CP—75—6

INTERNATIONAL INSTITUTE FOR IIASA APPLIED SYSTEMS ANALYSIS

CONFERENCE PROCEEDINGS

PROCEEDINGS OF THE UNEP/IIASA MEETING OF EXPERTS ON ENVIRONMENTAL MANAGEMENT

March 11—14, 1975

Hans Knop, Editor

SCHLOSS LAXENBURG

A-2361 AUSTRIA

CP–75–6

PROCEEDINGS OF THE UNEP/IIASA MEETING OF EXPERTS ON ENVIRONMENTAL MANAGEMENT

March 11—14, 1975

Hans Knop, Editor

TABLE OF CONTENTS

AGENDA

One of the principal aims of the expert group is to formulate recommendations to UNEP for the development of its program in the area of environmental management and for research. This should be kept in mind as various topics are discussed.

I. What is Environmental Management?

A. Key issues, definition(s) of environmental management.

B. Underlying values:

- maximize human welfare;
- keep future options open;
- safeguard, restore environment;
- utilize environment at minimum social and environmental cost;
- optimal resource conversion process on a sustainable yield basis;
- optimal mix of products and amenities.

C. Scope of the problem (global, regional, national, local, social, private); time horizon; target of environmental management.

D. Problems of measurement, definition and choice of variables.

II. Strategy of Environmental Management

A. Is the meaning of environmental management different for countries with different types of economic and social systems?

for countries at different levels of economic development?

linkages with international economic system.

B. Relationship of environmental management to traditional approaches of planning and management of socio-economic development;

the question of social cost and benefit of the environment and its use.

C. Environmental management as a condition "sine qua non" for the development process--ways and means of incorporating environmental management at various levels of societal and economic decision-making.

D. Tools of environmental management, e.g.:

- traditional financial and economic analysis;
- models;
- environmental impact assessment;
- stimulative, directive, deterrent instruments.

III. Formulation of Criteria for the Assessment and Evaluation of Environmental Impact of Development Projects

A. Conventional project evaluation-shortcomings.

B. Need to take into account most economic and social aspects of a project in the decision-making process, including direct and indirect side-effects and long-term impact.

C. Criteria for evaluation of environmental impact; how to integrate those criteria on the project level; their consequences.

LIST OF PARTICIPANTS

Prof. B. Bower
Resources for the Future
1755 Massachusetts Ave. N.W.
Washington D.C. 20036
USA

Prof. A. Ciborowski
Instytut Krztaltowania
Srodowiska
Bracka 4
Warsaw
Poland

Mr. H. Dirickx
United Nations Economic Commission
for Europe
Geneva
Switzerland

Prof. F. Fenner
Center for Resources and
Environmental Studies
Australian National University
Canberra
Australia

Mr. G. Harrison
Department of Zoology
Imperial College
London SW 7
UK

Prof. K. W. Kapp
Institut für Sozialwissenschaften
Universität Basel
Petersgraben 29
Basel
Switzerland

Dr. A. Khosla
Department of Science and Technology
Technology Bhavan
New Mehrauli Road
New Delhi - 110020
India

Prof. S-Ch. Kolm
Centre d'Etudes Prospectives
d'Economie Mathématique
Appliquées a la Planification
Cepremap
142, rue de Chevaleret
Paris 13
France

Mr. Ch. de Laet
1193 Phillips Place
14 Montreal
Canada

Prof. A. Molchanov
USSR Acadamy of Sciences
Department of Environment
11 Gorky Street
Moscow
USSR

Prof. H. Mottek
Academy of Sciences for the GDR
Leipziger Strasse 5
108 Berlin
GDR

Dr. O. Soemarwoto
Institute of Ecology
Padjadjanan University
Jalan Banda 40
Bandung
Indonesia

Mr. E. Strauss
Apartado 3638
Lima
Peru

IIASA Staff

Prof. H. Raiffa - Director
Prof. H. Knop - Leader of Large Organizations Project
Dr. B. Sazonov - Ecology Project
Dr. W. Bossert - General Activities Project
Dr. K. Ito - Integrated Industrial Systems/Ecology Projects
Dr. G. Majone - Bio-Medical Project

UNEP Staff, Nairobi, Kenya

Mr. R. A. Frosch - Assistant Executive Director
Mr. B. Gosovic
Mr. J. Hurtubia

WELCOMING ADDRESS

H. Knop, Opening Session Chairman

Professor Knop opened the meeting by extending his greetings and explaining to the delegates how this meeting came about.

