continue under substantially natural conditions. But, in addition to these protected areas, there is great scope for managing other land in such a way that it contains an abundance of wildlife, and, wherever possible, this should be made a supplementary objective of management. 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 these wild plants and animals may themselves be part of the crop. Where the land has been transformed for intensive agriculture, the maintenance of wild populations is sometimes more difficult. But the more ecological knowledge can be applied to maintaining a number of species in such areas, the less the risk of epidemic outbreaks of pests.

Guidelines

As an integral part of planning, suitably large examples of natural ecosystems and of populations of plant and animal species should be protected.

These represent an important resource and should be maintained as a reservoir of continually evolving genetic material, for their cultural, scientific and educational value, as samples of outstanding or typical natural landscapes, as a reservoir of wild animals and plants which may enable them to be cropped in surrounding areas and as samples of unchanged communities to provide controls against which the changes brought about by other forms of land use may be measured and assessed. It is important to maintain samples for these purposes even on potentially rich agricultural soils.

16. An assessment should be made of the intrinsic value of land in relation to the conservation of flora, fauna and natural ecosystems *.

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

18. The size and characteristics of the areas protected should be related to the needs of the plant and animal communities that they are intended to protect. Wherever possible large areas should be chosen to include examples of different ecosystems, representing, for example, different altitudinal zones on a mountain or gradations of climate.

19. 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 but can be used for any form of economic land use which does not interfere with the integrity of the protected area.

20. The objectives of management for such protected areas should be carefully defined and adhered to. They should include maintaining part of the area completely un-

* Suggested classes for such a capability classification are given on page 39.

disturbed as a standard for comparison; but in the remainder, use for scientific study, for education and for recreation should be encouraged, provided that these uses do not conflict with the primary purpose of protection.

21. 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.

In planning the overall development of any area, provision should be made for the migration of animals and dispersal ofplants between protected areas.

When the land surrounding protected areas becomes intensively used, these are left as " islands " and are very vulnerable to such external changes as fluctuations in climate. 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.

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.

This, by maintaining variety, may often prevent any of these species from becoming pests. It also serves to keep up populations of the species themselves.

The protection of plant genetic resources in natural protected areas should be supplemented by documented collections in botanic gardens, arboreta and seed banks.

This will provide an additional insurance against extinction in the wild but is no substitute for conservation in protected areas. It is impracticable to provide for all species, and natural evolution cannot continue under these conditions.

Protection forests

There are certain areas where the forest acts as a guardian of soil fertility, prevents erosion, regulates the run-off of water and possibly has a moderating influence on climate. It is very important to maintain these characteristics.

Guideline

Where slopes are so steep or unstable that disturbance of them would lead to soil erosion and accelerated run-off of water, the protection of these must be the primary aim of management.

The purpose of this is to maintain the quality of the soil in the catchment and to regulate the quantity and quality of the water delivered from it, by preventing erosion, siltation and excessive fluctuations in water flow.

22. Areas must be designated whose primary function shall be catchment protection. Such areas may be used for a harvest of forest produce or other use provided this does not interfere with their primary function of protection.

Modification of natural forest for timber production

Timber and other wood products for domestic use and for export come from three main sources: from managed indigenous forests; man-made plantations; and during the conversion of natural forests to other land uses.

The rate of timber extraction in tropical forest areas has grown very rapidly in the last decade. Indeed it is likely that the present situation of surplus will move to one of scarcity; and that supply from primary forest will have to be replaced by that from secondary forest or plantations, both producing wood of a different quality from that being harvested now.

The crop that is produced by manipulation of the natural forest may be economically more valuable than the original forest, having fewer species of a higher growth rate and more uniform wood, often of lower density.

As a result of land pressures, many lowland forest areas are being transformed into agricultural lands, and forestry production is being pushed onto poorer soils or hilly areas where many of the silvicultural problems of forestry have not yet been resolved.

Until the necessary knowledge is available it would be well to exercise caution in management, and research should be speeded up to provide the necessary information for sound management.

Where the primary objective of management of production forest is timber, combined with that of minor forest produce and wildlife, the objectives are usually met most satisfactorily in a forest having a structure and composition near to that of the natural forest, as this tends to be more stable under local conditions and to provide best security against epidemics, etc. Therefore it is advisable to go no further than is necessary in changing species and structure.

