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Conference on the human environment

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Environmental aspects  
of natural resources  
management

(subject area II)



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ENVIRONMENTAL ASPECTS  
OF NATURAL RESOURCES MANAGEMENT  
(subject area II)

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## Chapter I

### AN APPROACH TO INTEGRATED RESOURCE MANAGEMENT

1. Man's use of natural resources is the indispensable means to maintaining and improving the human condition. In his use of natural resources, however, man has, until recently, been unable to foresee - far less to assess and take account of - the impact of his actions on his well-being, or even on the resources themselves. Historically, in many regions of the world soils have been depleted, forests cut down and oceans and lakes have served as sinks for man's wastes. Why then, has concern over the environmental aspects of natural resource use and management recently reached major national and international proportions?
2. What is new is the magnitude of the claim on the world's resources and, hence, on the environment as a whole, together with a new awareness of cause-and-effect relationships. That claim flows from unprecedented rates of population growth, swiftly rising incomes and per capita demand which - magnified by scientific and technological advances - imposes demands on natural systems which may exceed their capacity to respond. As a result:
  - (a) the impact on the environment is such that, for the first time, the question could legitimately be raised whether the life-support system of the planet might be damaged beyond repair;
  - (b) in some parts of the world, especially where consumers are better informed through improved communications and better supplied by rising levels of affluence, there is mounting concern that demand may - in the case of some resources - overwhelm the supply.
3. As long as the volume and nature of man's productive activities were small, the environment was, by comparison, large enough to assimilate the waste products of production and consumption. Economic systems were for the most part geared to channelling resources into productive uses without considering the flow of used objects and waste materials. Rather, in many countries economic incentives were so structured as to maximize disposal in the air, in water bodies and in other communal resources. Now that open access has led to overtaking the assimilative capacity of these resources, new initiatives are called for in modifying the conventional incentive structure so as to make it a tool to minimize pollution. The scale of the environmental impact also has a spatial dimension. National boundaries seldom constitute barriers



to the movement of pollutants. Those who live downstream or down-wind from a source of water or air pollution are directly affected, and the distances involved are often substantial. Moreover, the resources of areas outside national jurisdiction, such as the oceans, are being increasingly degraded. This aspect is discussed in greater depth in connexion with subject area III, identification and control of pollutants of international significance.<sup>1/</sup>

4. In many countries, particularly the richer ones, rising incomes combined with the pressures of urban living have led to the expectation of improved amenity values. As attention has increasingly turned to these aspects of life, the supply of such amenities has been found to be insufficient to accomodate the rapidly rising demand. Accelerated use threatens to degrade, in particular, choice locations. The preservation of open space is consequently given an importance equal to that which was attributed to more conventional uses (e.g. mining, highways, airports, industrial facilities).

5. Although arising in different contexts, in different countries, and with differing intensity, there is emerging a changing view of ultimate values. While this is perhaps most striking in the industrialized countries where the questioning of the pursuit of growth in its traditional form has reached significant proportions, evidence of change is available around the world. This has fed into the general stream of thought that emphasizes the importance of intangibles and of environmental values in particular. In the developing countries the reconsideration of traditional pursuits has focused greater attention on minimum acceptable living standards. Although rates of growth continue to be of paramount importance, concern is now voiced about the composition of output.

6. These, briefly, are among the principal issues that have brought about the worldwide concern with the state of the human environment, spilling over into a reconsideration of traditional concepts of resource management. It is imperative to view this concern within the broader framework of the biosphere.

- (a) the biosphere is a thin surface layer surrounding the earth that comprises living organisms and the terrestrial environment with which they exchange energy and matter. It can be seen as a system

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<sup>1/</sup> A/CONF.48/8

capable of intercepting radiant energy from the sun, converting it into chemical energy through photosynthesis and distributing this energy in such a manner as to ensure the maintenance of the biosphere's functional structure. The survival on earth of living organisms, including man, thus depends not only on the photosynthetic process itself, but also on the energy-exchange processes responsible for maintaining the functional structure of the biosphere;

- (b) the biosphere contains many interacting parts. It is a mosaic of individual ecosystems, or self-contained entities, each comprising a living community and its inanimate physical environment;
- (c) ecosystems can exist on many levels and in many sizes - a small pond, a vast river basin transcending national boundaries, the biosphere itself. Each has its own equilibrium and interdependencies within which energy and matter are circulated;
- (d) a common set of processes permits the understanding and scientific management of the ecosystem. Photosynthesis and predation, decomposition and evaporation, adaptation and precipitation all take place at varying rates and in different quantities. The principles of carrying capacity, survival threshold, biological succession and resilience can be observed to assure the sustained yield of a particular resource;
- (e) all ecosystems generally include primary producers such as green plants, consumers such as herbivores, predators of different orders, and decomposers. Green plants are instrumental in photosynthesis, herbivores and predators contribute to the distribution of energy and matter, and decomposers break down dead organic matter so as to make the mineral elements it contains again available to plants again. It is thus possible to develop a model from which to study the optimal use of an ecosystem and to predict the sources and timing of its possible degradation.

7. The fact that perturbations in remote and seemingly unimportant parts of the biosphere can trigger off a chain of cause-effect reactions that ultimately provoke profound changes in the entire system, has given rise to the operating concept of "integrated resource management". This means that in altering one element in the system - for the purpose of deriving an advantage in terms of either goods or services -

one would be well advised to understand the impact of that alteration upon the remaining components of the system. Moreover, one should carefully calculate what should be done to make the system or unit or community as a whole as productive as possible or, as a more modest objective, to prevent the benefits that the modification makes possible from declining and eventually collapsing because crucial links and "feedback circuits" have been interfered with or severed.

8. Although integrated resource management is a sound concept, it does not always readily conform to economic and social realities. Many people engaged in on-going activities do not easily understand and accept the notion of integration. This does not mean that the ecology has traditionally been ignored. On the contrary, many of these people conform, however imperfectly, with ecological principles. Thus, man must have done some things right. True, this has mostly been a matter of trial and error. Nonetheless, tillers of the soil the world over have learned to live with nature without ever having heard of an ecosystem. When they have failed to learn, they have lost the soil and often also the basis for their existence. But in most parts of the world, they have been the original practitioners of "integrated resource management". Demand pressures, however, are inexorably pushing producers to increase both the productive base and the yields they wrest from the resources. In that process it has become increasingly apparent that nature usually can be pushed just so far, before diminishing returns set in.

9. Where a complex system of human activities is already in operation, the introduction of integrated management naturally faces great difficulties. It may be able to intervene only gradually as opportunities open up through obsolescence or other changes of one component or another. Nonetheless, the openings for injection of the principle should not be underestimated; even in developed countries or areas the possibilities of introducing new concepts are frequently considerable. But their most fitting field of application can, of course, be found in the developing areas.

10. The principal elements of integrated management need to be defined. The planning, development and management of natural resources, can be most efficient when it is carried out in an integrated manner. This provides the greatest opportunities for maximizing the economic, social and environmental benefits which can stem from natural resource development. Moreover, it may allow maximizing benefits through the timing of project developments. In other words, a series of resource development projects executed in a carefully planned sequence can be advantageous both from an economic

and environmental viewpoint. In short, the environment itself should be treated as one of the variables to be included in the comprehensive planning and management of natural resource development.

11. Integrated management requires expanding the planning process, where the economy is suitably organized. It also requires a high degree of co-ordination in the management of sectoral activities. In some cases development will be guided by articulated national goals - economic, social, and environmental; in other circumstances, the experience which can be drawn from the development process itself, will yield guiding principles over time.

12. Land use planning, in accordance with intrinsic land capabilities and limitations, is a major tool of integrated resource management. Its use can reduce, if not avert adverse environmental effects. Land inventories should be undertaken, where appropriate, to provide comprehensive surveys of the potential of land. Such surveys - including aerial surveys and remote sensing - can form one basis for land use and resource planning for agriculture, forestry, recreation, or wildlife, and may comprise a classification system which delineates the potential and constraints for each sector analysed.

13. Central to the integrated approach is the participation of specialists who can, between them, understand the full range of environmental elements and their dynamics while being equally sensitive to economic, social and cultural considerations. The process involved ranges from initial surveys, in the case of development projects, through feasibility studies, investment, management of the completed project and, very importantly, its subsequent evaluation in terms of the environmental impact it has had.

14. Integrated resource management need not require a massive reorganization of existing governmental institutional structures. Mechanisms providing for co-ordination and for promoting co-operation between existing institutions offer the most practical immediate courses of action. Such mechanisms could include inter-agency or intra-agency working groups, task forces drawn from several agencies to work together on a specific project, and liaison and exchange of information between governmental agencies concerned, about on-going and planned activities.

15. Certain basic institutions are, however, required at the national level and would need to be established where they do not exist. This applies particularly to agencies responsible for water and land use. In some cases, it may be best to establish new institutions with a functional, rather than a sectoral, focus. National institutions

responsible for integrated surveys of natural resources have been successfully established in a number of countries. Another organizational approach is to strengthen institutional mechanisms on a geographic basis. Many countries have given greater powers over natural resources to local administrative subdivisions, such as states and provinces. In this connexion river basin authorities have proved to be particularly effective.

16. It is important to appreciate that the foregoing sketchy blueprint is not yet widely practiced and is far from complete. Much additional research is needed in the techniques of integrated resource management, and the application of present knowledge is far from satisfactory in many parts of the world. Moreover, natural resource development and management have often failed to draw the necessary lessons from past failures or deficiencies, and too little attention has been devoted to a systematic analysis of completed projects to determine why they succeeded or failed in environmental terms. Overriding all such considerations is the concern that, given the pace at which pressures for production are mounting and causing productive systems to stress the limits of the biosphere, the margin for error is narrowing, both where development is far advanced and where it is in its early stages.

17. Once the meaning of the ecosystem concept and the importance of modifying this system in ways that will enable it to assist rather than vitiate productive activities has been understood, it becomes clear that existing production systems are not cast in ecological but in economic terms. The motivation of the producer is to combine his labour and certain inputs in such a way as to produce an output the value of which exceeds the sum of the inputs. The fact that in the course of his activity he may impinge on the ecology is taken as incidental. The producer is concerned with economizing or with seeking to make such choices among alternatives that will yield him a net "profit", by whatever name this may appear in a given economic system. Where the object is a large public undertaking, a development project, or some other large-scale activity, alternatives are, in the first instance, evaluated in terms of costs and benefits. Those that promise to yield a net benefit, receive further consideration, while those that do not must satisfy other criteria if they are to survive.

18. In the area of cost-benefit calculations, ecological considerations have had some of their earliest successes. Initially lumped under "intangibles", they have increasingly come to be explicitly recognized, even though it is very difficult to quantify them.

19. One advantage of economics is that, since everything is reduced to a common yardstick - a monetary unit of measurement of some kind - factors that in their original guise are incommensurable become commensurable. The common denominator permits a rough sorting out of available choices. It forces a substantial amount of discipline on decision-makers, without which conflicting aspirations and objectives would have to be reconciled wholly by means of what can be collectively called "political" arguments. Introducing monetary units conveniently narrows the area in which decisions have to be made on the more demanding basis of ultimate values.

20. In considering environmental effects, economic criteria permit a more rational view of trade-offs than would otherwise be possible. Trade-offs are important. It is a well-established fact that, as a certain reduction in environmental pollution or a certain level of environmental acceptability is achieved, further progress becomes increasingly costly. Economic, social, and environmental considerations must all be reviewed by a common measure. Difficult trade-offs must frequently be confronted. For example, one can scientifically manage a forest for sustained yield, while neglecting its aesthetic and recreational values. Thus trade-off decisions have to be made even in those cases that at first glance seem to meet integrated management criteria and to conform to ecological principles.

21. Instead of considering ecosystems as whole units and explicitly recognizing environmental considerations as parameters of decisions, public policies and private activities are still almost exclusively organized along sectoral lines. So is demand for products, and so are many professional and occupational classifications. Yet all these activities affect the environment through the demand they make on land, air, or water and through the modification of adjacent resources in the process of production. One cannot expect management to conduct operations aimed at producing goods and services, that do not simultaneously affect the resources involved and associated. Rather, the task of resource management is to provide a combination of production and rate of disturbance that enables the environment to retain its capacity to sustain the activity, and that furnishes society with the goods and services it requires.

22. In each of the sectors of Chapter II, environmental considerations may be viewed in a global, national, and local context. The nature of the action and the level at which it is taken will vary from one geographic perspective to the next. The constraints and capabilities of the biosphere are best understood at the global level. As its evolution clearly shows, the functional structure of the biosphere is very adaptable,

and many organisms have proved to be capable of performing similar functions. Man has taken advantage of this characteristic to modify the biosphere for his own benefit. The limit of the biosphere's capacity to adapt to these modifications may be approaching, however, and man must account for these limits in future resource development.

23. It is at the level of nations, however, that resources development, and its associated environmental considerations, are most meaningful. Despite the physical unity of the earth's biosphere, the world is a community of nations whose individual sovereignties must be respected. Each country attempts to identify its national goals, as conditioned by its social and cultural values and the stage of its economic development, and to review the supply and distribution of its natural resources in the light of these goals. Competing demands, including conflicts between short- and long-term considerations, will make reconciliation of objectives a difficult task. Resource use must ultimately be guided by society's objectives, although such objectives will frequently be conditioned by the availability and distribution of the resources themselves. Resource priorities will also shift over time, as social values change. What was yesterday a forest serving urban recreational needs might today be a source of timber and tomorrow converted to agricultural land. The face of each nation's landscape undergoes constant evolution. Whether transformed or maintained intact, however, the environmental value of the different parts of a nation's landscape should be appreciated. Savannah or forest, desert or pastureland, meadow or prairie, all perform unique functions that should be assessed before man introduces changes, especially irreversible ones. Marginal lands, for example, although frequently neglected as a resource are, in fact, instrumental in maintaining the ecological balance of a territory. They act as a buffer - for example, between deserts and croplands on the upper parts of a watershed and the alluvial plains - and provide multiple land use opportunities between areas where a single use is predominant.

24. The sub-national level - either regional or local - will usually provide the best unit for resource development indicated by national policy. The participation of the local community is necessary for first-hand information on land capabilities and for the inclusion of social considerations. Individual components of the national land inventory will require the scrutiny of local planning and management.

25. The inevitable burden on the environment, whatever the geographic scope may be, can be dealt with by a number of preventive measures. Recycling can reduce the demand on resources and diminish the mounting pressures on the world's air and water. The

environmental degradation arising from new technologies, suggests a reconsideration of the increasing substitution of synthetic for natural products. In balancing costs, careful attention must be given to include all factors. Costing systems can be modified to reflect the costs of adverse environmental impacts and thus to encourage less harmful processes. Finally, mention must be made of the possibility of re-directing or modifying growth itself. There are those, particularly in some of the more affluent nations, who believe that the orientation of production should be shifted to provide for more social services and amenities. Moreover, the fact that the high production levels of some of the industrialized countries already draw even more heavily upon the world's non-renewable resources, raises questions of adequacy for future production.

26. In one respect, Chapter II departs from the integrated approach. For reasons of convenience, recommendations are arranged under headings that reflect, with minor modifications, the conventional division by sectors of economic activity. Because policy formation and implementation continue to be very largely based along traditional sectoral lines, the Conference's agenda items were formulated and the material submitted along the same lines. Moreover, although the recommendations are directed to countries at all stages of economic development, the discussion is generally cast in terms of an ideal model which governments may modify as they find appropriate; but because the discussion is structured in a way which seems to imply that resource development is essentially starting afresh, it applies particularly to the developing countries.

27. Despite the inevitable differences among sectors and nations, however, all share the common need for an environmentally sound resource management, which will allow man to continue to reap the manifold benefits provided by resources while minimizing environmental costs.



## Chapter II

### SECTORAL RECOMMENDATIONS

#### A. Agriculture and soils

##### (i) Considerations for action

#### 28. AGRICULTURE IS A VITAL ACTIVITY FOR THE PROVISION OF MAN'S FOOD SUPPLY

- Agricultural activities - farming and related agro-industries - occupy more than half of the world's population.
  - Throughout much of the world, agricultural development has resulted in immeasurable benefits;
    - . living conditions of farmers and the quality of the rural environment have improved
    - . better agricultural products have been provided
    - . the productive capacity of natural resources has been enhanced
    - . these improvements have resulted primarily from the use of higher-yielding varieties and breeds, fertilizers, pesticides and other agrochemicals, improved land use planning and management practices and, in some areas, better supply of irrigation water and changes in land tenure systems;
  - In other parts of the world, particularly the developing countries, further agricultural development is still essential to meet the increasing demand for food and to improve the conditions of rural life;
    - . increasing populations and rising expectations lead to a demand for more food and other agricultural products
- .. it is estimated that world food production will have to double by 1985.

#### 29. THE INFLUENCES OF AGRICULTURAL ACTIVITIES ON THE ENVIRONMENT ARE SIGNIFICANT AND OFTEN INEVITABLE.

- Traditional agriculture has long been a major factor in maintaining and improving local natural resources and the environment, on which it closely depends.
- As the scale and rate of agricultural development increases, it becomes increasingly difficult to avoid harmful environmental side-effects which, if unchecked, could reduce the quantity and quality of the food production and detract from rural living conditions.
- Multiple changes are taking place in the agricultural landscape relating to the conditions of land use management.

30. ALTHOUGH SOME LAND RESERVES ARE NOT YET DEVELOPED, AGRICULTURE HAS BEEN INTENSIFIED AND EXTENDED BEYOND THE CARRYING CAPACITIES OF THE SOILS AND RESOURCES OF SOME AREAS.

- While the bulk of the earth's land surface is unarable, it is estimated that half of the 20 per cent covered by permanent pastures, meadows and forests could be cultivated.
- Of the remainder, it is estimated that 20 per cent is too cold, 20 per cent too steep, and 10 per cent lacks sufficient soil cover for cultivation. The balance is currently cultivated;
  - . in order to avoid environmental degradation, however, the capabilities of these land reserves should be carefully assessed before use.
- In other areas agricultural development has taken place without regard for the diversity and inherent limitations of the land;
  - . this is due to a lack of knowledge of land capabilities and, more particularly, to the insufficient use of available data and experience
  - . this has resulted in the introduction of new crops and animal breeds without accounting for climate, soils, liabilities to disease, and requirements for technological inputs.
- The increased amount of agricultural inputs exceeds the present ability of many farmers to manage economically the production process on a sustained yield basis and to compensate at the same time for harmful environmental side effects.

31. PRESSURES UPON AGRICULTURAL RESOURCES ARE INCREASING FOR SEVERAL REASONS.

- Although over centuries subsistence farmers have acquired an intimate knowledge of local climate, soils, water, plants, and animals and of the maintenance of their productive capacities, the introduction of new agricultural technology and land use systems tends to make some of this knowledge and experience obsolete.
- It is becoming increasingly difficult for extension and other advisory services to educate farmers in appropriate agricultural practices and in the safe use of new technologies;
  - . this is due to the large number of people and production units involved and the increasing rate at which changes are introduced into agriculture
  - . the problem is particularly acute where new lands are brought under cultivation, where new crops, varieties or breeds of animals are introduced, or where irrigation is used.

- Dependence on market conditions and, in some countries, obsolete land tenure systems put additional constraints on the farmer and further limit his ability to manage economically his farm and at the same time maintain the productive capacity of its resources and the protection of the environment. Under these conditions, many farmers, especially in developing countries, cannot afford to make basic land improvements, and apply soil and water conservation practices.