At discussions between UNEP and IIASA it was agreed that a panel of experts, including representatives from governments and international organizations, should be convened to assist in formulating criteria for the evaluation of development projects and their environmental consequences. The Organizations project of IIASA, which was dealing with retrospective studies of large regional development projects, agreed to assist UNEP in formal arrangements for such a meeting of experts and IIASA agreed to provide conference facilities.

The objectives of the meeting were described in the following manner:

I. To help establish the basis for a long-range plan of research work aimed at the inclusion of environmental dimensions into economic planning and management techniques;

II. To contribute to the formulation of criteria for the comprehensive evaluation of development projects and their consequences;

III. To delineate the concept of environmental management and draft a report which could serve as an important input into the further work of UNEP in the field of environmental management.

It was emphasized that the meeting would be one of the first steps made by UNEP for developing a comprehensive approach to the complex and still unexplored subject of environmental management. The delegates should strive to identify the problems associated with environmental management, to establish a basis for a research program, and to attempt to define the concept of environmental management.

It was explained that this meeting differed from others that the delegates may have attended in that previous work on environmental management would not be discussed. Rather, the delegates should consider the meeting a starting point for the scientific work to be done at IIASA and other scientific institutions within the framework of UNEP.

It was pointed out that participation in the meeting by IIASA staff was limited in order to ensure very informal discussion. IIASA specialists would be invited to participate in the working groups that would be formed if desired.

Professor Knop then introduced Professor H. Raiffa, Director of IIASA, who would say a few words about IIASA and research at the Institute related to environmental problems.

INTRODUCTORY REMARKS

H. Raiffa, Institute Director

Professor H. Raiffa gave a general introduction to the delegates concerning the history of IIASA and the goals that IIASA was striving to attain. He mentioned that President Johnson proposed in 1966 that an international institute be created for studying the problems of modern societies. President Johnson asked his assistant, McGeorge Bundy, to discuss this proposal with Professor J.M. Gvishiani of the Soviet Union. The basic idea was that a non-governmental institute would best serve this purpose, and that the institute should have healthy balance between East and West. In October 1972, representatives of twelve nations signed the Charter, and by July 1973, the first scientists arrived at IIASA, dedicated to work on significant problems that face mankind.

As one of IIASA's long-range goals, Professor Raiffa then expressed the hope that a network of research institutions with a coordinated research orientation would be established. He was aware that this would be a difficult task to accomplish, but felt that IIASA was on the right road to achievement. He stated that as the alumni left the Institute, they would help to make such coordination more workable. IIASA's other aims were to be a catalyst, disseminator, and critic of research ideas in systems analysis.

Professor Raiffa then commented that the UNEP/IIASA meeting could be considered to be a catalyst for ideas concerning the application of systems analysis to environmental management. By informal meetings of this type, it is hoped that IIASA will be able to contribute to increasing the level of sophistication of technical analysts and policy makers, and to bridge the chasm between scientist and policy maker. It was also mentioned that such meetings would be able to make the specialist and the concerned non-specialist alike aware of the dangers of fragmented thinking on complex global problems.

The structure of the Institute was then described as a very simple one, divided into three main organizational levels. The IIASA Council is the main governing body and is composed of designated representatives from the National Member Organizations

(NMO's), led by an Executive and Finance Committee. The next two levels are the Director of IIASA and the Deputy Director. The Council determines the broad areas of research, and the Director and his associates implement programs coordinated with these research areas.

It was explained that IIASA contains six applied projects --Energy, Ecology, Urban, Water, Integrated Industrial Systems, Bio-Medical--and three supporting projects--Methodology, Computer Science and Large Organizations. IIASA also has a somewhat miscellaneous category composed of General Activities and a state-of-the-art survey concerning systems analysis. The structure was stated to be similar to a matrix system, where the applied projects are located in the vertical columns and the supporting projects are in the horizontal rows (Table 1).

Professor Raiffa expressed the hope that as the Institute matured and had integrating themes, intimate connections would develop among various applied projects, and supporting personnel would permeate through the applied projects. IIASA contains sixty-five scientists working on a number of these projects, and several different task groups within the projects themselves.

Professor Raiffa described what he had talked about so far as "in-house" research activity. He said that if IIASA were to be effective, there were other things that would have to be done. Collaborative research was to be developed not only with UN agencies such as UNEP, IAEA and WHO, but there should be closer collaborative research with national institutions and research laboratories within the NMO countries. Not only was there the responsibility of doing in-house research and collaborative research, but IIASA had to act as an information exchange agency, a so-called clearinghouse of activities. One means of achieving this task was to convene international conferences and meetings. This then was one such meeting, the objective being not so much to exchange information on the solutions of environmental problems but rather to sensitize each other and to arrive at a common understanding of what the important environmental problems really are.