Guidelines

When an area is to be managed for the production of timber or other forest produce, including wildlife, this should be done in such a way that the potential for maximum sustained yield is maintained and the resource capital is not depleted.

The relative values of the various products may change from time to time and new uses may be discovered. Some areas of managed forest, for example, have an important supplementary value as a habitat for wildlife, which may provide a significant source of food, of revenue from exploitation and of reserve stocks of the species concerned. A forest which still retains its varied potential can best respond to changes in demand.

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

24. Management should be directed at getting the best total return from all forest products consistent with maintaining the potential.

The production of timber and other forest produce should be planned to meet predicted demands, including those for fuelwood and other local uses.

The forest is abused when demand exceeds supply. The need for fuelwood, for example, can under certain circumstances make very large inroads. The development of plantations can help to reduce pressure on those areas of forest which should be protected, and may also enable areas of forest to be kept in reserve for future allocation. The provision of adequate local fuel will reduce dependence on imported sources of energy.

25. 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, and alternative sources of fuel should be developed, (e.g. bio-gas).

26. In order to help meet predicted demands for timber and wood, trees should be planted in non-forested areas wherever there are suitable sites. These need not be confined to blocks of plantation.

27. Where agricultural land has been abandoned such land should be used for plantation forestry rather than clearing native forest for plantations.