52. ACCELERATED DEGRADATION AND DEPLETION OF BASIC AGRICULTURAL RESOURCES ARE RESULTING FROM THESE PRESSURES.

- Although some forms of natural resources degradation have always existed and can be found at all levels of agricultural practices, increasing problems are found throughout the world which substantially impair agricultural productivity and development. These include:
  - . accelerated soil erosion by wind and water, loss of soil fertility, through leaching or depletion of nutrients and decrease in humus content, degradation of soil structure, increased soil salinity, alkalinity and waterlogging under irrigation
  - . loss of useful genetic resources
  - . conversion into poor croplands or depletion of some grasslands by overgrazing
  - . local or regional modifications of climate through removal of forests and tree hedges, causing, inter alia, desertification in sub-arid areas
  - . encroachment from urban and industrial areas and transport facilities on good agricultural lands
  - . discharge of harmful wastes from urban areas and industries on to rural areas.

53. INTENSIVE AGRICULTURAL PRACTICES CAN PLACE A HEAVY BURDEN UPON THE ENVIRONMENT.

- Many agricultural systems, associating either intensive monoculture or animal husbandry with agro-industries, do not provide for the economical use of by-products and tend to accumulate wastes, the disposal of which becomes the source of major nuisances:
  - . unused plant residues can sometimes serve as reservoirs for the spread of pests and diseases; or the burning of these residues instead of being recycled by composting or consumption by cattle, may lead to a decrease of humus content and of overall soil fertility and to other nuisances
  - . intensification of livestock production often results inter alia in large concentrations of animal excreta and liquid effluents which may cause pollution of air and contaminate water bodies

- . processing industries discharge organic wastes and other effluents which, if uncontrolled, may be causes of air pollution and water contamination
  - .. they also, of course, improve the conservation and marketing possibilities of agricultural products.
- Intensive agricultural systems are also increasingly dependent on agro-chemicals, some of which can, when excessively or improperly used, be a major cause of pollution and contamination;
  - . overdoses or misuse of some pesticides may contaminate and sometimes kill desirable plant and animal life, disrupt the prey-predator parasite ecological balance, induce pest resistance; or accidentally harm users
    - .. pesticides are usually essential, however, for the protection of crops and livestock under present conditions
  - . dairy products, meat and fish may contain persistent residues of some wide-spectrum pesticides, which can be considered as harmful to man beyond certain levels of concentration
    - .. in some instances such contaminated foodstuffs have been declared unacceptable to certain markets
    - .. the use of some persistent pesticides has been banned or reduced in some countries
    - .. in many other cases, however, higher costs and insufficient knowledge and experience preclude the use of less persistent and more selective pesticides and other more sophisticated pest control techniques
  - . when used on erodible lands or, as in some industrialized countries, applied in excessive quantities, fertilizers may contribute, although perhaps to a minor extent, to water pollution and may occasionally cause nitrate poisoning of drinking waters
    - .. they are, however, essential not only for higher yields but also for the improvement and conservation of soils
  - . over-utilization or misuse of drugs and antibiotics, necessary for the conditions of highly intensive animal protection, can leave harmful residues in meat and dairy products
  - . contamination of water by agro-chemicals is often more acute on erodible and irrigated lands
    - .. however, little is yet known about the actual contribution of agro-chemicals to pollution and about their effects on man and natural resources

- improper irrigation may result in salinization, waterlogging, and other problems
- high-yielding grain varieties in certain tropical and sub-tropical regions might possibly be more vulnerable to widespread disease, herald the disappearance of native genetic stocks, result in social dislocations and increase the adverse effects arising from the higher levels of pesticide and fertilizer use.

(ii) Recommendations for national action

It is recommended that governments give consideration to the following proposals:

34. GOVERNMENTS SHOULD DEVELOP AGRICULTURAL PLANS AND POLICIES TO ENABLE FARMERS AND AGRO-INDUSTRIES TO FULFIL THEIR RESPONSIBILITIES IN MAINTAINING THE QUALITY OF THE HUMAN ENVIRONMENT.
- Agriculture will need to be increasingly recognized as an activity of general public interest:
    - for supplying food and other essential products in sufficient quantity and of satisfactory quality
    - for ensuring the conservation of a large part of the natural resources and of the environment
    - for employment opportunities in order to avoid excessive urban concentrations
    - for maintaining and enhancing the quality and attractiveness of rural areas for recreation and as buffer zones between urban areas
    - for recycling wastes emanating from sources such as municipal sewage.
  - At the planning stage, the adverse environmental impacts of development plans on agriculture and conversely the harmful environmental effects of agricultural development should be prevented.
  - The local environment will have to be regarded as a functioning ecosystem within which agricultural development takes place and to which it adapts, and not the reverse;
    - the conventional preoccupation with agricultural outputs must be balanced by a consideration of inputs and their environmental implications.
  - An ecological appreciation explains the need for various inputs beyond the capabilities of the individual farmer but required to maintain successfully an artificial equilibrium:

- . plant breeding programmes and the salvaging of threatened genetic resources
  - . soil and water conservation measures
  - . monitoring and control of soil, water, and plant contaminants
  - . integrated controls of insects, weeds and other pests.
  - Agricultural and soil institutions should play an increasing role in the assessment of land capabilities and in advising planners and designers of development projects.
  - Agricultural development plans and investment programmes should make provision for the early implementation of those basic land improvement and soil conservation projects and facilities for waste disposal which individual farmers and agro-industries cannot afford to carry out by themselves.
  - An important part of the agricultural planning process and other aspects of rural planning should be carried out at the local level so as to involve the farming community and enlist their participation in improving the quality of rural life.
35. GOVERNMENTS SHOULD CONDUCT SELECTIVE BASE LINE SURVEYS OF AGRICULTURAL AREAS WHERE BASIC AGRICULTURAL RESOURCES ARE KNOWN OR SUSPECTED TO BE SUFFERING ENVIRONMENTAL DEGRADATIONS.
- Prior to selecting priority areas, collection and review of available surveys, inventories and data should be made in order to identify specific sources of environmental degradation;
    - . subjects for study include loss of soil productivity; loss of useful genetic resources; depletion of grazing lands; recurrent destruction of crops, livestock and wild herbivores by pests, diseases, or pollution; accumulation of harmful agricultural wastes; and indications of climatic changes.
  - More comprehensive interpretations of existing data should then be made to identify similar agricultural areas;
    - . inter-relationships among ecological conditions, types and intensities of land use and management practices, and problems of environmental degradation should all be depicted.
  - On this basis, priorities for urgent actions of conservation and protection of agricultural resources and for additional surveys and research should be established;
    - . these should consider the areas where the productive capacity of the resources and the agricultural products are most affected or threatened by environmental degradations.

- Capabilities of existing institutions should be strengthened accordingly to undertake the action required.
- Additional inventories and surveys should then be continued by sectors in priority areas;
  - . these should be developed by successive stages of approximation and detail
  - . they should make provision for periodic joint compilation and interpretation, including consideration of environmental effects of agriculture on other resources such as air, water, aquatic resources and wildlife.

36. GOVERNMENTS SHOULD KEEP SYSTEMATIC RECORDS OF ENVIRONMENTAL PROBLEMS CAUSED BY OR AFFECTING AGRICULTURE USING THE ABOVE BASE-LINE SURVEYS.

- The existing agricultural institutions (e.g. research institutes, field stations and other services) should provide the necessary network for these monitoring activities.
- Special emphasis should be placed on surveillance of soil degradation and on early warning systems for pests, diseases and pollutants affecting crops, livestock and the quality of agricultural products.

37. GOVERNMENTS SHOULD STRENGTHEN BASIC AGRICULTURAL RESEARCH TO IMPROVE ECOLOGICAL UNDERSTANDING.

- Research should be undertaken in selected ecosystems and problem areas on the general subjects of:
  - . the functioning and productivity of agricultural systems
  - . the processes of degradation of land resources and contamination of agricultural products
  - . the environmental effects of certain specific agricultural practices and agricultural inputs, particularly agro-chemicals
  - . the relationship of climate to the above items.
- In addition, a variety of ecologically-sound management opportunities merit study:
  - . the recycling of municipal wastes, including their detoxication, onto agricultural lands
  - . multiple cropping in the tropics, including considerations of crop combinations and sequences, cover crops, fertilization and weed control
  - . systems to re-utilize the wastes of agricultural runoff

- . integrated pest controls, including combinations of regulated pesticide use, cultural controls, crop diversification.
38. GOVERNMENTS SHOULD DIRECT THEIR AGRICULTURAL RESEARCH SERVICES AND FIELD STATIONS TO INCORPORATE ENVIRONMENTAL CONSIDERATIONS INTO THEIR PROGRAMMES OF INVESTIGATION AND EXPERIMENTATION.
- The findings of basic ecological research should be applied to the study, design, and experimentation of ecologically stable systems of land use and agricultural practices, particularly in tropical and subtropical areas, whereby:
    - . the productive capacity of land resources can be maintained on a long-term basis
    - . wastes can be disposed of or recycled in these systems without harmful effects on natural resources or on the environment generally.
  - In testing various combinations of crops and/or livestock, agricultural inputs, and management practices and in attempting to maximize yields or economic returns, experiments should be designed to assess:
    - . possible environmental side-effects of run-off, erosion, and other forms of soil degradation and of the accumulation of harmful residues, especially those from agro-chemicals
    - . the technical ability of local farmers to introduce new land use practices without causing deterioration to agricultural resources and the environment
    - . the economic feasibility of implementing agricultural practices which can better protect the resources and the environment without adding to farm management costs. To this end, special investigations should be undertaken to evaluate the costs and long-term benefits of environmental protection practices in agriculture.
  - Agricultural research institutions should, wherever feasible, use radioisotopes and radiation techniques to develop new, safer and more efficient management practices;
    - . this applies particularly to the application of fertilizers, pesticides, and irrigation water and to the biological control of pests.
39. GOVERNMENTS SHOULD DEVELOP AND FACILITATE INFORMATION EXCHANGE AND TRANSFER OF EXPERIENCE IN AGRICULTURE WITHIN AN ECOLOGICAL FRAMEWORK.
- The transfer of information and experience in agriculture should be based upon similar ecological conditions, especially climate and soil.
  - Within this framework, relevant and selected information should be made readily available to potential users (e.g. planners, extension services, farmers) in a form easily understandable and applicable, on:



- . soils, their characteristics, capabilities, and limitations for different uses
- . genetic resources, their requirements, potential resistance to pests and other adverse factors
- . agricultural practices most suitable for both increased production and minimum environmental damage, particularly soil conservation practices and integrated pest control techniques
- . most appropriate methods of agricultural waste disposal and recycling under local conditions.

40. GOVERNMENTS SHOULD INTRODUCE ENVIRONMENTAL CONSIDERATIONS INTO THEIR PROGRAMMES OF AGRICULTURAL EDUCATION AND TRAINING

- More emphasis should be placed on the creation of an understanding of:
  - . the vital role of agriculture for man's welfare and for the maintenance of environmental quality
  - . the environmental problems related to specific management practices, particularly those related to soil conservation and pest control
  - . the limits to the carrying capacities of natural resources under particular farming or grazing conditions.
- These considerations should be introduced at all levels of training and education.

41. GOVERNMENTS SHOULD INTRODUCE AN INSTITUTIONAL AND LEGISLATIVE FRAMEWORK WHICH ACCOUNTS FOR THE ENVIRONMENTAL DIMENSIONS OF AGRICULTURAL DEVELOPMENT

- Soil and agricultural institutions should be directed to consider the ecosystem as an operative unit in the management of air, soil, plant, and water resources;
  - . land settlement, agrarian reforms, and land consolidation should recognize local diversities of soil and climate
    - .. the extension and intensification of agriculture should be modified accordingly.
- Land use capabilities should serve as a basis for land zoning, land use legislation, licensing and regulations;
  - . measure should be designed to respond to degradation resulting from misuse of croplands, misuse of agricultural inputs, and from the careless disposal of agricultural wastes.

42. GOVERNMENTS SHOULD CONSIDER THE NEEDS TO PROVIDE INCENTIVES AND ASSISTANCE TO FARMERS AND AGRO-INDUSTRIES
- Measures could include, depending on a given country's social and economic system, credit, better marketing facilities, tax reductions or exemptions, and subsidies in cash or in kind.
  - Such measures would induce or enable recipients to undertake necessary actions to prevent or correct environmental degradation of general public interest caused by their activities.
  - Examples would include soil conservation, use of more selective pesticides, and recycling of wastes.
43. GOVERNMENTS SHOULD ESTABLISH OR STRENGTHEN NATIONAL PROGRAMMES OF CONSERVATION OF SOIL RESOURCES
- According to local conditions and requirements, these programmes may place emphasis on one or more of the following areas:
    - . rain fed crop lands, particularly dry farmed areas
    - . irrigated lands with salinization, alkali and waterlogging hazards
    - . erosion along rural roads and highways
    - . grazing lands, particularly in arid areas
    - . wind erosion, stabilization of sand dunes
    - . watershed protection and afforestation
    - . marginal lands, i.e. those areas falling between lands where intensive agricultural production is feasible and those unfit for agriculture and requiring protection.
  - The programme should be integrated with the actions proposed earlier on base line surveys, research, assessment of land capabilities, assistance to land use planning authorities, development of ecologically stable agricultural systems, soil conservation legislation, extension work and assistance to farmers;
    - . as such, it will go well beyond the mere promotion of soil conservation, erosion control practices, and land improvement works.
  - A number of specific measures might possibly be employed:
    - . erosion might be controlled through the use of various forms of mulches, primarily in the form of crop residues; engineering and agronomic techniques to stabilize the soil and lessen the erosive force of wind and water; control of fires; overgrazing, and deforestation; reseedling; and terracing

- . salinity and alkalinity control might employ knowledge of a plant's salt tolerance, the salinity of the water used for irrigation, and the soil characteristics for adequate irrigation and leaching
  - . the leaching and depletion of soils particularly in the tropics might be reduced through controlling the intensity of agricultural use, by providing fallow periods, by introducing horticulture or pasturage instead of short-cycle crops, or by the use of appropriate fertilizers.
  - Particular attention should be given in erosion control programmes to reducing sediment delivery to streams, reservoirs, dams and other water bodies in order to control physical, chemical and biological effects of these sediments on water quality and aquatic resources.
  - A special fund for the conservation of national soil resources may be needed to provide the necessary focus and means of action.
  - National soil institutions should be strengthened by reinforcing the soil conservation services and establishing, where needed, special units for land evaluation.
44. GOVERNMENTS SHOULD CONSIDER THE POSSIBILITIES OF RECYCLING AGRICULTURAL WASTES
- To the extent practicable and safe, animal or organic agro-industrial and municipal wastes could be used as fertilizers.
  - Likewise, crop residues could be used for composts or as animal feed.
  - In either case, the wastes or residues could be distributed to improve the structure and fertility of the soil.
    - . attention must be paid to guard against contamination of the soil resource and the spread of infectious diseases.
  - Wherever not feasible, these wastes should be collected, treated and disposed of under controlled conditions in order to:
    - . minimize pollution, contamination, fire and other hazards
    - . maintain the attractiveness and salubrity of rural lands and streams.
45. GOVERNMENTS SHOULD INSTITUTE OR REINFORCE NATIONAL PROGRAMMES TO REGULATE THE USE OF PESTICIDES AND OTHER BIOCIDES AND TO DEVELOP INTEGRATED PEST CONTROL
- Basic research is required on the fate and effects of pesticide residues in the environment and on their toxicity to man and other species.
  - Because of the recognized toxicity, persistence, and mobility of pesticides, particular care should be given to their efficient use.
  - Varieties and breeds more resistant to pests and diseases should be developed.

- The hazards of pests and diseases should be evaluated before the introduction of new crops, breeds, or management practices.
- Pesticides which are more selective and do not leave harmful persistent residues should be developed.
- The introduction of new pesticides should be controlled by appropriate regulatory measures for testing, registration, labelling, marketing and utilization.
- Biological pest control techniques such as the use of sterile male viruses pathogenic to insects, introduction of prey species and others should be developed and promoted with careful consideration for their possible environmental consequences.
- Farmers should be trained in the safe use of pesticides and in integrated pest control techniques, including such management practices as proper selection; dosage, and timing and waste disposal techniques. Bodily damage to users might thereby be minimized.

(iii) Recommendations for international action

46. IT IS RECOMMENDED THAT FAO, IN COOPERATION WITH OTHER INTERNATIONAL AGENCIES CONCERNED, STRENGTHEN THE NECESSARY MACHINERY FOR INTERNATIONAL ACQUISITION OF KNOWLEDGE AND TRANSFER OF EXPERIENCE ON SOIL CAPABILITIES, DEGRADATION, AND CONSERVATION
- Cooperative information exchange should be facilitated among those nations sharing similar soils, climate and agricultural conditions;
    - . the Soil Map of the World being prepared by FAO, UNESCO and ISSS should serve to indicate those areas among which transfer of knowledge on soil potentialities and soil degradation would be most valuable
    - . this map should be supplemented by establishing international criteria and methods for the assessment of soil capabilities and degradations and by collecting additional data based upon these methods and criteria
      - .. this should enable the preparation of a World Map of Soil Degradation Hazards as a framework for information exchange in this area.
    - . information exchange on soil use should account for similarities in vegetation and other environmental conditions as well as those of soil. climate, and agricultural practices.
    - . the FAO Soil Data Processing System should be developed beyond soil productivity considerations
      - .. to include the above data and relevant environmental parameters;
      - .. to facilitate information exchange between national soil institutions, and eventually soil monitoring stations.

- International cooperative research on soil capabilities and conservation should be strengthened and broadened to include:
    - . basic research on soil degradation processes in selected ecosystems under the auspices of the Man and Biosphere Programme
    - . applied research on soil and water conservation practices under specific land use conditions with the assistance of FAO and, where appropriate, other agencies (UNESCO, WHO, IAEA)
    - . research on using suitable soils for waste disposal and recycling
  - .. UNIDO, FAO and WHO should enter into joint consultations regarding the feasibility of an international programme in this area.
  - These efforts for international cooperation in research and information exchange on soils should be closely associated with those of the UNDP-WMO-FAO-UNESCO programme of agricultural bio-meteorology, in order to facilitate integration of data and practical findings and support national programmes of conservation of soil resources recommended above.
47. IT IS RECOMMENDED THAT GOVERNMENTS, FAO AND WHO, IN COOPERATION WITH UNESCO AND IAEA, STRENGTHEN AND COORDINATE INTERNATIONAL PROGRAMMES FOR INTEGRATED PEST CONTROL AND REDUCTION OF THE HARMFUL EFFECTS OF AGRO-CHEMICALS
- Existing international activities for the exchange of information and cooperative research and technical assistance to developing countries should be strengthened to support national programmes described above, with particular reference to:
    - . basic research on ecological effects of pesticides and fertilizer (IAEA)
    - . use of radio-isotope and radiation techniques in studying the fate of pesticides in the environment (joint IAEA/FAO Division)
    - . dose and timing of fertilizers' application and their effects on soil productivity and the environment (FAO)
    - . management practices and techniques for integrated pest control, including biological control (FAO/WHO)
    - . establishment or strengthening of national and regional centres for integrated pest control, particularly in developing countries (FAO/WHO).
  - Existing expert committees of FAO and WHO on various aspects of pest control should be periodically convened to:
    - . assess recent advances in the relevant fields of research mentioned above
    - . review and further develop international guidelines and standards with special reference to chlorinated hydrocarbons, pesticides containing heavy-metals, and the use of biological controls.

- In addition, ad hoc panels of experts should be convened, by FAO, WHO and, where appropriate, IAEA, in order to study specific problems, and facilitate the work of the above committees.

