

wastes generated by the nuclear industry in the United States until the end of this century.'

Another possibility that is under study is disposal of radioactive wastes in the ocean sea-bed, 'as the deep ocean is poor in resources that are likely to be exploited by Man.'

The core-melt at the Three Mile Island nuclear plant in Pennsylvania is described in the report as a 'loss-of-coolant' accident triggered by equipment failure and compounded by an 'operator error.' But the report points out that the plant's 'containment building performed as designed in containing the radioactive materials released from the core.' Thus the amount 'escaping into the environment was very low, about 2.5 parts in ten million of the iodine.'*

According to the IAEA/WHO report: 'The continuous concern for safety addresses the entire range of possible accidents — including the potential for large-consequence accidents, although these are considered unlikely.' In a foreword to the publication, the Directors-General of WHO and IAEA state that nuclear power 'is a technology whose hazardous effects are well understood and controlled,' being 'a fact of life that must be looked at objectively and rationally.'

PETER OZORIO
Division of Public Information
World Health Organization
1211 Geneva 27
Switzerland.

* We hope soon to publish an account of this celebrated event, by a member of the President's investigating team. Meanwhile our publication of the present comment should not be construed as indicating any lack on our part either of abhorrence at the existing build-up of nuclear weapons or of recognition of the risks of proliferation of peaceful uses that can be turned to belligerent ends.—Ed.

Fact-sheet on Tropical Rain-forests

Introduction

According to UN/FAO estimates, tropical rain-forests cover some 550 million hectares of the globe. In the last 20–30 years Man's interaction with these forest ecosystems has increased dramatically, not only in extent but also in intensity of impacts. Tropical forests are being severely modified or destroyed in response to pressures from the rapidly-expanding populations of tropical countries, their striving for economic development, and an accelerated search for new timber resources by industrial temperate-region countries. Improved technology, commerce patterns, and infrastructure development, have widely increased the effective impact of wood harvesting and land clearing activities. Most investigators agree that, if present trends continue and effective conservation measures are not implemented, most of the still-existing forests of the tropics will be destroyed or replaced by degraded communities by the end of the century.

Tropical rain-forests comprise uniquely rich biotic communities which are particularly sensitive to disturbance. The understanding of how to manage the many types of rain-forest in order to maintain their long-term productivity and character is limited or non-existent; the

potential values of rain-forest, and the benefits provided to mankind in direct economic terms and in contributions to maintaining a satisfactory human environment, have barely been explored. As a consequence, there are few restraints on the exploitation of the rain-forest resources of the Amazon Basin, coastal Central America, Congo Basin, Malay Peninsula, New Guinea, and numerous smaller areas of rain-forest occurrence.

Tropical Rain-forest Ecosystems

This 'ecosystem type' or biome has been called with good reason the richest and most exuberant expression of life on land, and is characterized by an exceptional diversity of plant and animal forms, species, and interactions. On some sites tropical rain-forests have provided continuous cover since the flowering plants evolved, developing over millennia in the relatively non-stressful environment of the tropics, where temperature and moisture fluctuations are the lowest of almost anywhere on Earth, and where plants grow apace. It is literally the genetic cradle of evolution and indeed constitutes our richest gene-pool. This outstanding diversity (50–200 species of higher plants per hectare as compared with perhaps 20 species per hectare in a rich temperate forest) also proves to be a liability. For it means that in a given area there are few individuals of any one tree species, and heavy exploitation of one or a few species can therefore quickly lead to their local extinction.

Primary rain-forest species are in general not aggressive, and thus tend to be quite vulnerable to disturbance. Moreover, regionally-limited distribution (endemism) is common for these plant and animal species of tropical rain-forests. Because of the characteristics of diversity and limited occurrence, destruction of the tropical rain-forest can often cause species to become rare or even extinct. Moreover rain-forest ecosystems, when once seriously disturbed, return to their former state only very gradually if at all (*see below*).

Values of Tropical Rain-forests

Currently, the chief direct economic values of tropical rain-forest are found in the production of wood and the use of their plants and animals for food, drugs, raw materials (hides, fibres, gums and resins, etc.), medical research, and breeding. There are, however, many tangible and intangible values which have important significance, but which are often overlooked, such as the following:

Scientific value:—The tropical rain-forests are not only an extremely important and scarcely-explored source of new products, but also constitute a major study-area for the expansion of knowledge about plant and animal interrelationships. They are the world's major gene-pool and are often considered the evolutionary cradle of terrestrial life; there is therefore an imperative need to slow the rate of disappearance of primary tropical rain-forests before these scientific values are irretrievably lost to society.

Effect on climate:—Certain aspects of climate are influenced by the presence or removal of rain-forest. There is scientific concern that large-scale removal of tropical rain-forests could result in a cooling of the tropics, with resultant shifts in world wind and rainfall patterns. More research is needed, but there is already much empirical evidence that clearing of rain-forest has led to local changes in rainfall that are so marked as to disrupt established land-uses of the area concerned.