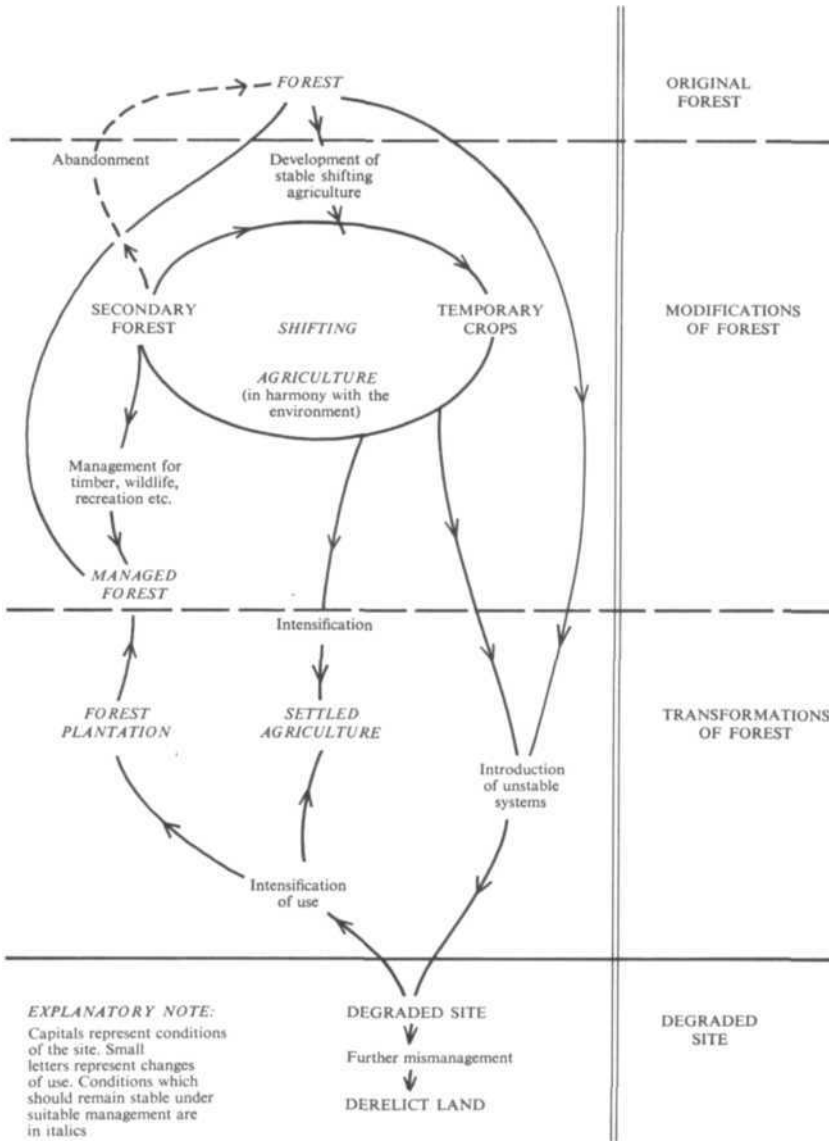


Fig. 1 : Interrelationships of shifting agriculture with other uses

Indigenous communities and shifting agriculture

Many areas in tropical forest are still the home of indigenous local communities, some hunter-gatherers, others practising various forms of simple agriculture. The hunter-gatherers are often in balance with their surroundings, as indeed are some of the cultivators, who practise certain kinds of shifting agriculture (" swidden cultivation ").

This can be defined as a system of the rotation of fields rather than of crops, by short periods of cropping (one to three years) alternating with generally longer fallow periods (up to twenty years or more, but often only four to eight years) and characterized by clearing by slash and burn 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 under various circumstances of technology and the availability of labour.

There is an important distinction between those systems of livelihood which are, and those which are not, in balance with the environment. The former, which are usually only possible where the density of population is low, are thought to be a harmonious adaptation to ecological conditions and not to lead even to a slow loss of fertility. In contrast, the latter, which arise when the balance of a stable system is upset or when new areas of forest are colonized from outside, are not in harmony with prevailing conditions and lead to deterioration of the areas where they are practised. It is important to recognize also the distinction between those systems which provide all the subsistence of a society and those in which the cultivators derive some of their income from cash cropping or other sources.

Many forces are at work, among them increases of population and spread of technology, which are tending to upset this harmonious relationship, where it still occurs. When such changes are considered likely, it is important to plan in advance for the social adjustments that are inevitable.

The relationships of these forms of shifting agriculture and other modifications and transformations of forest are shown in Fig. 1.

Guidelines

All measures should be designed with the greatest possible consideration for the interests and values of the indigenous community and in full 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. Change may, however, be inevitable in many circumstances because of growing population, rising expectations or other social pressures; it should then be planned in a humane and orderly way in collaboration with those affected.

28. When the present practice of shifting agriculture (" swidden cultivation ") is in harmony with the environment and is not leading to slow degradation, it should continue as necessary.

29. There should be regular monitoring to ensure that changes in the situation are detected and any necessary steps taken by providing for well-planned land settlement.

30. When shifting agriculture is not in harmony with the environment it should be discouraged. Efforts should be made to intensify use of such areas by transforming them into settled agriculture or plantation forestry, provided that these uses are consistent with the " capability " of the land.

Water resources

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

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

Guidelines

In considering any change of land use or management within a catchment prime consideration should be given to the effect of this on the quality and quantity of water, and the periodicity of discharge.