48. IT IS RECOMMENDED THAT FAO UNDER ITS PROGRAMME "WAR ON WASTE" PLACE INCREASED EMPHASIS ON CONTROL AND RECYCLING OF WASTES IN AGRICULTURE

- This programme should assist national activities recommended above relating to:
  - . control and recycling of crop residues and animal wastes
  - . control and recycling of agro-industrial waste
  - . use of municipal wastes as fertilizers.

B. Forests

(i) Consideration for action

49. FORESTS ARE AMONG THE LARGEST, MOST COMPLEX, AND MOST SELF-PERPETUATING OF ALL ECOSYSTEMS

- They cover about one-third of the world land area.
- They constitute one-half of the world land biomass.

50. THE ENVIRONMENTAL AND PRODUCTIVE VALUE OF FORESTS IS SIGNIFICANT

- At the world level,
  - . they have a direct and beneficial influence on all parts of the biosphere as a result of photosynthesis, heat capacity, conductivity and reflectivity, aero-dynamic roughness, influence on the water cycle, and emissivity in the infra-red band
  - . they act as buffer zones between man-made ecosystems
  - . they represent half of the world's photosynthetic fixation of carbon from the atmosphere, with its concurrent release of oxygen
  - . they serve as the source of wood and wood products
  - . they harbour valuable wild plant and animal species
- At local levels, they contribute to:
  - . regulation of water catchment and release
  - . protection of soil against erosion by wind and water and against other forms of soil degradation
  - . protection of wildlife
  - . recreational resources
  - . improvement of living conditions both in and around human settlement through:
    - .. the control of nuisances such as noise and air pollution
    - .. improve aesthetics
    - .. psychological relief
    - .. provision of shade, particularly in the tropics

- . agricultural protection and improvement when introduced as shelter belts and windbreaks
- .. trees serve to moderate wind velocities and improve the micrometeorological and soil moisture conditions in adjacent fields

51. FORESTS ARE SUBJECT TO INCREASING PRESSURE FROM COMPETING FORMS OF LAND AND FOREST USE

- The total demand for forest products is expected to double by 1985.
- Clearing forests is often considered a pre-requisite for economic development in countries where large forest tracts still exist. Pressure increases from:
  - . the demands for more agricultural land - particularly in the tropics where shifting cultivation is increasingly practised
  - . the establishment of new human settlements
  - . the development of water impoundments, transportation systems, etc.
- The world's forestry resources are shrinking at an alarming rate.
  - . in Latin America, between 5 and 10 million hectares are felled annually for agriculture
    - .. while the felling of trees and the "slash and burn" techniques of shifting agriculture are not always undesirable, their dimensions and intensity now argue for careful control and management.

52. SOME AREAS ARE BETTER ABLE TO COPE WITH CONFLICTING DEMANDS ON FORESTS THAN OTHERS

- In some areas, other needs can be satisfied without reducing the long-term productive capacity of forests and without deteriorating other natural resources or the environment in general;
  - . recreation, grazing, and aesthetic considerations usually constrain timber production, however,
- in other areas, such as tropical regions, arid regions, regions of dense population or adjacent to major industrial concentrations, forest depletion and degradation are taking place at an accelerated rate;
  - . adverse changes in micro-climates, soils, and water cycles sometimes result



- . both the quality of the environment and the productive capacity of other natural resources are then affected by:
  - .. local and possibly regional changes in climate
  - .. the increased frequency of floods
  - .. accelerating soil erosion by wind and runoff, and subsequent silting of water bodies
  - .. the destruction of the natural habitat of wildlife.

53. FOREST-BASED INDUSTRIES ARE CONSIDERED TO BE SUBSTANTIAL POLLUTERS OF AIR AND WATER

- The pulp and paper industry can place a particularly heavy burden upon the environment
  - . the chemicals and organic matter in the waste liquid from the pulp mill are normally disposed of in adjacent water bodies
  - . inorganic salts, mercury, and heat are all released
  - . unpleasant odours and gases, some of which are toxic in concentrated forms, are produced
  - . Sulphur dioxide, sulphides, and particulate matter are also released.
- Pollution - particularly noxious smoke and particulate contamination of the air - is also created by the mechanical woodworking industries such as sawmilling, plywood, particle-board and fibreboard manufacture.

54. INVENTORIES OF FOREST LAND AND RESOURCES SHOULD BE DEVELOPED OR EXPANDED

- Consideration should be given to low-cost aerial remote sensing techniques and to improved information on wood volumes and values, non-wood products, ownership, productivity, and trends of land use.

55. THE ENVIRONMENTAL VALUE OF FORESTS SHOULD BE INCLUDED AS AN IMPORTANT ELEMENT OF ANY LAND USE POLICY

- Competing demands on forest lands should be reconciled;
  - . frequently, the use of forest lands for other purposes, such as agriculture or human settlements, will be judged more important, and the lands will be cleared
  - . it is essential, in any case, that the costs and benefits be carefully analyzed and alternatives examined before trees are felled.

56. FOREST MANAGEMENT SHOULD RECOGNIZE THE VALUE OF FORESTS IN PROTECTING OTHER NATURAL RESOURCES AND IN ENHANCING THE ENVIRONMENT, AS WELL AS IN PRODUCING TIMBER
- The traditional production orientation of forest management should be modified to meet these newly recognized demands and to provide multiple-uses;
    - . it should be remembered, however, that whether public or private, forests should be at least economic
  - Forest legislation and institutions should be revised accordingly
  - The vulnerability of drastically changed forest ecosystems should be recognized.
57. VARIOUS SYSTEMS OF MANAGING FORESTS HAVE BEEN DEVELOPED AND SHOULD NOW BE APPLIED
- These concern the method of regenerating the forest crop, the form of the crop produced, the orderly arrangement of the forest in accordance with silvicultural and protective considerations and the economic and aesthetic value of the trees produced.
  - Relevant developments in management science include the application of operation research methods to forestry (linear programming, simulation, etc.).
58. THE DYNAMIC POSSIBILITIES OF BREEDING AND FARMING TREES SHOULD BE DEVELOPED
- Opportunities are emerging as forest genetics produce superior strains, fertilization of forests becomes commercially feasible, and soil and fertility research are expanded.
59. URBAN SILVICULTURE SHOULD BE AN IMPORTANT ELEMENT OF ANY NATIONAL PROGRAMME FOR THE DEVELOPMENT OF FORESTRY
- The breeding and propagation of trees suitable for the congested, more-or-less polluted urban environment would provide important psychological, aesthetic and anti-pollution relief.
  - The provision of shade is an important consideration in the tropics.
  - Attractive landscapes through the use of properly selected tree plantings should be planned in any development scheme.

60. THE OPPORTUNITIES FOR MANAGING FORESTS UNDER PUBLIC OWNERSHIP SHOULD BE FULLY EXPLOITED

- Approximately 70 per cent of the world's forests are under public ownership, where the possibilities for intensive and integrated management increase proportionately.

61. THE NECESSARY ECONOMIC ADJUSTMENTS TO CONTROL POLLUTION CAUSED BY FOREST INDUSTRIES SHOULD BE INTRODUCED

- Technologies are now generally available to control or eliminate pollution;
  - . the expenditure involved, although substantial, is increasingly considered both feasible and necessary
  - . less costly technologies should be developed.

(ii) Recommendations for national action

It is recommended that national governments give consideration to the following proposals:

62. GOVERNMENTS SHOULD UNDERTAKE BOTH BASIC AND APPLIED RESEARCH FOR IMPROVED FOREST PLANNING AND MANAGEMENT

- Considerable knowledge already exists, particularly as relates to forest ecosystems and management in the temperate zones, that should be collected, evaluated, and applied where practicable.
- General research needs, particularly in the tropical and subtropical areas, relate to:
  - . the functioning of "natural" and man-made forest ecosystems
  - . the mechanisms responsible for favourable or unfavourable influences of forests and forestry on other natural resources and on the environment
  - . the qualitative and quantitative effects of these mechanisms
    - .. both genetic and economic considerations require development.
- Research priorities in the tropics should be assigned according to the functions which require further knowledge;
  - . Immediate supplies of timber represent man's primary need, and vast tropical forest areas require management

- .. scientific knowledge of the life histories and growth requirements of trees and forests, upon which forest management is based, is largely lacking in the tropics. Research is needed on such processes as ecological succession, energy conversion and nutrient cycling before adequate management systems can be devised or their effects predicted
- .. research on the identification and potential uses of tropical timber trees must still take place in many cases, as must further study on the strength, density, chemical and other properties of such timber
- .. soil and water of tropical forest lands, causing problems after forest removal that are intensified by high temperatures and heavy precipitation, must be studied for prediction, correction and prevention
- .. knowledge of the tropical rainforests, particularly the multi-storied hardwoods, is especially lacking
- .. research on forest resource survey methods and techniques is required
- . the introduction or improvement of new species is of high priority of forest management
  - .. research is required to determine which tropical tree species are quick growing and most suited to intensive culture for early yields
  - .. insect and disease problems in the biotically-rich tropical forests must be anticipated, and means of prevention and control studied
- . the more effective use of forests and trees for the environmental improvement of human settlements in the tropics must also be studied
  - .. the benefits of trees to urban areas are potentially very high in the tropics, particularly because shade is so critical for daytime comfort.
- Both present and future knowledge should be applied to develop multipurpose silvicultural methods that meet the demand for both increased production and environmental protection and improvement;
  - . although knowledge of the basic components - including their ecology and genetics - is often sufficient in the developed countries, management systems for their integration are frequently lacking
  - . specific research is required for:

- .. the definition and standardization of criteria and methods for the economic appraisal of forest influences and for the comparison of alternative uses
- .. the preparation of guidelines - to be periodically updated - for environmental forest management.
- The potential contribution of different tree varieties to urban beauty, sound abatement, atmospheric quality, and temperature amelioration is poorly understood and underutilized and requires further study.
- Research should be initiated on the laws, land tenure systems, and forest institutions now in use in order to find the combination that will ensure safe and profitable multiple uses of forests;
  - . research might be conducted along the following lines:
    - .. studies on the influence of land tenure systems on the protective and recreational role of forests
    - .. research on the development of public administration for environmental forestry
    - .. the revision of current education and training programmes to accommodate new techniques of forest resources management
    - .. comparative study, research and training in forestry legislation, wherever needed.

63. GOVERNMENTS SHOULD DEVELOP FOREST POLICIES AND PLANNING AS PART OF AN OVERALL POLICY FOR THE RATIONAL AND INTEGRATED USE OF NATURAL RESOURCES

- Particular attention should be given to the rapidly increasing demands for and benefits from amenities which forests provide.
- Forest zoning should be used as a basis for planning and management of forests and should be strengthened by adequate legislation and law enforcement.
- Land use planning commissions both in rural and urban areas should seek the advice of environmental foresters to improve the appearance of urban and rural landscapes and reduce hazards of pollution and other nuisances by rational use of tree plantations.
- Technology is needed to minimize damage to forests caused by fire, insects and diseases;
  - . means for fighting forest fires and pests, integrated pest control systems, and early detection and evaluation techniques should be developed.

64. GOVERNMENTS SHOULD DESIGN ENVIRONMENTAL FOREST MANAGEMENT TO MEET THE  
COMPETING DEMANDS ON FOREST RESOURCES

- Modern forest management concepts, including multiple-use where desirable, should be introduced wherever feasible and in accordance with local conditions. Legislative and institutional provisions should be made, and accounting the budgeting procedures should be adjusted, to reflect the costs and benefits of the amenities which forests provide.
- Special measures should be taken to ensure that the introduction of intensive forest management techniques and the extension of manmade forests will not cause the disappearance of useful forest genetic resources and of wildlife or seriously impair soil and water values.
- Prevention and control of forest fires, pests and diseases should be given high priority.

65. GOVERNMENTS SHOULD INTRODUCE MINIMUM MANAGEMENT PLANS WHERE NONE CURRENTLY  
EXIST AND GOVERNMENTS ALREADY COMMITTED SHOULD INCREASE THEIR EFFORTS

- The opportunities of increasing public ownership and improving management of publicly-owned forests should be explored.
- Attempts should be made to settle shifting cultivations to control the use of fire, and to demarcate forest resources.
- Pilot projects using advanced management systems should be introduced into the developing countries, with appropriate assistance from the international community.

(iii) Recommendations for international action

66. It is recommended that the Secretary-General take steps to ensure that:

(a) THE UN BODIES CONCERNED CO-OPERATE TO MEET THE NEEDS FOR NEW KNOWLEDGE

- Where appropriate, research should be promoted, assisted, co-ordinated, or undertaken by the Man and Biosphere Programme (UNESCO), ICSU, or IUFRO, in close co-operation with FAO and WMO.
- Studies on comparative legislation, land tenure, institutions tropical forest management, and the effects of the international trade in forest products on national forest environments, and public administration, might be sponsored or co-ordinated by FAO, in co-operation with other appropriate organizations.

(b) CONTINUING SURVEILLANCE OF THE WORLD'S FOREST COVER IS PROVIDED FOR  
THROUGH THE ESTABLISHMENT OF AN APPROPRIATE MONITORING SYSTEM

- Such a World Forest Appraisal Programme would provide an indication of global environmental stability;

- . the balance between the world's forest biomass and the prevailing environment would be continuously measured
- . changes in the forest biomass, considered to have a significant impact on the environment, would be recorded.
- The information could be collected from existing inventories and on-going activities and through remote sensing techniques.
- The forest protection programme described above might be incorporated within this effort, through the use of advanced technology, such as satellites using different types of imagery and which could constantly survey all forests.

67. It is further recommended that FAO

(a) CO-ORDINATE AN INTERNATIONAL PROGRAMME FOR RESEARCH AND EXCHANGE OF INFORMATION ON FOREST FIRES, PESTS, AND DISEASES

- The programme should include data collection and dissemination, identification of potentially susceptible areas and of means of suppression; exchange of information on technologies, equipment and techniques; research, including integrated pest control and the influences of fires on forest ecosystems, to be undertaken by IUFRO; establishment of a forecasting system in co-operation with WMO; organization of seminars and study tours; the facilitation of bilateral agreements for forest protection between neighbouring countries, and the development of effective international quarantines.
- Forest fires, pests and diseases will frequently each require separate individual treatment.

(b) FACILITATE THE TRANSFER OF INFORMATION ON FORESTS AND FOREST MANAGEMENT

- The amount of knowledge that can be usefully exchanged is limited by the differences of climatic zones and forest types.
- The exchange of information should however be encouraged among nations sharing similarities;
  - . considerable knowledge is already exchanged among the industrialized nations of the temperate zone .
- Opportunities exist, despite differences, for the useful transfer of information to developing countries on the environmental aspects of such items as:

- . the harvesting of some tropical hardwoods
- . pine cultures
- . the principles of forest management systems and management science
- . soils and soil interpretations relating to forest management
- . forest industries pollution controls, including both technical and economic data
- . methods for evaluation of forest resources through sampling techniques, remote sensing, and data processing
- . control of destructive fires and pest outbreaks .



C. Wildlife, parks and other protected areas

Part One: Wildlife<sup>2/</sup>

(i) Consideration for action

68. WILD ANIMAL LIFE IS A NATURAL RESOURCE OF GREAT VALUE TO MANKIND.

- It contributes to the normal functioning of all natural biotic communities and ecosystems upon which the health and productivity of the biosphere depends and it also reflects the health of the biosphere itself.
- It has economic value as an attraction for tourism and for outdoor recreation activities.
- It serves as a source of protein, hides, furs and other animal products which may be harvested on a sustained basis if properly managed.

69. THROUGHOUT THE WORLD, GREATLY INCREASED PRESSURE ON WILD ANIMAL LIFE THREATENS THE SURVIVAL OF MANY SPECIES OF GREAT PRESENT AND POTENTIAL VALUE.

- Expanding human populations and land use practices incompatible with the maintenance of stable wildlife habitats are contributing to the deterioration of these habitats.
- The increasing use of pesticides and other pollutants threatens the existence of certain birds.
- Poaching and exploitation for trade sometimes deplete species below minimum levels of self-regeneration.
- It must be noted, however, that in many instances wildlife has proved to be compatible with man and his land uses, or that modifications in land use sometimes benefit wildlife;
  - . many stocks, such as deer in the United States or saiga antelope in the USSR, have increased dramatically through scientific management.

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<sup>2/</sup> The topic of this chapter has been restricted to wild animal life. The general character of the considerations and recommendations for wild plant life would be similar. Although it could be argued that the conservation of wildlife is inherently an international concern, the distinction between national and international recommendations has been retained. Apart from conservation itself, wildlife management for aesthetic, recreational or economic objectives clearly addresses itself to national treatment.

70. WHALES ARE A COMMON MARINE RESOURCE OF CONCERN TO ALL MANKIND, AND ARE IMPORTANT IN MAINTAINING THE HEALTH AND STABILITY OF THE MARINE ENVIRONMENT

- The population of many species of whales has declined in the last few decades. The IUCN Book of Endangered, Rare and Depleted Species lists several whale species as in danger of extinction.
- Other aquatic mammals such as dolphins and porpoises are also becoming endangered due to prevailing fishery practices.

71. WILDLIFE MUST BE CAREFULLY MANAGED AS AN IMPORTANT RESOURCE. ITS POPULATIONS MUST BE AS LARGE AND AS VARIED AS IS COMPATIBLE WITH OTHER IMPORTANT LAND USES.

- In formulating policies for management, it is useful to distinguish between endangered or depleted species and those of potential economic benefit.
- It is also important to recognize that the bulk of wildlife populations are found on land already being used by man for another purpose;
- The use and preservation of wild animal resources must be reconciled with conflicting activities of mankind so that maximum long-term interests are assured.
- Wildlife's value for tourism, sport and game cropping must be fully realized in the short term and should be maintained over time;
  - . large populations of wild animals exist on a local or regional basis in comparatively under-developed lands whose economic value remains to be developed.
- However, the health and diversity of wildlife species must be carefully safeguarded;
  - . stable and protected habitats must be assured to provide for the survival of a variety of natural ecosystems and the wild animals that may still be found within their boundaries
  - . the damaging effects of certain wild animals upon man's activities, such as destruction of crops and transmission of disease, must be reconciled with the benefits of such animals.
- Habitat management involves many approaches:
  - . modified or artificial habitats can be provided to enhance wildlife populations following the best principles of scientific wildlife management
  - . in other areas, where natural populations are abundant within natural habitats, attempts can be made to maintain the integrity of both.

72. WORLDWIDE ACTION IS REQUIRED TO ENSURE THE CONTINUING VALUE OF THE WILDLIFE.

- A worldwide inventory of wildlife resources and habitat is a prerequisite for any global involvement in appropriate management.
- Although wildlife management is a well advanced science in many of the industrialized countries, it is only in its infant stages in some parts of the developing world.
- This is particularly serious, for wild animals are in a most vulnerable position in the developing countries, where:
  - they have until recently lived under pristine conditions with no need to adapt to man's disruptive activities;
  - they are suddenly subjected to the unprecedented pressures of human populations.

(ii) Recommendations for national action

It is recommended that national governments give consideration to the following proposals.

73. EACH COUNTRY SHOULD ESTABLISH REGIONS OF NATURE RESERVES AND OTHER PROTECTED AREAS

- These areas should include adequate representation of all naturally occurring ecosystems, appropriate to the space and habitat requirements of the wild species involved.
- The management of these regions will require an understanding of habitat requirements, at present known for very few species.
- Assistance will frequently be required from the international community.

74. COUNTRIES SHOULD ENACT AND ENFORCE PROTECTIVE LAWS REGULATING THE HARVESTING AND MARKETING OF WILD ANIMALS AND THEIR PRODUCTS, TO GUARANTEE THAT POPULATIONS ARE NOT EXPLOITED TO A DEGREE THAT WOULD THREATEN THEIR SURVIVAL.