Professor Raiffa then made a short presentation on the activities of the various IIASA projects in relation to environmental issues.

The first project mentioned was Ecology, under the leadership of Professor C.S. Holling. He and his group are trying to develop a new science of Ecosystem Management/Engineering. The Project examined concrete problems by making case studies of them. The first such study concerned an area in New Brunswick,

Table 1.

METHODOLOGY	APPLIED AREAS					
	ENERGY	WATER	ECOLOGY	REGIONAL	BIO-MEDICAL	INDUSTRIAL
Applied Mathematics						
Mathematical Programming						
Control Theory						
Statistics						
Stochastic Processes						
⋮						
Computer Sciences						
⋮						
Managerial Sciences						
⋮						
Behavioral Sciences						
Economics						
Sociology						
⋮						
Legal						
Historical						

Canada, which was infested by a forest pest called the budworm. Other studies undertaken by the Ecology Project are the impact of development on an Alpine area in Austria, and salmon fisheries management in the far western part of Canada. The goal of the Project is to continue the case studies, develop the science of ecological management/engineering further and to consider topics of global environmental concern such as energy and the environment, urbanization and the environment, industrialization and the environment, and the like.

The Energy Project is under the leadership of Professor Wolf Haefele, F.R.G. This Project initially studied the supply and demand of all types of fuels--scenarios of fuel usage, transition from one type of fuel system to another, and the long-term effects of fuel usage. These studies also included environmental effects due to the usage of different types of fuel. Some of the topics concerned nuclear fuels, solar energy, nuclear fusion, geothermal usage, etc. In the first year, the scientists were particularly concerned with the nuclear aspects of energy supply, and at present they are considering solar energy and the use of coal. In 1976 and 1977 the Project will be concerned with geothermal and other types of energy sources.

Further, the Project deals with devising institutional mechanisms for the transition process from fossil to nuclear fuels, and the climatic effects of energy usage such as heat, pollution of air and water, etc. In conjunction with the International Atomic Energy Agency, a project on comparative risk analysis has been undertaken which includes determining the attitudes of societies and the level of risks. Siting problems are also studied, and such items as thermal pollution, urban problems and water supply are being considered.

The Water Project, originally led by Professor Letov of the Soviet Union and now headed by Professor Kaczmarek of Poland, began by looking at the problem of control of international river systems, water supply for agriculture, recreation for urban systems, etc. The Water Project will, in the future, be concerned with the problems of water scarcity.

The Urban Project is led by Dr. Harry Swain of Canada. This Project deals with national settlement policies, migration patterns and what can be done to influence migration to desirable areas. The Project also has scientists dealing with emergency city services such as ambulance, fire, and police, with some work being done on computerized traffic control systems. The Urban Project also hopes to look at resource-conserving techniques in urban design and management.

The Integrated Industrial Systems Project is led by Profs. A. Cheliustkin, U.S.S.R., and I. Lefkowitz, U.S. The Project initially dealt with efficient steel production and included in this program a world-wide survey of steel production and techniques. The Project hopes to work towards the examination of regional/industrial development projects. The results of the Project's efforts will be published in a detailed report.

The Methodology Project of IIASA is involved with two major tasks. The first is helping other projects with techniques of modelling, validation, inference, experimental design and policy analysis. In their work with the other projects they strive to develop common methodological themes for analysis within the project itself. Examples are large system optimization problems, problems of policy and decision analysis with multiple conflicting objectives, examination of trade-offs to be made and the development of new methodologies such as the incorporation of risk analysis with natural and man made hazards. Work has also been done on conflict resolution associated with water resource systems, and on the stability and resilience of systems, especially applied to natural systems.

The Large Organizations Project is under the leadership of Professor H. Knop of the G.D.R. This Project was designed to permeate the activities of the Institute, which will be an important factor in future activities. At present, the Project deals with the problems of management, planning, and decision-making in large organizations and also includes aspects of environmental management. The Project began by studying the large planning projects, specifically the TVA in the United States, and will continue the work done in this regard by comparing the TVA study with a similar long-term planning project in the Soviet Union--the Bratsk-Ilim Program.

The General Activities Project now led by Professor W. Bossert began by reviewing existing global models, documenting the structure of these models, and listing the mathematical techniques employed. The next phase will be a concentration on food and agriculture models--a review of the present global model in use, with the idea of obtaining the scientific documentation and having the computer software available for further scientific study at the Institute.