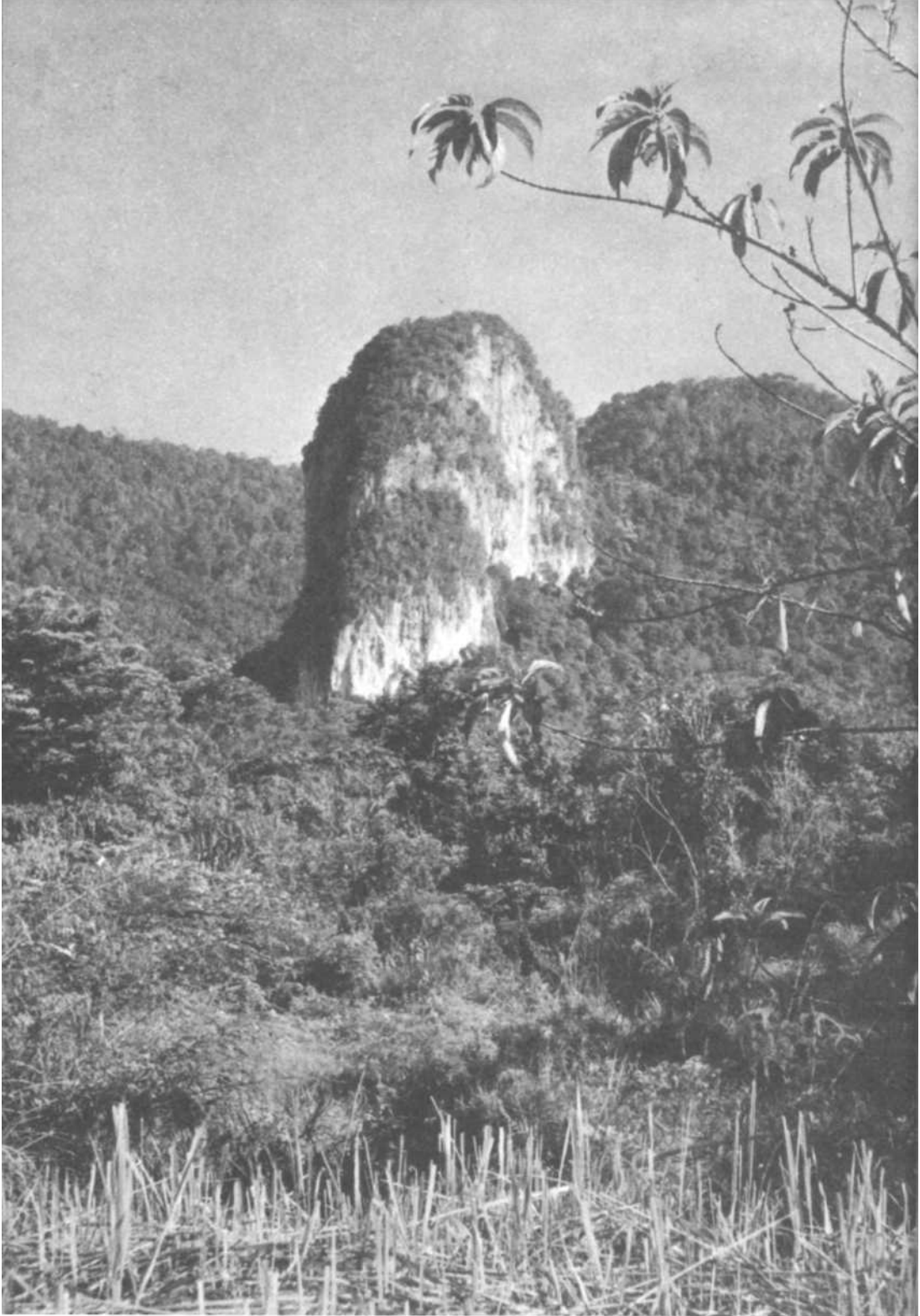
Adequate provision must be made for safeguarding and perpetuating water supplies for domestic, food, power and industrial requirements.

Other uses of the land may interfere with, or reduce, the capacity of the land to deliver a regular and plentiful supply of pure water.

31. Multiple use of catchments should be consistent with the above objectives and include full provision for present and future fishery and wildlife needs.

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

33. Management of the catchment should ensure delivery of water of the quality required.



Transformation of natural forest into field and plantation crops

Although highly successful systems of agriculture both for food and cash crops have been developed—for example, in parts of South East Asia—the humid tropics are not an easy area in which to conduct stable and profitable agriculture. Large areas of scrub and secondary grassland bear witness to efforts that have been less successful. Soils are often infertile and have a poor structure; they are readily damaged by exposure to insolation and the impact of rain drops; many areas with high rainfall suffer from 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 recognized, however, that the greater the specialization or tendency towards monoculture, the more likely the dependence on imported energy and fertilizer. Where systems of productive agriculture exist which do not depend on great imports of energy and fertilizers these will have the advantage of stability in a world in which energy is likely to become scarce and more expensive.

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.

Guidelines

When, after careful assessment, it has been decided that forest should be transformed for some other use, all possible ecological knowledge should be brought to bear on (i) the choice of that future use; (ii) the methods used to carry out the change and; (iii) possible incidental effects.

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

34. 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 if appropriate methods of cultivation are used; and field trials or observations have confirmed this assessment.

35. Any modification or transformation of the 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.

36. 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 elements of them.

37. Particular attention should be paid to the public health problems arising from forest clearance.

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

39. Careful studies should be made before the transformation of mangrove and swamp forests to agriculture or fisheries so as to avoid long-term and irreversible effects to these ecosystems.