75. GOVERNMENTS SHOULD ALSO EXERCISE CAREFUL CONTROL OVER THE INTRODUCTION OF EXOTIC SPECIES INTO NEW AREAS WITH A VIEW TO PREVENTING THE DISPLACEMENT OF INDIGENOUS SPECIES.

- Where consequences are predictable, impacts should be considered before introducing the animals; where consequences are unknown, research will be required to predict the environmental effects of a given introduction.
- Each country should consider the establishment of an advisory board of experts which would be independent of local decisions and which could have access to the world wildlife scientific community.

76. METHODS FOR ASSESSING THE IMPACT UPON WILDLIFE OF BUILDING LARGE-SCALE CONSTRUCTIONS, OF CLEARING AND DEVELOPING LAND, AND OF ALTERING PRESENT FORMS OF LAND USE, SHOULD BE DEVISED AND IMPLEMENTED.
- Estimates of potential impact should be taken into account in the early planning stages of any development project.
  - Where appropriate, intergovernmental organizations should co-operate in this assessment.
77. THE CONSIDERATION OF WILDLIFE RESOURCES AND OTHER HABITAT SHOULD BE INCORPORATED INTO LAND USE PLANNING AND DEVELOPMENT, PARTICULARLY IN RESPECT TO LONG RANGE CONSIDERATIONS.
- An evaluation should be made of the extent to which wildlife may interfere with adjacent forms of land use, complement existing forms of use by adding extra values, or be used as a major form of land use in its own right.
78. FACILITIES SHOULD BE DEVELOPED, PARTICULARLY IN THE DEVELOPING COUNTRIES, TO ATTRACT AND SERVICE TOURISM BASED ON WILDLIFE RESOURCES.
- Large potentials should be developed by first promoting and supervising hunting tourism and, subsequently, expanding the tourist industry by providing for wildlife viewing and necessary infrastructure.
  - Governments, particularly those of the developing countries, should formulate demonstration cropping and hunting programmes for large game animals with substantial populations.
  - Those projects underway in Africa should be extended, and new ones initiated in the Middle East, Latin America and Asia.
  - Areas which should receive high priority are
    - . those where present forms of land use have proved unsatisfactory
    - . lands that are marginal to domestic animals, such as those frequently found in arid or adverse climates.
  - More experimentation and research should be undertaken on the biological and economic advantages of game ranching, and on the most efficient producers of protein, as a basis for future action.
  - Means should be examined and implemented to resolve the frequently occurring technical difficulties of harvesting, processing and marketing the meat;
    - . demonstration pilot schemes for developing commercial utilization of game, underway in Zambia and Kenya, should be expanded.

79. RESEARCH IS NEEDED ON HABITAT REQUIREMENTS.

- This will contribute to the solution of many problems, ranging from those of species in danger of extinction to those of over-abundance of populations.
- It will respond to the need for knowledge on productive meat management.
- It will help determine the optimum size of areas and ensure high species diversity
- Research should include methods of assessing changes in the plant and animal communities and animal diseases.
- The interaction of livestock with other forms of land use requires considerable study.

80. GOVERNMENTS SHOULD INITIATE OR EXTEND APPLIED RESEARCH PROJECTS TO ASSESS THE INTERRELATIONSHIPS BETWEEN FOREST AND RANGE MANAGEMENT AND WILDLIFE POPULATIONS.

- Different combinations of forest and range management practices and wild species should be tested to identify situations where each complements the value of the other.

(iii) Recommendations for international action

It is recommended that the Secretary-General take the following steps:

81. ENSURE THAT THE EFFECTS OF POLLUTANTS UPON WILDLIFE ARE CONSIDERED, WHERE APPROPRIATE, WITHIN ENVIRONMENTAL MONITORING SYSTEMS.

- Particular attention should be paid to those species of wildlife which may serve as indicators for;
  - . future wide environmental disturbances to other species
  - . an ultimate impact upon human populations.

82. ENSURE THAT A PROGRAMME TO EXPAND PRESENT DATA GATHERING PROCESSES SO AS TO ASSESS THE TOTAL ECONOMIC VALUE OF WILDLIFE RESOURCE, IS ESTABLISHED.

- Such data would facilitate the task of monitoring the current situation of animals endangered by their trade value, and demonstrate to questioning nations the value of their resource.
- Such a programme should elaborate upon present FAO efforts and might well produce a yearbook of wildlife statistics.

83. ENSURE THAT THE APPROPRIATE UN AGENCIES COOPERATE WITH THE GOVERNMENTS OF THE DEVELOPING COUNTRIES TO DEVELOP SPECIAL SHORT-TERM TRAINING COURSES ON WILDLIFE MANAGEMENT.
- The priority should be on conversion courses for personnel trained in related disciplines such as forestry or animal husbandry.
  - Special attention should be given to the establishment and support of regional training schools for technicians.
84. IT IS FURTHER RECOMMENDED THAT GOVERNMENTS GIVE ATTENTION TO THE NEED TO ENACT INTERNATIONAL CONVENTIONS AND TREATIES TO PROTECT SPECIES INHABITING INTERNATIONAL WATERS OR THOSE WHICH MIGRATE FROM ONE COUNTRY TO ANOTHER.
- A broadly-based convention might be considered which would provide a framework by which criteria for game regulations could be agreed and the over exploitation of resources curtailed by signatory countries.
85. IT IS RECOMMENDED THAT GOVERNMENTS MOVE TO AGREE TO THE PROPOSED CONVENTION ON THE EXPORT, IMPORT, AND TRANSIT OF CERTAIN SPECIES OF WILD ANIMALS AND PLANTS<sup>3/</sup>
86. IT IS RECOMMENDED THAT GOVERNMENTS AGREE TO STRENGTHEN THE INTERNATIONAL WHALING COMMISSION AND TO CONSIDER AN INTERNATIONAL AGREEMENT CALLING FOR A 10-YEAR MORATORIUM ON COMMERCIAL WHALING.

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<sup>3/</sup> This subject is treated in detail in Subject Area IV.

Part Two: Parks and other protected areas

(i) Considerations for action

87. NATIONAL PARKS AND SIMILAR PROTECTED AREAS ARE DESIGNED TO PROTECT IN PERPETUITY THOSE AREAS WHICH OUTSTANDINGLY REPRESENT THE BEAUTY AND DIVERSITY OF MAN'S HERITAGE

- These areas include:

- . large tracts of land set aside for the protection of wildlife and its habitat
- . areas of great natural beauty or unique interest
- . areas containing rare forms of plant and animal life
- . areas representing unusual geologic formations
- . places of historic and prehistoric interest
- . areas containing ecosystems of special importance for scientific investigation and study
- . areas which safeguard the needs of the biosphere.

- These areas serve a number of specific purposes:

- . some provide recreation for large numbers of people without seriously detracting from the natural values
- . some aim to retain their more pristine beauty through greater restrictions
- . others (strict nature reserves) are reserved solely for scientific research as relatively undisturbed environments
- . still others provide a reservoir of genetic materials in a spectrum of organisms adapted to a particular range of soil and climatic conditions.

88. THE NEED FOR THE EXTENSION OF PROTECTED AREAS IS BECOMING ACUTE IN MANY COUNTRIES

- Many national parks of high tourist value are being flooded by rising numbers of tourists and suffer from insufficient or inappropriate planning and management;
  - . such parks, particularly in the developing countries, represent a major source of income which could be jeopardized if they deteriorate.

- Valuable wildlands are threatened by pressures detrimental to their protection and use;
  - . damage frequently arises from a lack of understanding or interest, particularly in some developing countries, of the value of such wildlands
  - . deterioration often results from a lack of knowledge, or political or economic considerations generally inhibiting or delaying the required action, until the parks exist on paper only
  - . the possibilities of such deterioration increase whenever a park or otherwise protected area is shared by two or more countries.

89. THE PRESENT WORLD HOLDINGS OF PROTECTED AREAS MUST BE EXPANDED AS WIDELY AS POSSIBLE

- Efforts must be made to accommodate the pressures of exploding populations of both tourists and urban dwellers which are increasingly turning to the refuge of such areas.
- As many representative samples of ecosystems as is possible must be protected, before they inevitably disappear, for study, reference, preservation of species and future scientific needs.
- National park policy will vary considerably, however, with the stage of economic development.

90. PROTECTED AREAS MUST BE PLANNED AND MANAGED TO MAXIMIZE THEIR PRESENT AND FUTURE VALUE

- Maximum use of recreation and tourist resources must be provided while carefully observing the carrying capacity of each protected area.
- The rate and scale of development of new parks must be determined so as to guard against possible environmental problems;
  - . parks can be managed, however, to accommodate heavy use.

(ii) Recommendations for national action

It is recommended that national governments give consideration to the following proposals

91. GOVERNMENTS SHOULD SET ASIDE WILDLAND WHEREVER POSSIBLE

- Policies which provide for the needs of tourism and recreation and for the protection of representative ecosystems should guide such action.



92. GOVERNMENTS SHOULD ENGAGE IN RESEARCH ON PARK MANAGEMENT, WITH PARTICULAR EMPHASIS ON:
- Assessing the recreational carrying capacity of individual ecosystems and subsequently the desirable rates and scale of their development as parks.
  - Determining the optimum use for different protected areas, including the appropriate zoning for single or multiple use.
  - Identifying the most appropriate means of organizing and managing large numbers of people within protected areas.
93. GOVERNMENTS SHOULD EDUCATE THEIR PEOPLES ON THE VALUE AND PURPOSES OF PROTECTED AREAS AND DESIGN MEANS TO USE PARKS AS AN EDUCATIONAL TOOL
- The concept that "parks are for the benefit and enjoyment of people" should be communicated, particularly in the developing countries.
  - Educational tourism should be promoted within the services of protected areas.
94. GOVERNMENTS SHOULD ACCELERATE THE DEVELOPMENT OF RECREATIONAL FACILITIES WITHIN OR NEARBY URBAN AREAS
- Such action would relieve pressures on over-extended national parks.
  - Measures of landscape planning such as cluster development of new housing areas and decontamination of polluted waters should be stressed.
- (iii) Recommendations for international action
95. IT IS RECOMMENDED THAT GOVERNMENTS AND THE SECRETARY-GENERAL GIVE SPECIAL ATTENTION TO TRAINING REQUIREMENTS
- High level training should be provided and supported;
    - . in addition to integrating aspects of national park planning and management into courses on forestry and other subjects, special degrees should be offered in park management
      - .. the traditional forestry or geology background of the park manager must be broadened into an integrated approach
    - . graduate courses in natural resources administration should be made available in at least one major university in every continent.
  - Schools offering courses in national parks management at a medium grade level should be assisted by the establishment or expansion of facilities, particularly in Latin America and Asia.

96. IT IS FURTHER RECOMMENDED THAT THE SECRETARY-GENERAL TAKE STEPS TO:  
ENSURE THAT AN APPROPRIATE MECHANISM EXISTS FOR THE TRANSFER OF INFORMATION ON PARK LEGISLATION AND PLANNING AND MANAGEMENT TECHNIQUES DEVELOPED IN SOME INDUSTRIALIZED COUNTRIES WHICH COULD SERVE AS MODELS TO BE MADE AVAILABLE TO ANY INTERESTED DEVELOPING COUNTRY
97. ENSURE THAT THE APPROPRIATE UNITED NATIONS AGENCIES ASSIST THE DEVELOPING COUNTRIES TO PLAN FOR THE INFLOW OF VISITORS INTO THEIR PROTECTED AREAS, IN SUCH A WAY AS TO RECONCILE REVENUE AND ENVIRONMENTAL CONSIDERATIONS
98. IT IS ALSO RECOMMENDED THAT GOVERNMENTS:
- (a) TAKE STEPS TO CO-ORDINATE AND CO-OPERATE ON THE MANAGEMENT OF SHARED PROTECTED AREAS
    - Agreement should be reached on such aspects as the rights of guards to follow poachers across international boundaries, mutual legislation, patrolling systems, exchange of information, research projects, collaboration on measures of burning, plant and animal control, fishery regulations, censuses, tourist circuits and frontier formalities.
  - (b) MOVE TO AGREE ON THE PROPOSED CONVENTIONS ON CONSERVATION OF CERTAIN ISLANDS FOR SCIENCE AND CONSERVATION OF THE WORLD HERITATE 4/
  - (c) TAKE STEPS TO SET ASIDE AREAS REPRESENTING ECOSYSTEMS OF INTERNATIONAL SIGNIFICANCE FOR PROTECTION UNDER INTERNATIONAL AGREEMENT
99. IT IS RECOMMENDED THAT INTERESTED GOVERNMENTS - WHICH HAVE NOT YET DONE SO - SIGN AND RATIFY THE CONVENTION ON CONSERVATION OF WETLANDS OF INTERNATIONAL IMPORTANCE APPROVED AT THE CONFERENCE OF RAMSAR (IRAN) 5/

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4/ See also A/CONF.48/9.

5/ See also A/CONF.48/9.

D. The Conservation of Genetic Resources

(i) Considerations for action

100. IT IS IMPORTANT THAT THE WIDEST POSSIBLE DIVERSITY OF AND WITHIN SPECIES BE MAINTAINED.

- For the ecological stability of the biosphere.
- For use as natural resources.
- For their scientific, educational and recreational value.

101. THE SURVIVAL OF SPECIES, INCLUDING MAN HIMSELF, DEPENDS ON GENETIC DIVERSITY.

- The availability of broadly based gene pools is an essential condition for adaptation to environmental change, both natural and man-made, such as
  - . the replacement of pesticides by genetic defenses
  - . the adaptation of high-yield varieties to local conditions
  - . the development of resistance to evolving parasites
  - . the correction of nutritional defects, such as low content of protein or specific amino-acids.
- Genetic diversity is required to counter the inadaptability to local conditions that sometimes follows the introduction of highly selected animal species;
  - . continual selection for specific traits within a breed or type sometimes dangerously reduces genetic variability.
- The full variety of microscopic organisms provides the indispensable link in the carbon and nitrogen cycles upon which all life depends;
  - . micro-organisms include bacteria, yeasts, molds, algae, protozoa, and viruses
  - . the quality and flavour of man's food and drink often depends upon beneficial bacteria and fungi
  - . industry uses micro-organisms to manufacture chemical products including antibiotics
  - . micro-organisms help man to understand the underlying causes of many pathological conditions
  - . pollutant organic wastes are rendered harmless by the use of bacteria.

102. MAN'S IMPACT ON THE BIOSPHERE IS INCREASINGLY REDUCING THE GENETIC RESILIENCY OF MANY SPECIES.

- Not only agricultural plant varieties, but also forest species, aquatic organisms, and certain types of animals and micro-organisms are affected.
- Man's development - transforming and disrupting new areas for his use - is depleting or displacing valuable genetic resources. Wild species and primitive domesticates are lost.
- Areas in Asia, Latin America and Africa are threatened that have traditionally served as
  - . the "centres of natural diversity" or the natural habitation of wild varieties
  - . the source of genetic resources for plant improvement.
- Indigenous crops are replaced by new higher yielding varieties of greater genetic uniformity and less adaptability to local conditions.
- Many plant characters - protein quality, oils, unique growth habit, dwarfness, etc. - may someday be required but are being lost with the disappearance of wild species.
- The introduction by man of exotic diseases and insects poses a great risk to some of the world's gene resources;
  - . for example, the chestnut blight has wiped out all but scattered remnants of the American chestnut tree.
- Also threatened are the outliers and remnants of forest species whose populations, often critical for breeding, can be substantially reduced and sometimes eliminated.

103. MANY OPPORTUNITIES, AS YET UNEXPLOITED, EXIST FOR THE DEVELOPMENT OF GENETIC RESOURCES.

- The opportunities for breeding improved strains which have been well recognized and developed should be continued and supported.
- Man must protect himself against his increasing dependence on a diminishing number of crops;
  - . these will require new genetic inputs as they are introduced into local conditions demanding new elements of diversity
  - .. the 15 crops upon which he principally depends will require new genetic inputs as they are introduced into increasingly less favourable environments

- . genetically resistant varieties and hybrids offer great potential for overcoming damage and threats of extinction caused by insects and diseases.
- Opportunities for developing the world's forest gene resources for the purpose of genetic improvement are many and with the exception of a few species as yet unexploited;
  - . this potential is amply demonstrated by the high productivity of North American pines when planted throughout the Southern Hemisphere.
- A selection of breeds, types, and varieties of mammals and birds could be intensively studied to assess their production potential.
- The employment of micro-organism germ plasms could be expanded to benefit many sectors of human activity such as;
  - . the assembling of taxonomic type strains for reference purposes  
or
  - . the preservation of unique mutant strains for fundamental genetic work.
- The availability of many unexploited species and races of aquatic organisms should be assessed for possible domestication.

104. BENEFICIAL INSECTS CAN BE DEVELOPED TO PROTECT PLANTS FROM THE THREATS OF PREDATION AND DISEASE AND TO ERADICATE UNDESIRABLE WEEDY PLANTS.

- Biological control - still in its infancy - can be vastly expanded through the establishment of insect gene centres and intensive breeding and experimentation.
- Likewise, strains better adapted as pollutants should be developed.

105. THE CONSERVATION OF GENETIC RESOURCES MUST RECEIVE URGENT ATTENTION IN ALL SECTORS.

- A diversity of gene pools must be maintained so as to assist current economic and social development.
- Genetic resources must be preserved for the evolving and unpredictable needs of future generations;
  - . many species of no current and direct use to mankind will someday answer some of its future needs
  - . the health of man's future environment requires a broad genetic base.

106. ACTION MUST PROCEED ON A WORLDWIDE BASIS, BECAUSE OF THE ENORMOUS RANGE OF SPECIES INVOLVED AND THE DIMENSIONS OF WORLD AGRICULTURE.

- Only a programme of international co-operation can work because
  - . those countries most actively engaged in advanced domestication and genetic resource conservation are usually remote from the origins of the species
  - . means must be assured, therefore, to assist developing countries through co-ordinating international activities
    - .. to establish conservation centres
    - .. to grant all countries access to basic breeding materials.

(ii) Recommendations for action

IT IS RECOMMENDED THAT GOVERNMENTS, IN CO-OPERATION WITH THE SECRETARY-GENERAL AND FAO WHERE INDICATED, TAKE THE FOLLOWING STEPS.

107. AGREE TO AN INTERNATIONAL PROGRAMME TO PRESERVE THE WORLD'S GENETIC RESOURCES.

- Active participation at the national and international levels is involved;
  - . it must be recognized, however, that while survey, collection, and dissemination of these genetic resources is best carried out on a regional or international basis, their actual evaluation and utilization are matters for specific institutions and individual workers
    - .. international participation in the latter should concern exchange of techniques and findings.
- An international network is required with appropriate machinery to facilitate the interchange of information and genetic material among countries.
- Both static (seed banks, culture collections, etc.) and dynamic (conservation of populations in evolving natural environments) ways are needed.
- Action is necessary in six inter-related areas;
  - . survey of genetic resources
  - . inventory of collections
  - . exploration and collecting

- . documentation
- . evaluation and utilization
- . conservation
  - .. conservation represents the crucial element to which all other programmes relate.

- Although the international programme relates to all types of genetic resources, the action required for each resource will vary according to existing needs and activities.

108. MAKE INVENTORIES OF GENETIC RESOURCES MOST ENDANGERED BY DEPLETION OR EXTINCTION.

- All species threatened by man's development should be included in such inventories.
- Special attention should be given to locating in this field those areas of natural genetic diversity which are disappearing.
- These inventories should be periodically reviewed and updated by appropriate monitoring.
- The survey conducted by FAO in collaboration with IBP is designed to provide information on endangered crop genetic resources by 1972, but will require extension and follow-up.