Hydrology:—Rain-forests are important regulators of water supply and quality. Cloud-forests are actually able to 'capture' moisture from the atmosphere and make it available as stream-flow and underground water-supplies. Rain-forests can prevent erosion and keep soil from moving into streams, reservoirs, and lakes, where it would reduce the usefulness of these for agriculture, power production, navigation, municipal water-supply, fishing, and recreation.

Soils:—In tropical rain-forest ecosystems, it is not the soils, but primarily the lush vegetation, that holds fertility. In this warm, moist, non-seasonal environment, nutrients cycle very rapidly from vegetation back into vegetation, in a virtually leak-proof system. When the forest is removed, this highly efficient recycling sequence is broken, and unless the site is left fallow, or is treated with large amounts of organic matter or fertilizer, the soil quickly becomes impoverished. In some soils, hard impervious crusts develop. With conditions of heavy rain-fall, devastating problems of erosion and increased water discharge occur on steep slopes, and a common chain of degradation follows, aggravated by weed and pest invasion, which makes it almost impossible for true tropical rain-forest to return to these sites.

Wood production:—Forests are one natural resource which is renewable, and if harvested wisely the many useful species of the rain-forest can produce a sustained flow of products. Timber can be an important part of a country's economic development, by filling domestic needs and by providing material for foreign commerce. Moreover, on the commonly nutrient-poor soils, forests are the only productive crop which can effectively utilize the solar energy of many sites.

Animal wildlife habitat:—Rain-forests are home for some of the world's most unusual and interesting animal wildlife. As with rain-forest flora, one finds the same characteristics of high diversity, but a relatively low number of any one species. Maintenance of forest habitats of sufficient size is essential to prevent their animal denizens' extinction.

Indigenous peoples:—Rain-forest native peoples have evolved a way of life which is adjusted to and dependent on a stable relationship with the tropical forest environment. In co-existing with the forest rather than replacing it, they are truly ecosystem people. In general, either because of their mobility or a lack of experience in dealing with cultures having entirely different value-systems, they are ill-equipped and often unable to cope with the pressures common to 'development'. Any exploitation of the tropical rain-forest must take into account the presence and rights of these peoples whose culture is threatened by such activity, and give recognition to the valuable lessons in adaptation that are yet to be learned from them.

Principal Causes of Deforestation

Forest clearing for agriculture and grazing (with associated burning), unrestricted timber harvesting, and large mining and hydroelectric projects, represent the major causes of deforestation. The UN/FAO estimates that in Latin America alone, between five and ten million hectares of forest are felled each year for agriculture. Where this land-use can be sustained, the decision is rational; but in many instances, only short-term, shifting agriculture is possible due to soil, slope, or climatic, limitations, and not only is the site lost to rain-forest, but its productivity is often completely destroyed, leaving a wasteland.

In addition, there is a world-wide increase in the rate of forest harvesting. Much commercial exploitation is done by foreign or multinational corporations, and their activities, particularly in southeastern Asia, have accelerated rapidly in recent years. Heavy cutting or clear-felling for wood chips has a much harsher impact on the complex rain-forest biome than former practices which utilized relatively few species. There is, unfortunately, much uncontrolled cutting taking place without care for the future. Of particularly serious consequence for rain-forests in some parts of the tropical world is the growing demand for fuel-wood, including charcoal wood. It is resulting in an unprecedented assault on all forests, and often occurs on steep slopes of important watersheds, sometimes including high-altitude cloud-forests. Cattle are often put on the site after cutting, fire is used to keep land clear, and the pattern of rain-forest destruction is complete.

It is, however, the roads associated with the above activities or designed to 'open up' a frontier which often play the key role in rain-forest destruction. In the past, much rain-forest was protected from Man's impacts by virtue of its inaccessibility; but with the penetration of roads into an area, the vulnerable forest is exposed to these and other severe threats.

Future Outlook: Alternatives to Additional Clearing?

Concerned scientists and international organizations are currently working on ways to intensify agriculture on those sites that have already been cleared, and to establish areas of protection where the integrity of the tropical rain-forest ecosystems can be maintained. Intensification, or a switch from horizontal to vertical expansion of agriculture, may require additional energy inputs in the form of fertilizers, irrigation water, or drainage, etc. These inputs are not without environmental costs of their own, and should be examined carefully. There is much potential for growing supplemental tree-crops on land that has been cleared for shifting agriculture; this agrisilviculture system can include both valuable food-producing and commercial timber species. 'Wood factories', or forest resource production in plantations on lands that have already been cleared, can also alleviate some of the pressure to open up new forest areas. Above all, useful information is needed, perhaps disseminated through an extension service, which emphasizes appropriate sustainable technology and not maximum technology, and which utilizes available labour and resources.

The second area of emphasis is protection of certain areas by their designation as national parks, forest reserves, or protected zones of some other type, where Man's activities are limited or controlled. Setting aside of such areas now leaves open numerous options for their future use—options which may prove vitally important not only to the society in whose care the forests rest, but to Mankind in general.