As far as possible systems of agriculture should be favoured that do not rely heavily on the import of energy and fertilizer.

Mechanization and the use of fertilizers should of course be favoured where appropriate, but the increased vulnerability of an agriculture which becomes dependent on them should be recognized. It is possible to intensify agriculture without either of them.

The conversion of humid forests to open grasslands for the grazing of ruminant livestock should be approached with caution.

Such pastures have sometimes proved productive, particularly when they have been developed on fertile soils, but more often they have failed,

resulting in degradation of the areas and low productivity of the livestock. Alternatively those practices which have involved integrating livestock and tree production in various ways are promising.

40. Alternative systems are urgently required both to improve animal production and to prevent unnecessary destruction of forest.

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

a) Development of new and suitable breeds;

b) Increasing the productivity and hence the carrying capacity of existing pastures by the use of multispecies forage and stress on improvements in management;

c) Integration with field and tree crop production; and

d) The utilization of all available by-product feeds.

42. The improvement of non-ruminant livestock production can probably best be accomplished by ensuring 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.

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

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

45. Further efforts should be made to domesticate indigenous animals for sustained production (e.g. deer, banteng, crocodile).

Management of fisheries in river systems

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

The complexity of these ecosystems is reflected in the large number of species present, which demonstrates the very effective occupation of existing ecological niches. Although the numerous interactions between species are not yet well known, a reduction in quantity, and especially the 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.

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. The introduced species have often, indeed, had a damaging effect and 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 may have effects in other and 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

Every effort should be made to retain the species diversity in natural water bodies, unless these are allocatedfor 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.

46. 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, and should only then be carried out after careful trials and with stringent precautions.

47. 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 any river system and to include the estuaries.

48. In floodplains that have high seasonal potential for fish production, and which 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.

Pest control

Guidelines

It is necessary for Governments to regulate the manufacture, distribution, sale and use of pesticides.

Controlled use of pesticides is necessary both in controlling disease and in increasing agricultural production. Some adverse effects have been recorded as a result of excessive or indiscriminate use of some pesticides, leading in some instances to hazards to health and to crop losses due to the emergence of new pests. Also there is not nearly enough information about the quantities of those chemicals used, their environmental effects, and their ultimate fate. These circumstances can combine to cancel the beneficial effects and to create a potentially serious threat not only to the environment, but to crop protection and public health.

49. Governments should immediately set up appropriate machinery to collect and interpret information on the kinds, amounts, distribution and local application of all pesticides (insecticides, herbicides, fungicides, and others), both those used for public health as well as for control of agricultural and forestry pests.

50. Regulations should be developed on production, importation, formulations, sales distribution and application. These should be made enforceable. Regulations should stipulate: that pesticides and pesticide formulations which may represent a special hazard to humans and other organisms should be sold and/or distributed only by designated persons, preferably under licence.

51. Wherever possible those pesticides should be used that are specific to the pest. Moreover in general the selectivity of pesticide applications should be optimized by selecting appropriate formulations and techniques of application.

52. Research and development should be promoted into selective pesticides which are degradable in the environment.

53. Spraying from the air should be prohibited near areas where the chemicals might have undesirable effects.

54. The amount of pesticide used and the area covered in its application should be kept as small as possible by a proper judgement of the degree of infestation at which damage becomes unacceptable, by using detailed knowledge of the habits of the pest and by avoiding overdosing.

55. In large-scale operations application of the pesticide should be confined within the limits of the ecosystem to be treated to avoid exterminating local taxa and to permit recolonization from outside by non-target organisms which have been killed off in the area of application.

56. Local research should be undertaken on the toxicological and ecological effects of various pesticides, as the results of research in temperate regions do not necessarily apply in the humid tropics.

57. Pesticides now in use should be examined first and the results of research should be used in designing regulations for their use.

58. Large-scale operations should be guided by epidemiological studies and by means of biological and chemical monitoring, including: changes in populations, physiological and behavioural changes, appearance of resistance or tolerance to chemicals in target populations and of concentrations of pesticides and their conversion products in soil, water and biota.

59. The methods selected for pesticide applications should be compatible with the local environmental conditions.

Programmes of biological control and integrated methods of pest management should be encouraged (including mechanical control).