109. COMPILE OR EXTEND, AS NECESSARY, REGISTERS OF EXISTING COLLECTIONS.

- Such a register should identify which breeding and experiment stations, research institutions and universities maintain which collections.
- Major gaps in existing collections should be identified where material is in danger of being lost.
- These inventories of collections should be transformed for computer handling and made available to all potential users.
- In respect to plants:
  - . it would be expected that the "advanced varieties" would be well represented, but that primitive materials would be found to be scarce and require subsequent action
  - . the action already initiated by FAO, several national institutions, and international foundations should be supported and expanded.

- In respect to micro-organisms, it is recommended that each nation develop comprehensive inventories of culture collections:
    - . a cataloguing of the large and small collections and the value of their holdings is required, rather than a listing of individual strains
    - . many very small but unique collections, sometimes the works of a single specialist, are lost
    - . governments should assure that valuable gene pools held by individuals or small institutes are also held in national or regional collections.
  - In regard to animal germ plasm, it is recommended that FAO establish a continuing mechanism to assess and maintain catalogues of the characteristics of domestic animal breeds, types and varieties in all nations of the world. Likewise, FAO should establish such lists where required.
  - In regard to aquatic organisms, it is recommended that FAO compile a catalogue of genetic resources of cultivated species and promote intensive studies on the methods of preservation and storage of genetic material.
110. INITIATE IMMEDIATELY, IN CO-OPERATION WITH ALL INTERESTED PARTIES, PROGRAMMES OF EXPLORATION AND COLLECTION WHEREVER ENDANGERED SPECIES HAVE BEEN IDENTIFIED WHICH ARE NOT INCLUDED IN EXISTING COLLECTIONS.
- An emergency programme with the co-operation of the MAB programme, of plant exploration and collection should be launched on the basis of the FAO List of Emergency Situations for a 5-year period.
  - With regard to forestry species, in addition to the efforts of the Danish/FAO Forest Tree Seed Center, IUFRO, and the FAO Panel of Experts on Forest Gene Resources, support is needed for missions planned for Latin America, West Africa, The East Indies and India.
111. CONSERVATION IS A MOST CRUCIAL PART OF ANY PROGRAMME OF GENETIC RESOURCES PROGRAMME. MOREOVER, MAJOR TYPES OF GENETIC RESOURCES MUST BE TREATED SEPARATELY BECAUSE:
- They are each subject to different programmes and priorities.
  - They serve different uses and purposes.
  - They require different expertise techniques and facilities.



112. PLANT GERM PLASM - AGRICULTURE AND FORESTRY: ORGANIZE AND EQUIP NATIONAL OR REGIONAL GENETIC RESOURCES CONSERVATION CENTRES.

- Such centres as The National Seed Storage Laboratory in the United States and the Vavilov Institute of Plant Industry in the USSR already provide good examples.
- Working collections should be established separately from the basic collections;
  - . these will usually be located at plant breeding stations and will be widely distributed.
- Three classes of genetic crop resources must be conserved;
  - . high-producing varieties in current use and those they have superseded
  - . primitive varieties of traditional pre-scientific agriculture (recognized as genetic treasures for plant improvement)
  - . mutations induced by radiation or chemical means.
- Species contributing to environmental improvement, such as sedge used to stabilize sand-dunes, should be conserved.
- Wild or weed relatives of crop species and those wild species of actual or potential use in rangelands, industry, new crops, etc., should be included.

113. MAINTAIN GENE POOLS OF WILD PLANT SPECIES WITHIN THEIR NATURAL COMMUNITIES.

- It is therefore essential that primeval forests, bushlands, and grasslands which contain important forest genetic resources be identified and protected by appropriate technical and legal means;
  - . systems of reserves exist in most countries, but a strengthening of international understanding on methods of protection and on availability of material may be desirable.
- Species of medical, aesthetic, or research value should be insured.
- The network of biological reserves proposed by UNESCO (MAB) should be designed, where feasible, to protect these natural communities.
- Where protection in nature becomes uncertain or impossible, then means such as seed storage or living collections in provenance trials or botanic gardens must be adopted.

114. FULLY IMPLEMENT THE PROGRAMMES INITIATED BY THE FAO PANELS OF EXPERTS ON FOREST GENE RESOURCES IN 1968 AND ON PLANT EXPLORATION AND INTRODUCTION IN 1970.
115. ANIMAL GERM PLASM: CONSIDER THE DESIRABILITY AND FEASIBILITY OF INTERNATIONAL ACTION TO PRESERVE BREEDS OR VARIETIES OF ANIMALS.
- Because such an endeavour would constitute a major effort beyond the scope of any one nation, FAO would be the logical executor of such a project;
    - . close co-operation with governments would be necessary, however
    - . IUCN might logically be given responsibility for wildlife, in co-operation with FAO, MAB (UNESCO), and governments.
  - Any such effort should also include research on how to preserve, store, and transport germ plasm.
  - Specific methods for the maintenance of gene pools of aquatic species should be developed.
  - The recommendations of the FAO Working Party Meeting on Genetic Selection and Conservation of Genetic Resources of Fish, held in 1971, should be implemented.
116. MICRO-ORGANISM GERM PLASM: CO-OPERATIVELY ESTABLISH AND PROPERLY FUND A FEW LARGE REGIONAL COLLECTIONS.
- Full use should be made of major collections now in existence;
    - . no new centres should be contemplated in the developed world until those existing achieve regional significance.
  - Although 19 major centres exist in the developed world, none can be found in developing countries;
    - . to provide geographic distribution and access to the developing nations, regional centres should be established in Africa, Asia, and Latin America.
117. ESTABLISH CONSERVATION CENTRES OF INSECT GERM PLASM.
- The very difficult and long process of selecting or breeding insects conducive to biological control programmes can only begin in this manner.
118. EVALUATION AND UTILIZATION ARE CRITICAL COROLLARIES TO THE CONSERVATION OF GENETIC RESOURCES.
- In respect to crop breeding programmes, it is recommended that governments give special emphasis to

- . the quality of varieties and breeds and the potential for increased yields
- . the ecological conditions to which the species are adapted
- . the resistance to diseases, pests and other adverse factors
- . the need for a multiplicity of effort so as to increase the chances of success.

119. COLLABORATE TO ESTABLISH A GLOBAL NETWORK OF NATIONAL AND REGIONAL INSTITUTES BASED ON AGREEMENTS ON THE AVAILABILITY OF MATERIAL AND INFORMATION, ON METHODS, ON TECHNICAL STANDARDS, AND ON THE NEED FOR TECHNICAL AND FINANCIAL ASSISTANCE WHEREVER REQUIRED.

- Facilities should be designed to assure the use by
  - . breeders, to develop varieties and breeds both giving higher yields and having higher resistance to local pests and diseases and other adverse factors
  - . users, providing facilities and advice for the safest and most profitable utilization of varieties and breeds most adapted to local conditions.
- Such co-operation would apply to all genetic resource conservation centres and to all types mentioned above.
- Standardized storage and retrieval facilities for the exchange of information and genetic material should be developed;
  - . information should be made generally available and its exchange facilitated through agreement on methods and technical standards
  - . international standards and regulations for the shipment of materials should be agreed upon
  - . basic collections and data banks should be replicated in at least two distinct sites, and should remain a national responsibility
  - . standardized and computerized system of documentation is required.
- Technical and financial assistance should be provided where required;
  - . areas of genetic diversity are most frequently located in those countries most poorly equipped to institute the necessary programmes.

170. THE NEED FOR LIAISON AMONG THE PARTIES PARTICIPATING IN THE GLOBAL SYSTEM OF GENETIC RESOURCES CONSERVATION REQUIRES CERTAIN INSTITUTIONAL INNOVATIONS.

- It is recommended that the appropriate United Nations agency establish an international liaison unit for plant genetic resources in order to
  - . improve liaison between governmental and non-governmental efforts
  - . assist in the liaison and co-operation between national and regional centres with special emphasis on
    - .. international agreements on methodology and standards of conservation of genetic material
    - .. standardization and co-ordination of computerized record systems.
    - .. exchange of information and material between these centres.
  - . assist in implementing training course in exploration, conservation and breeding methods and techniques
  - . act as a central repository for copies of computerized information on gene pools (discs and tapes)
  - . provide the secretariat for periodic meetings of international panels and seminars on the subject
    - .. a conference on Germ Plasm Conservation might be convened to follow-up the successful conference of 1967
  - . plan and co-ordinate the five-year emergency programme on the conservation of endangered species
  - . further assist governments, wherever required, to implement their national programmes
  - . promote the evaluation and utilization of genetic resources at national and international levels.
- It is recommended that the appropriate United Nations agency initiate the required programme on micro-organism germ plasm;
  - . periodic international conferences involving those concerned with the maintenance and research on gene pools of micro-organisms should be supported
  - . such a programme might interact with the proposed regional culture centres by

- .. assuring that each centre place high priority on the training of scientists and technicians from the developing nations
- .. acting as a necessary liaison
- .. lending financial assistance to those countries established outside the developed countries
- . the international exchange of pure collections of micro-organisms between the major collections of the world has operated for many years and requires little re-enforcement
- . study should be particularly conducted on waste disposal and recycling, controlling diseases and pests, and food technology and nutrition.
- It is recommended that FAO institute a programme in respect to animal germ plasm to assess and maintain catalogues of the economic characteristics of domestic animal breeds and types and of wild species and to establish gene pools of potentially useful types.
- It is recommended that the MAB project on the conservation of natural areas and the genetic material contained should be adequately supported.

E. Fisheries

(i) Considerations for action

121. CURRENT (1970) WORLD CATCHES OF MARINE FISH AND OTHER ORGANISMS AMOUNT TO SOME 57 MILLION TONS.
- The potential catches, considering only the types presently harvested, have been estimated by FAO at rather more than 100 million tons.
  - The harvest of proteins from the total hydrosphere has increased at an annual average of about six per cent over the past 25 years.
122. HOWEVER, IN SOME AREAS AND FOR SOME IMPORTANT STOCKS, SUBSTANTIAL DECREASES IN THE YIELDS OF AQUATIC RESOURCES IN TERMS OF BOTH QUANTITY AND QUALITY HAVE BEEN OBSERVED.
123. ALTHOUGH IT IS OFTEN DIFFICULT TO DISTINGUISH AMONG FACTORS AND EFFECTS INVOLVED, THE MAIN CAUSES OF THIS SITUATION ARE:
- Natural fluctuations or changes in environmental conditions.
  - Over-fishing with large fleets, new techniques, improved technology and increased means.
  - Pollution of the aquatic environments, in particular coastal and inland waters, by disposal of industrial and domestic wastes and other pollutants.
  - Other man-made modifications of aquatic ecosystems such as:
    - . consumption of water by irrigation and other uses
    - . changes in the flow of rivers and their sedimentation
    - . land reclamation and other works in coastal areas
    - . dredging and drilling operations for minerals and oil in offshore and inshore waters.
124. AN INCREASING NUMBER OF AQUATIC POPULATIONS SHOW THE CUMULATIVE EFFECT OF THESE VARIOUS STRESSES TO LEVELS BEYOND THEIR CAPABILITY OF ACCOMMODATION, e.g.:
- Some whale species, Californian sardines, North Atlantic herrings and several others which have been greatly depleted under heavy exploitation.
  - Fish stocks in inland waters such as the Great Lakes in North America and in several rivers such as the Rhine.
  - Oyster cultures etc. in coastal waters which were depleted or disappeared due to pollution or other man-made changes.

125. AQUACULTURE AND, IN SOME CASES, INTRODUCTION OF EXOTIC FISH SPECIES ARE INCREASINGLY USED TO SOLVE SOME OF THESE PROBLEMS.

- However, aquaculture is particularly vulnerable to various forms of pollution and contamination, although, in some cases, domestic wastes and thermal pollution could be beneficially utilized.
- Introduced fish species have, in some instances, seriously reduced the economic value of existing fisheries, notably in fresh waters, e.g. lamprey and alewife;
  - . national regulations have not been fully effective in guarding international waters against such occurrences.

(ii) Recommendations for national action

It is recommended that governments give consideration to the following proposals:

126. RESEARCH SHOULD BE STRENGTHENED RELATING TO:

- The functioning of aquatic ecosystems and their productivity.
- Transplantation of non-native species to new habitats and their acclimatisation; conducting of suitable tests on controlled conditions to achieve this.
- The basic physical, chemical, and biological processes of dilution, dispersal and decomposition of wastes and concentration of pollutants in the aquatic environment, especially in inshore waters.
- The effects of pollutants on aquatic resources and ecosystems including the sub-lethal effects (see Subject Area III paper).
- The effects of major man-made modifications of the river flows and of water movements in coastal areas.
- The treatment of waste waters to prevent the discharge of toxic and other undesirable substances in the aquatic environment.
- The use of aquaculture especially to recycle and conserve the resources present in domestic wastes particularly where there is a concurrent protein shortage, developing safeguards against the transmission of pathogens and pollutants to man.

127. SURVEYS AND MONITORING ACTIVITIES SHOULD BE DEVELOPED.

- Collection of data on catch state of resources and fisheries activities should be improved in order to provide a more reliable and accurate basis for the assessment of fish stocks, their management and fishery development activities.

- This information should be closely associated with data on the environment including that provided by the monitoring of pollutants in the aquatic environment. (See Subject Area III paper)
128. OVERALL DEVELOPMENT POLICIES AND PLANS SHOULD TAKE DUE ACCOUNT OF THE INCREASING ROLE OF FISHERIES IN WORLD FOOD SUPPLY AND OF THEIR VULNERABILITY TO MULTIPLE FORMS OF DAMAGE BY OTHER DEVELOPMENT ACTIVITIES, PARTICULARLY THOSE AFFECTING PRODUCTIVE COASTAL AREAS.
- Ecologically and economically valid interest of fisheries should be protected accordingly.
129. IN ORDER TO FURTHER ENLARGE THE PROTEIN HARVEST FROM THE HYDROSPHERE THE PRODUCTIVITY OF THE AQUATIC RESOURCES SHOULD BE PROTECTED AND ENHANCED BY:
- Rational management of fish stocks through implementing appropriate regulatory controls based upon monitoring and periodic assessments of fish stocks and catches.
  - Diversifying fisheries within the large resources of the hydrosphere.
  - Developing aquaculture.
  - Controlling the discharge of toxic wastes.
  - Using and recycling some of the non-toxic wastes for aquaculture.
  - Preventing and/or reducing the harmful consequences of man-made modifications of fresh water bodies and coastal areas.
  - Exerting a careful control on the conditions governing the transfer and introduction of exotic fish species.
130. THE FOLLOWING ACTION REQUIREMENTS SHOULD BE CONSIDERED:
- The required research institutions and related training facilities should be established or strengthened to implement action proposals presented in para.7 above, and to allow effective participation in the activities of the regional and international fisheries bodies.
  - Fisheries institutions should be adequately supported to undertake required environmental and biological research and to provide necessary data on catches state of resources and fisheries activities and make periodic assessment of fish stocks. These institutions should closely collaborate with those in charge of monitoring water pollution.
  - The exchange of information relating to aquaculture introducing of exotic species, as well as the exchange of expertise in these fields should be fostered.



- Fisheries legislation and regulatory control institutions will need to be reviewed and their effectiveness improved to cope with increasing demand for protecting fisheries. The training of specialists for these fields will be necessary, as will the provision of adequate resources and facilities.

(iii) Recommendations for international action

It is recommended that governments, and the Secretary-General in co-operation with FAO and other UN organizations concerned, as well as development assistance agencies take steps to:

131. SUPPORT RECENT GUIDELINES, RECOMMENDATIONS, AND PROGRAMMES OF THE VARIOUS INTERNATIONAL FISHING ORGANIZATIONS.

- A large part of the needed international action has been identified with action programmes initiated by FAO and its Intergovernmental Committee on Fisheries and approximately 24 other bilateral and multilateral international commissions, councils and committees. In particular these organizations are planning and undertaking:
  - . co-operative programmes such as that of LEPOR (Long-Term and Expanded Programme on Oceanic Research), GIPME (Global Investigation of Pollution in the Marine Environment) and IBP (International Biological Programme)
  - . exchange of data, supplementing and expanding the services maintained by FAO and bodies within its framework in compiling, disseminating and co-ordinating information on living aquatic resources and their environment and fisheries activities
  - . evaluation and monitoring of world fishery resources, environmental conditions, stock assessment, including statistics on catch and effort, and the economics of fisheries
  - . assistance to governments in interpreting the implications of such assessments, identifying alternative management measures, and formulating required actions
  - . special programmes and recommendations for management of stocks of fish and other aquatic animals proposed by the existing international fishery bodies;
    - .. damage to fish stocks has often occurred because regulatory action is taken too slowly
    - .. historically the need for management action to be nearly unanimous has
    - .. reduced action to the minimum acceptable level.

132. ENSURE CLOSE PARTICIPATION OF FISHERY AGENCIES AND INTERESTS IN THE PREPARATIONS FOR THE UN CONFERENCE ON THE LAW OF THE SEA.

- In order to safeguard the marine environment and its resources through the development of effective and workable principles and laws, the information and insight of international and regional fishery bodies, as well as the national fishery agencies are essential.

133. ENSURE INTERNATIONAL CO-OPERATION IN THE RESEARCH, CONTROL AND REGULATION OF THE SIDE EFFECTS OF NATIONAL ACTIVITIES IN RESOURCE UTILIZATION WHERE THESE AFFECT THE RESOURCES OF OTHER NATIONS.
- Estuaries, inter-tidal marshes, and other near-shore and inshore environments play a crucial role in the maintenance of several marine fish stocks. Similar problems exist in those fresh-water fisheries that occur in shared waters.
  - Discharge of toxic chemicals, heavy metals, and other wastes may effect even high seas resources.
  - Certain exotic species, notably the carp, lamprey, alewife, have invaded international waters with deleterious effects as a result of unregulated unilateral action.
134. FURTHER DEVELOP AND STRENGTHEN FACILITIES FOR COLLECTING, ANALYZING AND DISSEMINATING DATA ON LIVING AQUATIC RESOURCES AND THE ENVIRONMENT IN WHICH THEY LIVE.
- Data already exist concerning the total harvest from the oceans and of certain regions in respect of individual fish stocks, their quantity, the fishing efforts expended on them, and of their population structure, distribution and changes. This coverage needs to be improved and extended.
  - It is clear that a much greater range of biological parameters must be monitored and analyzed in order to provide an adequate basis for evaluating the interaction of stocks and managing the combined resources of many stocks. There is no institutional constraint on this expansion but a substantial increase in funding is needed by FAO and other international organizations concerned to meet the needs of this expanding need for data.
  - Full utilization of present and expanded data facilities is dependent on co-operation of governments in developing local and regional data networks, making existing data available to FAO and to the international bodies and formalizing the links between national and international agencies responsible for monitoring and evaluating fishery resources.
135. ENSURE FULL CO-OPERATION AMONG GOVERNMENTS BY STRENGTHENING THE EXISTING INTERNATIONAL AND REGIONAL MACHINERY FOR DEVELOPMENT AND MANAGEMENT OF FISHERIES AND THEIR RELATED ENVIRONMENTAL ASPECTS, AND IN THOSE REGIONS WHERE THESE DO NOT EXIST, ENCOURAGE THE ESTABLISHING OF FISHERY COUNCILS AND COMMISSIONS AS APPROPRIATED.
- The operational efficiency of these bodies will largely depend on the ability of the participating countries to carry out their share of the activities and programmes.

- Technical support and servicing from the specialized agencies, in particular from FAO, is also required.
- The assistance of bilateral and international funding agencies will be needed to ensure the full participation of the developing countries in these activities.