If benefit is to be derived from the tropical rain-forests and undesirable consequences of their exploitation duly avoided, three things are necessary: (1) sound planning for allocation and use of land, (2) careful consideration of each conversion from one land-use to another, and (3) good management and control of activities. This, of course, requires both vigorous government action and a much-improved understanding on the part of the general public regarding the importance of the issues.

As the main barriers to sound resource-management lie in attitudes and institutions, programmes of assistance (whether sponsored from inside or from outside a coun-

try) must address the issues in these terms in order to bring about any real change. The results of such efforts should mean that the burden of proof is placed, not on those making a case for retaining the tropical rain-forest, but, more appropriately, on those wishing to remove the forest. They should be obliged to demonstrate that the changes which they propose are genuinely of long-term benefit to the community. This is not an anti-development stance, but is rather one of prudent conservation of natural resources as an integral part of a total plan of wise development.

INTERNATIONAL EARTHCARE CENTER
Sierra Club Office of International Environment Affairs
800 Second Avenue
New York
NY 10017, USA.

The Bali Declaration

Meeting in Denpasar, Bali, from 11 to 22 October 1982, in response to the generous invitation of the Government of Indonesia, the World National Parks Congress considered principles and policies to guide the establishment and management of national parks and other types of protected areas in the light of the broad principles governing the interrelationships among population, resources, environment, and development, formulated by the series of intergovernmental conferences that began at Stockholm in 1972. In drafting the Declaration of the World National Parks Congress, note was taken of the World Conservation Strategy (Anon., 1980) and the Charter for Nature (Anon., 1983). The Congress reaffirmed the fundamental role of national parks and other protected areas in contributing to sustainable development and the spiritual and cultural needs of Mankind. Participants included scientists, planners, managers, and supporters of protected areas, from 70 countries.

DECLARATION OF THE WORLD NATIONAL PARKS CONGRESS HELD IN BALI, INDONESIA, 11–22 OCTOBER 1982

WE, the participants in the World National Parks Congress, BELIEVE that:

People are a part of Nature. Their spiritual and material well-being depends upon the wisdom applied to the protection and use of living resources. Development needed for the betterment of the human condition requires conservation of living resources for it to be sustainable.

Earth is the only place in the universe known to sustain life, yet as species are lost and ecosystems degraded, its capacity to do so is rapidly reduced, because of rising populations, excessive consumption and misuse of natural resources, pollution, careless development, and failure to establish an appropriate economic order among peoples and among States. The benefits of Nature and living resources that will be enjoyed by future generations will be determined by the decisions of today. Ours may be the last generation to choose large natural areas to protect.

Experience has shown that protected areas are an indispensable element of living resource conservation because:

- they maintain those essential ecological processes that depend on natural ecosystems;

- they preserve the diversity of species and the genetic material within them, thereby preventing irreversible damage to our natural heritage;
- they maintain the productive capacities of ecosystems and safeguard habitats critical for the sustainable use of species; and
- they provide opportunities for scientific research and for education and training.

By doing so, and by providing places for recreation and tourism, protected areas make an essential contribution to sustainable development.

At the same time protected areas serve the spiritual and cultural needs of people by securing the wilderness and sacred areas on which so many draw for aesthetic, emotional, and religious, nourishment. They provide a vital link between us, our past, and our future, confirming the oneness of humanity and Nature.

To these ends, therefore, WE DECLARE the following actions to be fundamental:

1. Expand and strengthen the global and regional networks of national parks and other protected areas, to give lasting security to: representative and unique ecosystems; as full a range as possible of Earth's biotic diversity including wild genetic resources; natural areas that are important for scientific research; and natural areas of spiritual and cultural value.
2. Support the establishment and management of protected areas through national commitment and international development assistance.
3. Provide permanent status for protected areas in legislation securing their objectives against compromise.
4. Plan and manage protected areas, using the best available scientific information; increase scientific knowledge through research and monitoring programmes; and make it readily available to scientists, managers, and the general public throughout the world.
5. Recognize the economic, cultural, and political, contexts of protected areas; increase local support for protected areas through such measures as education, revenue sharing, participation in decisions, complementary development schemes adjacent to the protected area, and, where compatible with the protected area's objectives, access to resources.
6. Implement fully the existing international conventions concerning protected areas, and adopt such new conventions as may be required.

WE PLEDGE ourselves to these actions as a contribution to sustainable development and hence to the spiritual and material welfare of all people; and CALL UPON all governments, singly and collectively, to take these actions with due dispatch, bearing in mind their responsibility for the whole of life and their accountability to present and future generations.

REFERENCES

- ANON. (1980). *World Conservation Strategy: Living Resource Conservation for Sustainable Development*. IUCN – UNEP – WWF (obtainable from IUCN, Avenue du Mont-Blanc, 1196 Gland, Switzerland: pack of ca 50 unnumbered pp., illustr., in stiff paper folder).
- ANON. (1983). *World Charter for Nature*. United Nations General Assembly, A/37/L.4, 28 October 1982, Thirty-seventh session, Agenda item 21, New York, NY, USA: 7 pp. (mimeogr.). With minor editing the Charter is printed above on pp. 67–8.