Research should be carried out into the development of pesticides suitable for the protection of tropical crops.

Wild plants in tropical forests may have evolved chemical protection from insect predation, and greater effort should be made to examine indigenous plants in order to identify and produce those substances in them that may limit attack by pests.

Settlements, engineering works and industry

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 develop, too, their own political momentum. For these reasons the possible harmful effect of both require early attention in planning and design.

Roads, for example, can result in developments which lead to misuse of resources and badly situated human settlements. Attention should be given to the incidental effects when choosing the route and design of new roads.

There is already considerable experience from the building of dams 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 than in large dams. Impoundments which expose large areas along their shores at low water can cause problems for lakeside settlements, for farming and for fisheries. No resettlement has been fully successful round 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 lacking or inadequate. Nor have the benefits been properly assessed.

Guidelines

Decisions on the placing of new settlements, roads, industry, engineering works and other such developments should be based on as much relevant information as possible.

A proper understanding of environmental conditions will enable such developments to be sited most advantageously and minimize the risk of environmental damage.

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

61. As well as the socio-economic effects, the probable ecological impact should be assessed in advance and the changes which occur afterwards should be kept under observation and evaluated.

Any proposed resettlement or development of new centres 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.

MEANS OF TRANSPORT AND COMMUNICATION

Guidelines

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 country are far reaching.

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

63. Allocation of land and land management along new routes of communication should be in accordance with land capability and the regional development plan.

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

65. If possible no roads should be routed through sensitive areas,

especially those designated as parks of reserves; but, if other considerations make this unavoidable, management plans should be drawn up before the roads are built, and no activity should be permitted which is not in accordance with these.

WATERWAYS, DAMS, ETC.

Guidelines

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

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

a) Streamflow, sediment load and bed load;

b) water chemistry;

c) precipitation and the chemical content of rainfall;

d) aquatic vegetation and its dynamics;

e) aquatic fauna, especially fish of economic importance, their life histories, food and feeding habits, reproductive patterns, spawning and migration;

f) groundwater in the neighbourhood of the proposed reservoir; and

g) the sedimentation patterns and water regime of flood plains, estuaries or deltas downstream.

68. Arrangements should be made to monitor the variables in *(a)* to *(g)* above and the cost of doing so should be included in the project.

69. 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 movement near the proposed reservoir are likely to bring new populations in contact with disease, the risk of this must be assessed in order to design programmes of public health.

70. Any problems of weed infestation after impoundment should be anticipated as far as possible and steps taken to prevent such infestation.

71. 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.

INDUSTRIES

Guideline

72. 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.

Categories of land use in relation to the conservation of flora, fauna and ecosystems

1. Natural ecosystems, unmodified or hardly modified by human activity. (A sample of these should be maintained inviolate; if disturbed, their integrity is seriously and perhaps irreversibly impaired.)
2. Semi-natural ecosystems in which conservation should be the primary purpose of management, but which are consistent with or depend on other forms of land use in varying degrees. (Areas in which animals or plants may be cropped as a resource should be included here.)
3. Areas which should not necessarily be conserved as total ecosystems, but which are necessary to provide for the whole or part of the life cycle of particular organisms.
4. Areas in which other uses should predominate, but in which the conservation of wild plants and animals can be ensured by various management expedients.
5. Areas in which the wildlife interest is so low or other uses are of such importance that conservation of flora and fauna should be confined to ensuring the health of the land and preventing irreversible deterioration.

Many of the problems of the world today can be traced to the pressure of population on resources. These problems can be alleviated, if not entirely solved, by a balanced development which makes the best present use of all resources, while retaining their capacity to provide for mankind in the future. Unfortunately development often follows a different course; in pursuit of short-term advantages, it dissipates the natural capital on which long-term prosperity should be based.

These Guidelines have been produced for those who have to take decisions on development in areas of tropical rain forests. It is hoped they will provide useful guidance in ensuring the very best use of these irreplaceable natural resources. Tropical forests provide a fine opportunity for statesmanship; great expanses of them still remain largely unexploited —unlike forests in other zones of the world. On the other hand, because of their fragility, it is exceptionally easy to make serious mistakes leading to the extinction of species, the irreversible loss of soil and local change of climate.

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