F. Water

(i) Considerations for action

136. WATER, AN ESSENTIAL COMPONENT OF MAN'S ENVIRONMENT, IS:

- . the primary constituent of all living things
- . the most abundant compound on the earth's surface
- . the universal solvent
- . a factor of weather and climate
- . a primary means of transportation
- . a critical element of man's development activities
- . the ultimate repository for many natural and man-made wastes.

137. ALTHOUGH A TOTALLY RENEWABLE RESOURCE, THE SUPPLY OF FRESH WATER IS LIMITED BY QUANTITY AND DISTRIBUTION.

- While 70 per cent of the earth's surface is covered by water, only 2 per cent of the total supply is fresh water;
  - . most of this is stored as groundwater, ice caps, or glaciers and except for groundwater is inaccessible to man
  - . only .002 per cent of the total amount is directly available for human activities
    - .. this represents slightly less than the total annual runoff from all lands of the world of 30,000 km<sup>3</sup>.
- The natural distribution of fresh water is highly variable from region to region and season to season.
- Of the manageable fresh water supply, groundwater represents 96 per cent, lakes 2 per cent, and stream channels less than 1 per cent.

138. MAN'S ACTIVITIES IMPOSE MANY DEMANDS UPON THIS LIMITED WATER SUPPLY. THE QUANTITY OF WATER REQUIRED BY MAN FOR HIS DIRECT USE IS CONSIDERABLE AND IS INCREASING;

- It is estimated that water use will increase from 2000 km<sup>3</sup> in 1967 to 5450 km<sup>3</sup> in the year 2000;
  - . the demands for water are already surpassing the available resources of many countries especially in the arid and semi-arid regions.

- Agriculture currently uses about 70 per cent of all water consumed in order to irrigate approximately 200 million hectares of land.
- The requirements of industry - for supply, waste disposal, and cooling - impose a severe strain on water resources;
  - a shift in the percentage of water use from agriculture to industry and power is expected as countries develop.
- Domestic and conventional needs for water are also increasing.
- The disposal of every conceivable variety of waste from human activities, ranging from domestic sewage to the acids and oils of industrial wastes, is a principal and historic use of water.

139. INEXTRICABLY LINKED TO THE VOLUME OF WATER MAN USES IS THE QUALITY OF THE WATER AS AFFECTED BY HIS ACTIVITIES.

- Direct use represents only a portion of man's activities adversely affecting the quality of water;
  - deterioration frequently proceeds from direct use. For example:
    - .. power plants, particularly nuclear, impose a heat load on the aquatic environment
    - .. the water runoff following irrigation may contain biocides and chemical fertilizers
    - .. interbasin transfers of water may increase the supply where needed, but such projects also may have an irreversible effect on the environment as regional water balances are changed. Such imbalances may seriously affect aquatic biota, climate and the mineral content of the water
    - .. industrial effluents and municipal sewage are frequently dumped directly into receiving waters
  - however, water quality also suffers considerably from independent human activities
    - .. uncontrolled deforestation induces erosion and subsequent sedimentation
    - .. automobile exhaust can contribute to water contamination.

- Water pollutants can be classified into several major categories:
  - . infectious agents - microbial or viral agents that can transmit disease to people
  - . oxygen-demanding wastes - wastes added to water that increase the gross respiration rate of aquatic or marine micro-organisms to the extent that the concentration of dissolved oxygen in the water is decreased
  - . plant nutrients - compounds of carbon, nitrogen, and phosphorous, such as fertilizers or detergents, that promote undesirable plant growth (primarily algae) in water
  - . organic chemicals - waste products from organic chemical manufacturing operations or pesticides that may be toxic to the flora and fauna in the water, or that may impart disagreeable taste and odours to the water
  - . inorganic chemical - dissolved inorganic materials such as chloride that may decrease the value of water for subsequent usage, or heavy metals such as mercury or lead that may be toxic to animal life
  - . sediments and other solids - soils and other material eroded from watersheds that may fill reservoirs, irrigation ditches, and navigation canals
  - . radioactive materials - radionuclides released from nuclear reactors or other sources, and
  - . heat - the utilization of a body of water as a heat sink, generally for an industrial process or a thermal-electric generating plant, that might result in excessive plant growth.
- It should be recognized, however, that only when concentrations are sufficiently high will water quality be impaired.

140. NATURAL POLLUTION OF THE WATER RESOURCE ALSO CONTINUES AT A RELATIVELY CONSTANT RATE.

- It takes the form of dissolution of rock minerals, natural transport of sediments, washing of the atmosphere, encroachment of mineralized waters and thermal stratification.

141. THIS CUMULATIVE AND INCREASING BURDEN UPON BOTH THE QUALITY AND QUANTITY OF THE RESOURCE THREATENS THE FUTURE SUPPLY OF USEFUL WATER.
- The aquatic ecosystem is more closed and vulnerable than its terrestrial counterparts.
  - The demands imposed upon it will continue to increase dramatically.
  - A high percentage of the world's population already has insufficient access to safe water.
142. THE ENVIRONMENTAL DETERIORATION OF OTHER RESOURCES RESULTING FROM THE MISUSE OF WATER ALSO MERITS ATTENTION.
- Waterlogging, salinization, and land subsidence represent some of the most striking examples;
    - . improper drainage for the soil of arid regions sometimes results in salinization and alkalization
    - . overpumping of groundwater resources may lead to salt water intrusion and to subsidence of land surfaces.
  - Other examples include overflow, flooding, and erosion.
  - Environmental repercussions arising from water impoundments also require serious attention;
    - . in one or another projects water-borne diseases have been spawned; sedimentation from surrounding erosion has filled reservoirs; aquatic weeds have spread uncontrollably; down-stream fisheries have dried up; without the silt of the spring floods, delta land has been disappearing and losing its fertility; resettling of the displaced population has often proved difficult and social costs have been high; microclimates have been altered.
143. WATER, TO BE OF USE IN ANY GIVEN ACTIVITY, MUST BE MADE AVAILABLE IN THE REQUIRED AMOUNT, AT THE REQUIRED TIME AND PLACE, AND IN THE REQUIRED QUALITY FOR THE SPECIFIC APPLICATION INTENDED.
- In pursuit of this objective, attention must be paid to avoid environmental repercussions adverse to other resources and social objectives.
  - To meet this goal, the pressures on quality and quantity should be anticipated and countered by preventive measures.

144. INTEGRATED PLANNING AND MANAGEMENT OF WATER DEVELOPMENT AND CONSERVATION IS NEEDED.

- The complementary and competitive relationships among various uses and objectives - water quality improvement, energy generation, navigation, flood, irrigation, water supply, and water-based recreation control - should be reconciled and co-operatively planned and managed by inter-disciplinary teams;
  - . once all demands are identified, analyses should be made to determine what programmes should be undertaken and how they should be financed
    - .. the appropriate pricing structures and mechanisms for regulating water supply and demand under each alternative should be assessed
  - . all feasible system plans and procedures should be considered
    - .. the full possibilities of management of both water quantity and quality should be explored
    - .. the most efficient use of water by agriculture, industry and municipalities should be determined
    - .. opportunities for re-use should be fully developed
  - . a solution would hopefully be derived which would indicate the optimum combination of elements and operating procedures in light of the relevant objectives and constraints
    - .. the complexity of the problem, the absence of required data, and the unpredictability of natural phenomena frequently preclude optimum solutions, however
    - .. in any case, this approach should provide major economies over conventional treatment.
- The unified approach can be best implemented through large-scale comprehensive regional or river-basin resources development programmes.
- The necessary legal and administrative framework should be provided to permit national inter-agency co-operation and implementation of water resource policies through the adoption and enforcement of standards, and the use of incentives. Negative incentives in the form of taxes against undesirable practices, or positive incentives that may provide cost sharing for desirable actions can be used.
- The compatibility of surrounding land use practices should be assured.



- The extent to which legal, policy and managerial factors are considered should be expected to vary according to;
  - . particular cultural and social values
  - . the stage of a region's or country's development
  - . environmental standards to be adopted.
- However, the absence of a unified approach will result in a sub-optimal solution, characterized by conflicting objectives and adverse environmental repercussions.
- The Ruhr area of West Germany, the English River Authorities and the River Plate Intergovernmental Commission represent a few examples of successful integrated management.

145. AN INTEGRATED APPROACH TO WATER QUALITY IS A PRINCIPAL COMPONENT OF ANY COMPREHENSIVE PLAN.

- Standards for water quality must first be selected on the basis of
  - . the results of an initial water resource survey
  - . the scientific assessment of the current water quality
  - . the best available estimate of the pollutant assimilative capacity of the water resource
    - .. measurements to be considered include the oxygen content of the water, the nature and quantity of suspended solids, the existence and speed of currents and thermal stratification the nature of the water body, etc.
  - . the intended use of the water resource.
- Moreover, the continuous monitoring of water resources should be encouraged.
- All parameters will vary from one set of circumstances to the next and will change over time, so that constant review is required.
- Standard setting will sometimes be particularly difficult within federal states; and agreement on objectives might be the only alternative.

- The degree to which the effects of poor water quality are discernable will vary;
  - . the effects on municipal and industrial uses can be measured directly in terms of costs
  - . agriculture is complicated because of the complex interactions between water quality and crop yield
  - . still more complicated is determination of the effects on aquatic life, water-based recreation, and aesthetics.
- All methods of improving the quality of receiving waters should be explored. These include:
  - . methods for diminishing waste discharge through reducing:
    - .. wastes generation
    - .. wastes after generation
  - . methods for increasing or making better use of assimilative capacity.
- The best method for treating industrial or municipal wastes should be selected from many alternatives.
- Alternatives to waste treatment should also be examined;
  - . alternative modes for disposal of concentrated wastes include: land burial, incineration, deep well disposal and placement in cavities formed below circulating water
    - .. these must be undertaken with great caution, however
  - . other alternatives include streamflow regulation, in-stream water quality improvement measures, the diversion of waste waters from sensitive areas, the use of waste waters for irrigation, or a revision of the incentive system bearing on the generation and disposal of waste waters
    - .. the productive use of heat released into receiving waters should be further developed.

146. THE PROPER USE OF WATER FOR AGRICULTURAL PURPOSES NEEDS TO BE ASSESSED, WHERE NECESSARY, AND CAREFULLY REGULATED.

- Knowledge of water-soil-plant relations, and proper farm irrigation system design and operation, should be applied in order that maximum crop returns may be realized with minimum adverse effects on the water and soil resources.

- The proper combination of water, fertilizer and pesticide should be applied in order that there is a minimum excess to degrade surplus waters.

147. A VARIETY OF METHODS EXIST FOR MANAGING THE SUPPLY AND DISTRIBUTION OF WATER.

- Methods such as dams, canals, and groundwater pumping and recharge are relatively well known;
  - . their environmental repercussion should now be closely examined.
- Several newer methods exist on which development work should be continued:
  - . weather modification
  - . desalination.
    - .. although desalination is technically feasible, it is costly
  - . lining distribution networks in agriculture and improved drainage of irrigated fields
  - . water re-use.
    - .. water must not only be available, but also of a suitable quality for specific functions, be it processing, boiler feed water, cooling, or sanitary purposes
  - . multiple-use reservoirs
  - . technological modification to require less water in the industrial process.

148. THE ECONOMIC ASPECTS OF INTEGRATED PLANNING AND MANAGEMENT ARE CRUCIAL.

- Conflicting uses could be evaluated within expanded cost-benefit analysis.
- Supply and demand should be reflected in the appropriate price structure.

149. LEGISLATIVE INNOVATIONS MAY BE REQUIRED TO ENSURE THE INTEGRATED MANAGEMENT OF WATER RESOURCES.

- Although the technical means for a unified approach are largely available, realization is frequently impeded by the ad hoc nature of past and present water projects;
  - . projects are too frequently governed by separate legal enactments and administered by different governmental departments.

- Legislation should balance the sociological, religious and philosophical character of the people with ecological and economic considerations;
  - . community participation should be strongly supported in the planning of all water projects.
- A basic code or act might well include the following provisions:
  - . the ownership of water should be defined with respect to both surface and ground water
    - .. if public ownership is not feasible, the right of state to regulate or control ownerships should be considered essential
  - . the right to the use of water should be distinct from ownership
  - . water conservation should include considerations of public health, land conservation, improvement of supplies, drainage, waterlogging and salinization, pollution abatement and environmental protection
  - . a water rights administration or water planning board should allocate water as to amount, purpose and time, and these should be centrally administered, within each region, river or basin
  - . co-ordination should be assured with other enactments related to water such as forestry, fisheries, housing, land use and settlement, mining, land reform, and municipal and town planning
  - . implementation and enforcement should include judicial and administrative protection of water rights and claims
  - . existing water legislation inconsistent with the basic or consolidated water act or code should be repealed
  - . water institutions and administration needed to bring water under centralized administrative management should be established.

150. A NUMBER OF FACTORS PREVENT TAKING FULL ADVANTAGE OF KNOWN TECHNOLOGY.

- As problems become more complex there are numerous inter-relationships that must be taken into account, all of which are not well understood.
- Some of the newly developed control and management techniques are too costly for some countries to adopt.
- In developing countries the technologies that have been tried and proven in industrialized countries may require some modification in order that water resources be managed relatively cheaply;

- this will mean the training of technicians and engineers from developing countries in skills required to design and construct machinery suitable for local use.
- There is inadequate communication between those who construct a water project and those who use it, i.e., the engineers and the agriculturists.

(ii) Recommendations for national action

It is recommended that national governments give consideration to the following proposals:

151. GOVERNMENTS SHOULD ESTABLISH, WHERE THIS HAS NOT YET BEEN DONE, AN INTEGRATED INSTITUTIONAL FRAMEWORK FOR WATER RESOURCES MANAGEMENT AND DEVELOPMENT.

- The institutional framework should include appropriate institutions (agencies, authorities, institutes, boards, councils, etc.) of nationwide as well as of regional and local competence;
  - in the subdivision of the responsibilities, among areas, due attention should be paid to the boundaries of the national hydrological regions (river basins, lake basins, groundwater systems)
  - the institutional framework should not be subordinated to any of the agricultural or industrial departments representing only one or a group of the water management fields.
- The institutional framework should be structured and staffed for the execution or supervision and co-ordination of the following principal functions:
  - legal and fiscal administration in all the fields of water management relevant under the conditions of the country.  
This includes:
    - .. providing affected parties the opportunity to have a voice in decisions
    - .. granting rights and issuing licenses, permits, or concessions
    - .. provision that externalities associated with waste discharge be accounted for
  - operation of water supply and water management systems
  - water resources development planning
  - construction and maintenance of water management projects and structures
  - data acquisition and research.

- Allocation of water as to amount, quality and timing should be centralized at the national and regional levels in planning as well as in operational decisions.
- Structures and procedures should be established assuring an equitable co-operation with other branches of the national administration at appropriate levels.

152. GOVERNMENTS SHOULD UNDERTAKE, WHERE NECESSARY, COMPREHENSIVE SURVEYS OF WATER RESOURCES AND WATER DEMANDS.

- The surveys should include:
  - . the assessment of the actually and potentially available fresh water resources with due attention to
    - .. the availability of hydrological, meteorological and hydrogeographical data and inventories
    - .. the interdependences among the water resources of the adjacent regions as well as among the different types of the water resources (rivers, lakes, groundwaters)
    - .. the opportunities of augmenting the available resources by storage reservoirs, artificial recharge of groundwaters, watershed management and other measures
    - .. the quality and time distribution of the available resources
  - . the assessment of the actual water uses and expected future water requirements whereby
    - .. particular attention should be paid to domestic and public water supply
    - .. elasticity of the industrial and agricultural water requirements should be considered
    - .. quality requirements and polluting effects should be identified.
  - . an integrated evaluation of the resources and demands with due attention to
    - .. the opportunities of balancing the discrepancies in the distribution of their time and area
    - .. the possibilities of multiple use of water
    - .. flood control
    - .. pollution control and other environmental effects.

- Major changes in the water uses should be registered on an annual basis and the comprehensive surveys should be renewed periodically in order to detect inevitable changes in water distribution and quality.
- The results of the surveys should be evaluated also in the broader contexts of co-operation with neighbouring countries.

153. GOVERNMENTS SHOULD FORMULATE AND ADOPT INTEGRATED WATER RESOURCES POLICIES.

- The national water resources policy should be based on the results of the surveys of water resources and demands and it should identify
  - . the basic principles and fundamental procedures under which water is managed and developed
  - . the basic approaches in assuring the proper place and role of water management in the general national and regional planning and development
  - . the interests and potential roles of the country in the broader context of the bilateral, multilateral and international issues of water resources development.
- All funding should be done on the basis of comprehensive national or regional plans, and individual projects supported only within the framework of such plans;
  - . treatment facilities can thereby be combined and economies of scale achieved
  - . priorities can be assigned by identifying areas of greatest need.
- Price mechanisms including effluent charges and other economic measures should be used where appropriate to stimulate more efficient use of water.
- The necessary legal and legislative adjustments to conform to such a policy should be effected.
- All social and cultural factors, including public participation, should be provided for.
- A multidisciplinary team should be assembled to undertake the necessary planning and management.

154. GOVERNMENTS SHOULD GIVE SPECIAL ATTENTION TO POLLUTION CONTROL AND OTHER ENVIRONMENTAL ASPECTS OF WATER RESOURCES MANAGEMENT.

- Pollutants of special concern are toxic industrial wastes, chemicals including heavy metals, and bacterial contaminants and viruses.
- Various independent activities, such as uncontrolled deforestation or land reclamation should also be viewed with a concern for water quality.
- Local, regional and national water quality monitoring systems should be established, where appropriate, to prevent damages from unexpected pollution.
- Systems of national environmental impact statements should be developed and introduced as organic parts of the national water resources planning regulations.

155. GOVERNMENTS SHOULD ENCOURAGE THE INCREASED EFFICIENCY OF WATER USE IN AGRICULTURE AND IN INDUSTRY.

- Existing networks of irrigation, drainage, and water management practices, at the farm level, should be improved to
  - . increase yields of crop and grazing lands
  - . avoid losses of water, soil and plant nutrients by runoff and percolation, thus reducing the hazards of water pollution and of soil degradation by erosion, salinization and water-logging.
- Increased efficiency should be achieved in order to
  - . save water enabling further extension of the existing water supply systems
  - . reduce the spread of water-borne diseases.
- Water saving programmes could be introduced and stimulated by
  - . promoting closer co-operation between the water supplying and water using agencies and undertakings
  - . the application of price-systems reflecting real costs of water supply and pollution control.

156. GOVERNMENTS SHOULD ENGAGE IN THE ACQUISITION OF NEW KNOWLEDGE AND CO-OPERATE IN THE TRANSFER OF EXISTING KNOWLEDGE, AS PRIORITIES INDICATE.

- Technology exists to treat water to prevent the transmission of bacterial diseases, although more knowledge is needed about the removal of more complex contaminants and, in particular, viral organisms.



- Technology exists for the removal of specific contaminants from point sources, for economically treating municipal wastes for the efficient removal of suspended and dissolved solids and for preventing increases in biochemical oxygen demand loadings;
  - . however, the operation of systems for handling residues from a number of dispersed sources and their common treatment is not too well understood due to the complex and unrelated varieties of the disposal sources.
- Technology exists to provide tertiary treatment of wastes to remove nutrients and dissolved solids, among other things, but in many cases this degree of treatment is not economically acceptable depending on the quality reached in the treatment process and that demanded by the consumers.
- Systems analysis techniques are well developed but their application to water resource management problems has been limited because of the lack of knowledge about the varieties components of the system as they apply to water problems. These are
  - . identification of new parameters for evaluating the social and economic values that are essential for making the best choice among alternatives
  - . development of various type institutional arrangements to facilitate water resource management on a national and international basis.
- Technology exists to recover waste products for recycling, but more efficient methods of removal and recovery are frequently needed to make such practices more economical. Moreover, technologies are needed which decrease the demand on water.
- Technology exists for the recharging of groundwater and for deep well disposal, but more knowledge is required on leaching effects and the behaviour of groundwater.
- Isotope techniques provide a new and often cheaper tool to study the interrelationships of lakes and groundwater, different aquifers, areas of recharge, and groundwater flow.
- Other major gaps in knowledge include:
  - . prevention of water losses by runoff, evaporation and percolation effects of irrigation and drainage on the environmental, management and efficient use of soil water
  - . use of water of poor quality and re-use of water by industry and in agriculture

- . improved water recycling techniques for various industrial uses
  - . development and management of groundwater resources, particularly in relation to surface waters and including consideration of the selective transport of pollutants through underground aquifers
  - . improved management of water where it falls, including the development of improved techniques in rain-fed agriculture
  - . management of water for fisheries developments
  - . development of water quality indices, which could note trends and upon which policy decisions could be taken (as are economic decisions on the basis of GNP)
  - . long-range toxic effects of certain metals and of new synthetic organic substances that persist in the receiving water even after conventional treatment and that are stable to biological attack
  - . improvement in methods and procedures to identify and measure the presence of toxic metals, organic chemicals, and other contaminants in water
  - . the action, under various conditions, of oxidation ponds and other cheap methods of waste treatment, and the use of such procedures for the treatment of industrial wastes
  - . the institutional aspects of water quality control
  - . the management rather than the analytical techniques for planning
  - . the relationship between water quality control and bathers' health
  - . the environmental impacts of water development projects.
- Many other research needs can be readily identified but cannot be included here.
- Each nation should carefully identify its research priorities:
- . those countries with relatively undeveloped resources should focus on applied studies of the more practical kind, development orientated, and related to local resources and manpower skills
  - . those countries with more advanced management capabilities should focus on more fundamental investigations requiring more sophisticated skills and physical as well as financial resources.

157. GOVERNMENTS SHOULD SUPPORT FORMAL AND SHORT-TERM TRAINING COURSES  
ESSENTIAL TO THE DEVELOPMENT OF EFFECTIVE WATER MANAGEMENT PROGRAMMES.

- Courses should be initiated that will permit the updating of current staff in techniques and methodologies being developed.
- Governments should encourage those seeking training in industrialized countries to concentrate their efforts, particularly any research studies, on problems relevant to their own countries' needs.
- Governments should support the creation within their academic institutions of interdisciplinary courses and degrees on unified water planning and management
  - the traditional sectors of sociology, engineering, economics, agronomy, ecology, etc. must be combined and fitted to the new needs of integration.
- The inadequate number of sewage treatment operators, familiar with the increasingly sophisticated facilities, must be remedied by training courses.

158. GOVERNMENTS SHOULD ENCOURAGE THE TRANSLATION OF LABORATORY INVESTIGATIONS  
TO FIELD PRACTICE.

- The exchange of personnel between operating and research agencies.
- The funding of investigations by operating agencies.
- Having operating agencies participate in decision-making on study programmes.

(iii) Recommendations for international action

159. IT IS RECOMMENDED THAT GOVERNMENTS CONCERNED CONSIDER THE CREATION OF APPROPRIATE  
MULTINATIONAL INSTITUTIONS IN THE FORM OF INTERNATIONAL RIVER-BASIN COMMISSIONS,  
FOR WATER RESOURCES COMMON TO MORE THAN ONE JURISDICTION.

- Full consideration should be given to the sovereign rights of each country concerned to develop its own resources.
- The following principles should be upheld:
  - that nations agree that when water resource activities are contemplated that may have an environmental effect on another country, the other country be notified well in advance of the activity envisaged
  - that the basic objective of all water resource use and development activities is to provide maximum net benefits to the combination of all nations affected by such activities

- . that the net benefits of hydrologic regions common to more than one national jurisdiction are to be shared equitably by the nations affected.
- Such arrangements will permit undertaking on a regional basis;
  - . collection, analysis, and exchange of hydrologic data through some agreed upon international mechanism
  - . joint data-collection programmes to serve planning needs
  - . assessment of environmental effects of existing water uses
  - . joint study of the causes and symptoms of problems related to water resources, taking into account the technical, economic, and social considerations of water quality control
  - . co-operative management, including a programme of quality control, of the water resource as an economic asset
  - . provision for the judicial and administrative protection of water rights and claims
  - . prevention and settlement of disputes with reference to equitable apportionment and conservation of water resources
  - . financial and technical co-operation of a shared resource.
- Regional conferences should be organized to promote the above considerations.

160. IT IS RECOMMENDED THAT THE SECRETARY-GENERAL TAKE STEPS TO:

- (a) ENSURE THAT APPROPRIATE UNITED NATIONS BODIES SUPPORT GOVERNMENT ACTION WHERE REQUIRED;
  - . reference is made to FAO, WHO, WMO, ESA/RTD, and the regional economic commissions. For example
    - .. the first has established a Commission on Land and Water Use for the Middle East which promotes regional co-operation in research, training and information inter-alia on water management problems
    - .. the second has available the International Reference Centre for Waste Disposal located in Dübendorf, Switzerland and the International Reference Centre of Community Water Supply in the Netherlands
    - .. the third has a Commission on Hydrology which provides guidance on data collection and establishment of hydrological networks

- .. the fourth has established the United Nations Water Resources Development Centre
  - . similar specialized centres should be established at regional level in developing countries for training, research and information exchange on
    - .. inland water pollution and waste disposal in co-operation with WHO, FAO and regional economic commissions of the United Nations
    - .. water management for rain-fed and irrigated agriculture, by FAO in co-operation with the regional economic commissions
    - .. integrated water resources planning and management in co-operation with ESA/RTD and the regional economic commissions.
- (b) ENSURE THAT THE UNITED NATIONS SYSTEM IS PREPARED TO PROVIDE TECHNICAL AND FINANCIAL ASSISTANCE TO GOVERNMENTS WHEN REQUESTED IN THE DIFFERENT FUNCTIONS OF WATER RESOURCE MANAGEMENT.
  - Surveys and inventories.
  - Water resources administration and policies, including
    - . establishment of institutional frameworks
    - . economic structures of water resources management and development
    - . water resources law and legislation.
  - Planning and management techniques, including
    - . assignment of water quality standards
    - . implementation of appropriate technology
    - . more efficient use and reuse of limited water supplies.
  - Basic and applied studies and research.
  - Transfer of existing knowledge.
  - Continuing support of the programme of the International Hydrological Decade.

- (c) ESTABLISH A ROSTER OF EXPERTS WHO WOULD BE AVAILABLE TO ASSIST GOVERNMENTS, UPON REQUEST, TO ANTICIPATE AND EVALUATE THE ENVIRONMENTAL EFFECTS OF MAJOR WATER DEVELOPMENT PROJECTS.
  - Governments would have the opportunity of consulting teams of experts drawn from this roster, in the first stages of project planning;
    - . guidelines could be prepared to assist in the review and choice of alternatives.
- (d) PREPARE A COMPREHENSIVE ASSESSMENT AND EVALUATION OF THE ACTUAL AND POTENTIAL ENVIRONMENTAL EFFECTS OF WATER MANAGEMENT UPON THE OCEANS.
  - The oceans are the ultimate recipient for the natural and man-made wastes discharged into the river systems of the continents.
  - Changes in the amount of riverflow into the oceans, as well as in its distribution in space and time may considerably affect the physical, chemical and biological regime of the estuary regions and influence the oceanic water systems.

G. Mining and primary mineral processing

(i) Considerations for action

161. INDUSTRIAL CIVILIZATION WOULD BE IMPOSSIBLE WITHOUT MINERALS, YET MINERAL EXPLORATION, MINING, AND DRILLING ARE ALL ACTIVITIES THAT REQUIRE TEMPORARY OCCUPATION OF LAND AND THAT MAY DEGRADE THE ENVIRONMENT.

- Large amounts of land are disturbed, especially by surface mining, subsidence over underground mines, the proliferation of small quarries, and waste dumps.
- Plants and wildlife may be stunted or destroyed.
- Fires may be ignited.
- Fresh or salt water bodies may be contaminated.
- Dusts and fumes are emitted into the air;
  - . part of the problem involves air quality, but it also affects the miner who, through chronic exposure to airborne dust or radiation, may be subjected to severe health hazards.

162. HOWEVER, IN THE PRIMARY PROCESSING STAGE - SMELTING, REDUCING, REFINING ETC. - THE DISTURBANCE OF LAND IS NOT A MAJOR PROBLEM BUT AIR AND WATER POLLUTION MAY BE.

163. MOST MINING DAMAGE IS RELATIVELY LOCALIZED IN NATURE.

- Acid drainage, mostly from coal mines, sulphur dioxide from metal smelters, and seepage or blowouts at offshore oil wells are exceptions.
- However, this does not diminish their significance;
  - . when deposits occur in beautiful areas, a problem largely but not entirely restricted to metallics, choices must be made between incompatible uses
  - . mineral exploration and production will often have a big impact, on their own or as the stimulus for other activity, because they are frequently the first industrial activity in an otherwise environmentally undisturbed area
  - .. this is particularly true in sensitive and ecologically fragile areas like the Arctic.

164. THE CONSUMPTION OF FORTH FUEL AND NON-FUEL MINERAL PRODUCTS INVOLVES MAJOR POLLUTION PROBLEMS<sup>1/</sup>

165. ENVIRONMENTAL CONTROL OF MINING AND MINERAL PROCESSING WILL NOT BE EASY TO ACHIEVE.

- The growing demand for mineral products is such that damage may continue to increase in total even though it is reduced per unit of output.
- While many practices damaging to human health or to the environment can be modified without significant additional cost, in other cases large costs will be required.

166. IF ANY PROGRESS IS TO BE MADE IN AMELIORATING ENVIRONMENTALLY ADVERSE EFFECTS, MINERAL DEVELOPMENT PLANS SHOULD BE INTEGRATED WITH THE MANAGEMENT OF OTHER NATURAL RESOURCES AND SHOULD PROVIDE FOR THE CONSERVATION OF BOTH THE MINERAL AND THE ENVIRONMENTAL RESOURCES. TO THIS END, A NUMBER OF MANAGEMENT OPPORTUNITIES ARE USUALLY AVAILABLE.

- Sequential land use planning. Since all mines are eventually exhausted, mining should be planned as one of a series of land uses.
- Exploration. During exploration restrictions can be very stringent because there is no certainty that there will be any significant returns and because the costs of environmental protection are generally low.
- Siting. The fact that mining is inherently a temporary land use suggests that siting of other economic activities should be delayed to allow for the prior removal of valuable minerals. Where other activities predate mining, accommodation may or may not be possible. Further, even in uninhabited areas, the alternative of not mining must also be considered as legitimate and, in some cases, desirable.
- Economic land use. While mine site selection is more resource-bound than are most other forms of economic activity, there are ways to economize on the use of land during mineral production.

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<sup>1/</sup> Problems connected with energy consumption are discussed in the section on energy. Problems stemming from use of non-fuel minerals, which with some exceptions such as fertilizers are less directly the source of pollution, are discussed under Subject Area III (A/CONF.48/8).



- Operational restrictions. Once a decision has been reached to allow mining, operational restrictions should be invoked to reduce the undesirable side effects as much as possible for each unit of output;
  - . the main problems relate to proper disposal of waste materials
    - acid drainage, sediment from surface mines, flammable or radioactive wastes, and sulphur dioxide from smelters -
    - to oil losses from undersea operations, and to subsidence, all of which can cause long-term or irreversible damages.
- Health care. The human suffering and tangible costs of such lung diseases as silicosis are so high, and the control methods so readily available, that it may be reasonable to aim for an incidence rate of zero;
  - . because human susceptibility to lung diseases varies greatly, this will not actually be obtained, but if provision is made for early diagnosis of the incipient disease and transfer of susceptible individuals to other forms of employment, it becomes a meaningful target.
- Land reclamation. Mines should be planned and operated so as to make reclamation feasible;
  - . there should be no continuing off-site damages after the mine has closed
  - . the mine site itself, while possibly different in form and appearance from its pre-mining state, should be aesthetic and no less productive for other purposes than before mining
  - .. if reclamation to meet these two criteria appears to be excessively expensive at a proposed mine, a serious question must be raised as to whether the mine should be allowed to open at all.
- Recycling. More extensive recycling of obsolete mineral-based products should be encouraged;
  - . to the extent recycling is employed, the problems associated with primary mining and processing are avoided
  - . on the other hand, it must be remembered that the recycling process has its own demands for energy and materials and its own impact on the environment
  - . recycling technologies must be advanced, some institutions and incentives created, and final products redesigned before the circle will in fact be closed.

(ii) Recommendations for national action

It is recommended that national governments give consideration to the following proposals.

167. COUNTRIES SHOULD ADOPT THE VIEW THAT MOST MINERAL EXPLORATION AND PRODUCTION ARE PARTS OF A SERIES OF SEQUENTIAL LAND USES. THIS VIEW SHOULD BE INTEGRATED WITH OTHER ASPECTS OF THE COUNTRY'S NATURAL RESOURCE MANAGEMENT PLANS.
168. EACH COUNTRY SHOULD DEVELOP FIRM POLICIES APPROPRIATE TO ITS GOALS AND ENVIRONMENTAL CONCERNS.
  - These policies should cover:
    - . minimum environmental standards for each set of environmental conditions and
    - . special considerations that may modify the general standards
      - .. particular features, such as national parks
      - .. particular goals, such as the preservation of a rural society, or, conversely, the development of a planned mining region.
  - These policies should be clearly set out in advance so that they become a force to which mineral proposals respond rather than be developed as a reaction to such proposals.
  - These policies should also seek to add costs of environmental damage to production costs, so that producers will be encouraged to seek less damaging processes.
  - In addition, they should be rooted as firmly as possibly in each country's legal and institutional framework rather than relying on ad hoc measures.
169. COUNTRIES SHOULD DEVELOP LAND-USE REGULATIONS THAT WILL PERMIT MINERAL EXTRACTION, AND SUBSEQUENT MINED-LAND RECLAMATION, PRIOR TO THE ADVENT OF OTHER ECONOMIC ACTIVITY THAT WOULD PRECLUDE MINING, EXCEPT FOR THOSE CASES WHERE MINING WOULD DESTROY OTHER RESOURCES DEEMED TO BE OF GREATER AESTHETIC, CULTURAL, OR ECONOMIC VALUE.

170. EACH NATION SHOULD VEST ITS PROPOSED LAND USE AGENCY WITH THE AUTHORITY TO IMPLEMENT THE PRECEDING RECOMMENDATIONS.

- With a single agency, there is more likelihood of an integrated approach rather than the mere transfer of problems from one domain to another.
- Each country should consider the advantages of granting this agency some degree of autonomy from mining interests, be these governmental or private.

171. FURTHERMORE GOVERNMENTS SHOULD

- Establish base lines of natural activity and monitor changes in actual and potential mining areas so that the impact of mining can be measured - and eventually predicted.
- Redirect part of their often extensive mining research programme to develop mining and processing methods that will avoid or reduce these impacts during mining, to determine how to stabilize waste disposal sites, and to search for ways in which the wastes can be put to beneficial use.

172. COUNTRIES SHOULD ADOPT THE STANDARD OF NO NEW INCIDENCE OF ADVANCED CASES OF OCCUPATIONAL LUNG DISEASE AND SET UP SYSTEMS FOR EARLY DIAGNOSIS OF THE DISEASE.

173. COUNTRIES SHOULD ADOPT RECLAMATION STANDARDS AND REGULATIONS TO THE EFFECT THAT ALL EXPLORATION ACTIVITY AND ALL MINING BE COMPLETED IN SUCH WAYS THAT THERE ARE NO CONTINUING DAMAGES.

174. NATIONS SHOULD STUDY MEANS TO INCREASE THE RECYCLING OF MINERAL-BASED PRODUCTS AND, WHEREVER JUSTIFIED BY A CONSIDERATION OF THE COMPARATIVE COSTS, ENCOURAGE RECYCLING PROCESSES.

(iii) Recommendations for international action

175. IT IS RECOMMENDED THAT THE SECRETARY GENERAL PROVIDE THE APPROPRIATE VEHICLE FOR THE EXCHANGE OF INFORMATION.

- Improved accessibility and dissemination of existing information is required;
  - . the body of literature and experience is already larger than one would think.

- Possibilities include the accumulation of information on:
  - . the environmental conditions of mine sites
  - . the action taken in respect to the environment
  - . the positive and negative environmental repercussions.
- Such a body of information could be used for prediction. Criteria for the planning and management of mineral production would emerge and would indicate where certain kinds of mining should be limited, where reclamation costs will be particularly high, or where other problems will arise.

H. Energy - Its processing, transportation and consumption

(i) Considerations for action

176. ANY REMARKS ON THE ENVIRONMENTAL COSTS OF ENERGY MUST FIRST ACKNOWLEDGE ITS INDISPENSIBLE CONTRIBUTION TO THE PROGRESS OF SOCIETY.

177. EACH STAGE IN THE FLOW OF ENERGY, FROM PRODUCTION TO CONVERSION TO FINAL USE IN HOMES, FACTORIES OR MEANS OF TRANSPORTATION, IS ACCOMPANIED BY SECONDARY EFFECTS THAT, WHEN GENERATED IN SUFFICIENT VOLUME, EXERT AN ADVERSE IMPACT ON ONE OR MORE ASPECTS OF THE ENVIRONMENT.7/

- At the stage of conversion to electricity, serious pollution problems abound through emission of noxious gases and particulates into the air and the discharge of hot water into rivers and lakes;
  - . conventional thermal power plants must all contend with thermal pollution, and those based on coal or oil with emissions of gases and particulates; gas-based plants face less difficult problems in the latter respect
  - . nuclear power plants, although they have been the object of greater scrutiny than any technology in the past, and although they offer certain environmental advantages over conventional thermal plants, require continuous surveillance of the most careful kind because of the large losses that could result from escape of radio-active matter
  - . most recently, electricity generated in hydro facilities - which is generally considered a "clean" operation - has come under criticism because of
    - .. the spread of water-borne diseases
    - .. displacement of population
    - .. the often severe alterations in the ecology of the area newly occupied by man-made lakes.
- The main pollution problems in energy transportation are related to;
  - . spillage of oil into the ocean, either by way of accident or deliberate act (e.g. ship-cleaning operations, runoff from disposal of lubricants on land)
  - . pipeline safety, including both the explosion hazard where gas is transported and spillage where oil is transported
  - . the as yet quite limited movement of radioactive fuel elements from fuel-processing facilities for reprocessing, and from both reactors and fuel plants to sites of spent fuel disposal

7/ Primary production including refining has been treated in the previous section.

- . the disfiguring of landscapes by overhead transmission lines.
- The use of energy may be accompanied by highly significant pollution effects:
  - . the most significant is probably the burning of liquid fuel in the internal combustion engine where large amounts of carbon monoxide, hydrocarbons and other combustion products are produced
  - . where coal and oil are used for space-heating, the result of combustion again results in air pollution
  - . fuel used directly by industry, especially the metallurgical and chemical branches, also contributes significantly to air pollution
  - . mention must also be made of the inescapable generation and injection into the atmosphere of heat usually accompanying each stage of energy flow and in each variety of use.
- Particulates, carbon dioxide, and heat emissions appear to play a role in climate and weather modifications that is certainly of local significance and that may ultimately affect global climate.

178. THE ABOVE OBSERVATIONS SUFFICE TO SHOW THAT IT IS ESSENTIAL TO CONSIDER MULTIPLE CHOICES IN THE PLANNING AND MANAGEMENT OF ANY ENERGY ECONOMY.

- Each of many possible combinations of energy flow systems - different energy sources, conversion processes, transport modes and final applications - is associated with identifiable benefits, along with equally identifiable costs of environmental damage of required pollution control of safety precautions and of other impacts;
- . in recent years, a great deal has been done to identify and/or quantify various benefits and costs, and full advantage should be taken of this work.

179. THERE IS MUCH INTEREST IN THE SUBSTITUTION OF NEW, LESS-POLLUTING SOURCES OF ENERGY FOR CONVENTIONAL ONES.

- Fusion offers the promise of virtually unlimited raw material supply and very high efficiencies (thus less thermal pollution). It offers advantages over fission power in management of radioactive wastes although it may involve larger routine releases.
- Geothermal energy solar energy and wind and tidal power are other less polluting sources of promise;
- . however, they apply to a limited number of regions and the contribution they might make to the future world supply is not yet certain.

180. INVESTIGATIONS ARE ALSO BEING CONDUCTED INTO NEW CONVERSION PROCESSES THAT GENERATE LESS POLLUTION THAN DO PROCESSES NOW IN USE.

- At one level, work must proceed on the most promising of the new conversion processes, which either by reducing polluting potential at the point of consumption or by increasing system efficiency, provide a net reduction in pollution per unit of usable energy. Possibilities include;
  - . magnetohydrodynamics; various combinations of gas and steam turbines; and other systems that convert heat to electricity more efficiently
  - . batteries, fuel cells and exhaust combustion engine to replace the internal combustion engine
  - . gasification or liquefaction of coal, with removal of polluting sulphur prior to combustion
  - . fast breeder reactors, which result in less thermal pollution and reduce the need for new uranium mining.
- There must also be a second level objective in which entirely new energy production-distribution-consumption systems are reviewed, such as house-sized total-energy systems based on the fuel cell;
  - . investigation of a wide range of such systems should be pursued
  - . such research is speculative at this point and should be considered only by those countries that can afford it.

181. RESEARCH MUST INCLUDE A CAREFUL TECHNOLOGICAL ASSESSMENT OF ANY NEW METHOD, FOR ONLY THIS WILL REVEAL WHAT KINDS OF POLLUTION MIGHT COME IN ITS WAKE.

- Electric power from geothermal sources, often cited for its potential in some countries, may raise the problem of disposing of large flows of highly saline water.
- Rechargeable battery systems impose significant added demands on electric power facilities.

182. ENERGY TRANSPORT IS A SUBJECT EQUALLY SUSCEPTIBLE TO RESEARCH.

- The objective is to seek ways to minimize the impact, in both the construction and the operation phases, of pipelines, transmission lines, boat transport, and the like for each level of use;
  - . such alternatives as the establishment of utility corridors as conduits for all conveyors of energy communications, etc., should be considered.

183. AMONG THE USES TO WHICH ENERGY IS PUT, THE AUTOMOBILE IS ONE OF THE MAJOR POLLUTERS, ESPECIALLY IN URBAN AREAS.
- The choice of transportation systems, particularly passenger-owned versus mass transportation, carries implications far beyond the provision for the movement of people.
  - Similarly, a commitment to the internal combustion engine as the single or major propulsion system sets the stage for easily predictable pollution problems, pending the outcome of efforts to modify its characteristics.
184. SITING SHOULD BE DESIGNED TO MINIMIZE ENVIRONMENTAL IMPACT AT ANY LEVEL OF UTILIZATION. OFTEN THIS WILL ADD MINOR COSTS BUT HELP AVOID HIGH REMEDIAL COSTS IN THE FUTURE.
- Experience suggests that it is only after pollution problems have arisen, usually in areas of high concentrations of population, or as the result of the environmental impact of very large installations, that the siting of new facilities receives attention.
  - To avoid this timing trap, an extensive review of various alternatives involving economies of scale, patterns of land use, and environmental pollution should be made before deciding upon the siting of an energy producing facility.
  - The configuration of human settlements is also an important siting consideration related to energy use.
185. ENERGY PRODUCTION AND TRANSPORTATION ARE PERHAPS UNIQUE IN RESOURCE MANAGEMENT IN THE EXTENT TO WHICH ACCIDENTS ARE A DANGER.
- Accidents in the course of nuclear generation and transportation and of liquid fuel production and transportation, in particular, can be very serious, at least locally;
    - . the record is replete with tanker accidents and oil spills
    - . there have been a few worrisome though minor incidents at reactors.
  - Efforts must be made in proportion to the risks imposed to reduce the probability of such accidents.
186. ALL ALTERNATIVES FOR DOMESTIC FUEL AND SPACE-HEATING MERIT EXAMINATION.
- Countries have traditionally followed a sequence in sources of energy - commonly wood, coal, fuel oil, natural gas, and electricity - which might be reordered;
    - . these sources vary in their impact upon the environment and the alternative costs and benefits should be examined



.. the possibilities of central heating plants should also be examined, where appropriate.

- The possibilities of improved building design and construction should not be neglected.
- Developing countries should also consider moving directly to more environmentally efficient sources of space-heating.

187. THE ENERGY REQUIRED BY VARIOUS PRODUCTION PROCESSES, AND THE ATTENDANT ENVIRONMENTAL IMPACT, MUST BE CONSIDERED.

- The external costs arising from the energy required should be evaluated prior to the decision to introduce a new product onto the market and should be reflected in its price.
- The substitution of products with increased energy demands should be closely examined and possibly reconsidered.

188. SOME CONSIDERATION HAS TO BE GIVEN TO THE OBJECTIVE OF SLOWING DOWN THE RATE OF GROWTH OF ENERGY-CONSUMPTION, WHERE HIGH LEVELS HAVE ALREADY BEEN ACHIEVED.

- This becomes necessary because certain adverse effects of energy use, notably problems related to heat and gaseous emissions, appear to be intrinsic to energy use and because higher costs resulting from the depletion of cheap energy sources (a possibility for fluid fossil fuels) could limit development plans of developing countries.
- This objective must be posed very carefully, for energy growth has been closely associated with higher levels of economic development and material well being;
  - . it should in no way be applied in a manner which would slow development in the majority of nations still requiring more energy.
- Nevertheless, it can be approached
  - . by all nations observing greater efficiency in the use of energy per unit of final product (higher conversion ratios, lower heat losses, etc.)
  - . by those areas already well supplied questioning the need for per capita additions to energy consumptions.
- Changes in the price structure and other measures to encourage lower use might do much to achieve this objective.

(ii) Recommendations for national action

It is recommended that national governments give consideration to the following proposals.

189. EACH NATION SHOULD SET UP A NATIONAL ENERGY BOARD TO COORDINATE ENERGY DEVELOPMENT AND UTILIZATION POLICIES, STAFFED WITH HIGHLY QUALIFIED PERSONNEL, INCLUDING SOME IN THOSE DISCIPLINES RELATING TO THE ADVERSE ENVIRONMENTAL EFFECTS OF ENERGY.
  - If such a national agency is not feasible it is recommended that each nation adopt a coordinated energy policy, so as not to forget environmental considerations;
    - . this is all too often the result when there are competing single-purpose agencies, each responsible for a different form of energy
    - . coordination will also have other benefits.
190. THOSE GOVERNMENTS WITH HIGH PER CAPITA USE SHOULD CONSIDER THE OPPORTUNITIES FOR REDUCING THE GROWTH OF ENERGY CONSUMPTION AS ONE OF THE ALTERNATIVES IN MINIMIZING ALL OF THE COSTS - DIRECT, ENVIRONMENTAL AND CULTURAL - FROM ECONOMIC DEVELOPMENT.
191. COUNTRIES SHOULD ALSO DEVELOP EXPLICIT TRANSPORTATION POLICIES AND INTEGRATE THESE WITH CONSIDERATIONS DEVELOPED ABOVE.
192. COUNTRIES SHOULD PROMOTE ECONOMIC AND TECHNOLOGICAL RESEARCH CAPABILITIES FOR DEVELOPING OR ASSESSING NEW ENERGY SYSTEMS OR FOR DETERMINING THE BEST OR IMPROVED USE OF EXISTING SYSTEMS.
  - Within industrial nations, this effort should take place on a large scale and include basic research programmes that have no short-run returns but involve desirable long-term reorientation;
    - . it is important that the implications to energy consumption of product substitution be examined
    - . research and development of new conversion processes should receive high priority
    - . the effort to determine the technological feasibility of fusion power should be strongly supported in order to see whether development is merited.
  - In developing nations, the focus should be more on the solution of their particular energy constraints, generally by highly applied research on practical problems;
    - . countries should study the alternatives in order to determine the most appropriate combination of systems for different uses.

- In either case, as emphasized above, careful technological assessments must be made of the environmental impacts of any proposed change in energy economics or technology.

193. COUNTRIES SHOULD DEVOTE SPECIAL ATTENTION TO MINIMIZING ENVIRONMENTAL IMPACTS WHEN SITING ENERGY PRODUCTION, CONVERSION AND TRANSPORTATION FACILITIES.

- Appropriate review and appeal procedures should also be established.

194. EACH NATION SHOULD ALSO SET UP OR, IF THEY ALREADY EXIST, REVIEW THE EFFECTIVENESS OF AGENCIES TO ADMINISTER MINIMUM STANDARDS IN AREAS WHERE ACCIDENTS MUST BE CONTROLLED.

- Because of the possible conflicts, the functions of promoting and regulating each source of energy should be vested in separate agencies.

195. DESPITE BEST EFFORTS, A FINITE PROBABILITY OF ACCIDENTS MUST REMAIN. FOR THIS REASON, EACH NATION MAY WISH TO SET UP A POLLUTION CRISIS CENTRE TO DEAL WITH ACCIDENTS.

- Such a centre need only be a "skeleton organization" but must have strong communications links and the authority to command what it needs to cope with accidents and prevent damage from spreading.
- Equipment not readily available should be held on reserve in high-risk areas for mobilization during such accidents.

(iii) Recommendations for international action

196. IT IS RECOMMENDED THAT THE SECRETARY GENERAL TAKE STEPS TO:

(a) ENSURE PROPER COLLECTION, MEASUREMENT AND ANALYSIS OF DATA RELATING TO THE ENVIRONMENTAL EFFECTS OF ENERGY USE AND PRODUCTION WITHIN APPROPRIATE MONITORING SYSTEMS.

- The design and operation of such networks should include, in particular, monitoring the effects of emissions of carbon dioxide, sulphur dioxide, heat, and particulates, as well as the effects of releases of oil and radioactivity;
- In each case the objective is to learn more about the effects on weather, human health, plant and animal life, and amenity values.

(b) GIVE SPECIAL ATTENTION TO PROVIDING A MECHANISM FOR THE EXCHANGE OF INFORMATION.

- Clearly, to rationalize and integrate resource management for energy will require a solid understanding of the complexity of the problem and the multiplicity of alternative solutions.
- Access to the large body of existing information should be facilitated;

- . data on the environmental consequences of different energy systems should be provided through an exchange of national experiences, studies, seminars, and other appropriate meetings
  - . a continually updated register of research involving both entire systems and each of its stages should be maintained.
- (c) ENSURE THAT A STUDY BE UNDERTAKEN ON AVAILABLE ENERGY SOURCES AND CONSUMPTION TRENDS IN ORDER TO PLAN FOR AND FORECAST THE ENVIRONMENTAL EFFECTS OF FUTURE USE.

### Chapter III

#### SUMMARY OF RECOMMENDATIONS FOR INTERNATIONAL ACTION

197. The principal objective of international action in this subject area is to support national efforts towards a more rational and integrated management of natural resources which takes account of environmental concerns.

198. For the convenience of governments, the recommendations for international action which appear in Chapter I and under each principal resource sector of the preceding Chapter II are summarized below. These recommendations have been re-grouped by function (e.g. research, monitoring, information exchange) so as to provide the reader with an over-all view of the scope of the measures for the management of natural resources which are submitted to the Conference.

199. Since there are already in operation agencies and mechanisms which provide many functions that fall into the natural resources area, the recommendations cover principally those objectives that are not now served, partly or wholly.

#### A. Acquisition of knowledge

##### (i) Evaluation and review

200. The impact of resource development upon the environment should be examined periodically during the planning and management process. Conflicts with other social objectives could thereby be identified and the most appropriate means of development selected.

201. It is recommended that the Secretary-General, in co-operation with governments concerned, take the following steps:

- (a) arrange that systematic post audits of completed natural resource development projects be undertaken in representative ecosystems of international significance;<sup>8/</sup>

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<sup>8/</sup> Projects might include new agricultural settlement of sub-tropical and tropical zones, irrigation and drainage in arid zones, tropical forestry development, major hydroelectric developments, land reclamation works in tropical lowland coastal areas, and settlement of nomads in semi-arid zones. The cost of post audits in developing countries should not be imputed to the costs of the resource development projects but financed from separate international sources.

- (b) provide that pilot studies be conducted in representative ecosystems of international significance to assess the environmental impact of alternative approaches to the survey, planning, and development of resource projects;
- (c) prepare a comprehensive assessment and evaluation of the actual and potential environmental effects of water management upon the oceans;
- (d) ensure that a programme to expand present data gathering processes so as to assess the total economic value of wildlife resources, is established.

(ii) Research

202. International support for research, study, and demonstration projects should be mobilized where there are serious gaps of knowledge which individual governments are unable to fill independently or which relate to common property resources.

203. It is recommended that the Secretary-General take steps to ensure that:

- (a) the United Nations bodies concerned co-operate to meet the needs for new knowledge related to the environmental aspects of forest management;
- (b) international development assistance agencies, in co-operation with recipient governments, intensify efforts to revise and broaden the criteria of development project analysis to incorporate environmental impact considerations;
- (c) a study on the relative costs and benefits of synthetic and natural products serving identical end uses be launched;
- (d) the international programme of biosphere research be vigorously pursued;
- (e) a study be undertaken on available energy sources and consumption trends in order to plan for and forecast the environmental effects of future energy use.

204. It is recommended that WMO initiate or intensify studies on the inter-relationships of resource development and meteorology.

205. It is recommended that FAO co-ordinate and strengthen international co-operative research on soil capabilities and conservation.

(iii) Monitoring

206. Co-operative surveys or monitoring systems should be established to assist nations to assess their resources and control possible degradation.

207. It is recommended that the Secretary-General, in co-operation with interested Governments, take the necessary steps to develop further remote sensing techniques in order to implement resources surveys and to ensure that the use of remote sensing devices be shared, where appropriate.

208. It is recommended that the Secretary-General take steps to ensure that
- (a) continuing surveillance of the world's forest cover is provided for through the establishment of an appropriate monitoring system;
  - (b) the collection, measurement and analysis of data relating to the environmental effects of energy use and production is undertaken within appropriate monitoring systems;
  - (c) the effects of pollutants upon wildlife are considered, where appropriate, within environmental monitoring systems.

(iv) Information exchange

209. Large bodies of knowledge already exist in different parts of the world on many natural resource subjects. Measures should be adopted to ensure that the appropriate information is transferred to those who need it and can apply it.

210. It is recommended that the Secretary-General:

- (a) provide the appropriate vehicle for the exchange of information on the environmental impact of mining and primary mineral processing;
- (b) give special attention to providing a mechanism for the exchange of information on the environmental impact of energy processing, transportation and consumption;
- (c) ensure that an appropriate mechanism exists for the transfer of information on park legislation and planning and management techniques developed in some industrialized countries which could serve as models to be made available to any interested developing country;
- (d) provide for the co-ordination of information transfer regarding water-related technologies and techniques now shared by several agencies.

211. It is recommended that FAO:

- (a) strengthen the transfer of information on forest and forest management;
- (b) strengthen, in co-operation with other international agencies concerned, the necessary machinery for the international transfer of experience on soil capabilities, degradation, and conservation.

B. International agreements

212. International agreements are required to regulate the development or use of resources considered to be of direct interest to more than one nation.

213. It is recommended that governments take steps to reach agreements to:
- (a) co-ordinate and co-operate on the management of shared protected areas;
  - (b) set aside for protection areas representing ecosystems of international significance;
  - (c) enact international conventions and treaties to protect species inhabiting international waters or those which migrate from one country to another;
  - (d) sign the proposed convention on the export, import, and transit of certain species of wild animals and plants;
  - (e) sign the proposed conventions on conservation of wetlands of international importance, conservation of certain islands for science, and conservation of the world heritage;
  - (f) give attention to and, where required, implement the guidelines and recommendations on fisheries elaborated by various intergovernmental organizations and international bodies.
214. It is recommended that governments agree to strengthen the International Whaling Commission and to consider an international agreement calling for a 10-year moratorium on commercial whaling.
215. It is recommended that Governments, the Secretary-General and FAO ensure close participation of fishery agencies and interests in the preparations of the UN Conference on the Law of the Sea.
- C. Supporting measures
- (i) Training
216. Training will frequently require support from the international community in order to ensure that the available information is properly applied. Clearly, additional training would be beneficial in nearly all disciplines associated with natural resources management. Special attention is, however, called to the need for training in protected areas which appear particularly barren and in wildlife management.
217. It is recommended that Governments and the Secretary-General give special attention to training requirements for protected areas.
218. It is recommended that the Secretary-General ensure that the appropriate United Nations agencies co-operate with the Governments of the developing countries to develop special short-term training courses on wildlife management.



(ii) Technical and financial assistance

219. It is recommended that the Secretary-General:

- (a) ensure that the United Nations system is prepared to provide technical and financial assistance to governments upon request in water resource management;
- (b) establish a roster of experts who would be available to assist governments, upon request, to anticipate and evaluate the environmental effects of major water development projects;
- (c) ensure that the appropriate UN agencies assist the developing countries to plan for the inflow of visitors into their protected areas, in such a way as to reconcile revenue and environmental considerations.

220. It is recommended that FAO under its programme "War on Waste" place increased emphasis on control and recycling of wastes in agriculture.

D. Organizational recommendations

221. New organizations will sometimes be required to facilitate the management of a common resource or to assist governments with similar resource problems.

222. It is recommended that Governments concerned consider the creation of appropriate multinational institutions in the form of international river-basin commissions, for water resources common to more than one jurisdiction.

223. It is recommended that the Secretary-General take steps to ensure that specialized centres on water-related environmental problems be established.

224. It is recommended that Governments, in co-operation with FAO, strengthen the existing international and regional machinery for development and management of fisheries and their related environmental aspects and - in those regions where these do not exist - encourage the establishment of fishery councils and commissions as appropriate.

E. Comprehensive programmes

225. In response to a particular resource problem, programmes are sometimes required that provide technical and financial assistance at several stages of the process of information acquisition and application.

226. It is recommended that Governments, FAO and WHO, in co-operation with UNESCO and IAEA, strengthen and co-ordinate international programmes for integrated pest control and for the reduction of the harmful effects of agro-chemicals.

227. It is recommended that FAO:

- (a) co-ordinate an international programme for research and the exchange of information on forest fires, pests, and diseases;
- (b) expand its present programme on the stabilization of marginal lands;
- (c) further develop and strengthen facilities for collecting, analyzing and disseminating data on living aquatic resources and the environment in which they live.

228. It is recommended that Governments agree to an International Programme to preserve the world's genetic resources.

229. It is recommended that the Secretary-General, in co-operation with the UN organizations concerned, takes the necessary steps to ensure international co-operation in the research, control and regulation of the side effects of national activities in resource utilization where these affect resources of other nations.