The Survey Project is under the guidance of Dr. R. Levien of the United States. Its main purpose is to determine, systematize and disseminate the international state of the art of applied systems analysis. This also includes such items as the foundation of systems analysis and source materials including references and bibliographies. State-of-the-art surveys on various problems will be published as well as a handbook on systems analysis and techniques in audio-visual communication.

Professor Raiffa then said a few words concerning the collaboration of IIASA with UN agencies such as UNEP, UNIDO, WHO and FAO. He said that there would be collaboration with UN projects which would prove to be mutually beneficial. In the case of UNEP, IIASA is grateful for the support they have given various projects, and for the discussions that have taken place. The support and the discussions have brought IIASA closer to UNEP and other UN agencies, and in the future one of the main themes to be pursued by IIASA will be the interaction of environmental concerns with the management of urban and industrial complexes and others of a similar nature.

INTRODUCTORY REMARKS

R. Frosch, Assistant Executive Director of UNEP

Mr. Frosch began by relating his background and interests with regard to environmental management. He said that he was delighted to be cooperating with IIASA, not only at this particular meeting, but also in other projects of mutual interest. He further stated the following:

"Environmental management is a term that existed before the Stockholm Conference on the Environment in 1972. It existed as a rather vague set of ideas concerned with the mixture of environmental factors in planning and management and developmental concerns, but without any great precision in either definition or content. This meeting should be considered as an initial stage for UNEP. Consider the title 'environmental management' and perhaps give us the beginning of a taxonomy of ideas that are involved in this, and perhaps also some definitions and suggestions for a program of work that might further elaborate this set of ideas that could be turned into a proper program that would have the right kind of content and direction.

I think it is clear from the discussions of the first session that each of us has some qualitative and sometimes quantitative ideas that bear on the subject, but collectively we do not at this point have a set of detailed definitions and categorizations of what should be done. I think this is the real objective of this meeting."

RESOURCE MANAGEMENT VERSUS ENVIRONMENTAL MANAGEMENT (SYNOPSIS)

H. Knop

The environment consists of two parts: the natural environment and the man-made environment. Where the influence of man occurs, the quality of the environment usually decreases. All aspects of the environment are related to a system of human satisfaction--how much degredation a society or a group of people will tolerate. This may allow the environment to deteriorate to a "catastrophe" situation. We have no direct means of determining the satisfaction level, but we can measure indications of a decrease in this level. These indicators may be such items as the total outmigration from an area, an increase in the rate of suicide, and increase in the cost of cleaning water for production purposes, etc. It must be understood that environmental management cannot be limited to cost/benefit analysis; human satisfaction levels must also be taken into account.

All systems must make decisions, and thus we need yardsticks for measurements on which to base decisions. In the world we have today, these decisions are usually economic in nature. When a society wants to include environmental problems in the decision-making process, these must be discussed in economic terms. For this, the decision makers need measurable quantities. Ideally, these decisions should reflect the various levels of perception of problems concerning the environment. The chart below gives an indication of what perception levels may be included in a decision.

NATURAL ENVIRONMENT	INDIVIDUALS	SETTLEMENTS	REGION	NATION	MULTI-NATIONAL
AIR					
WATER					
SOIL					
SOCIETAL SETTLEMENT					
DENSITY					
TRAFFIC DENSITY					
....					
....					
....					

This array of perceptions would then allow decision makers to develop a system of environmental aims or goals which are basically objective in nature. In this way, decisions concerning environmental management could be better optimized to reflect the level on which problems of environmental management interact.

Decision makers at the present time have difficulty in relating their decisions to environmental management considerations. This is largely due to the fact that research of various aspects of environmental management are inadequate or non-existent. Research on the following topics is needed to provide decision makers with information on which to base sound and objective decisions on environmental management.

1. Standards--These could also be considered as normative. It would reflect a satisfaction level which could be reached and tolerated by the various sub-groups of a societal system.

2. Thresholds--Would be defined as a catastrophe level, or the point where irrevocable damage would be done to an environmental system.

3. Measurements of Social Impact--An important characteristic of any decision process, and perhaps the one that needs the most work at the present time.

4. Combined Evaluation of Effects of Environmental Factors--Stresses the fact that environmental factors represent an environmental system, and that individual parts of the system cannot be treated in a vacuum: an ecological approach to the environment.

5. Costs and Investments Caused by Deterioration of Environmental Conditions and by Environmental Protection--An important aspect of decision and systems analysis.

6. Embedding in Regional and National Development Problems--Represents the trade-offs to be made concerning environmental quality and economic and industrial expansion.

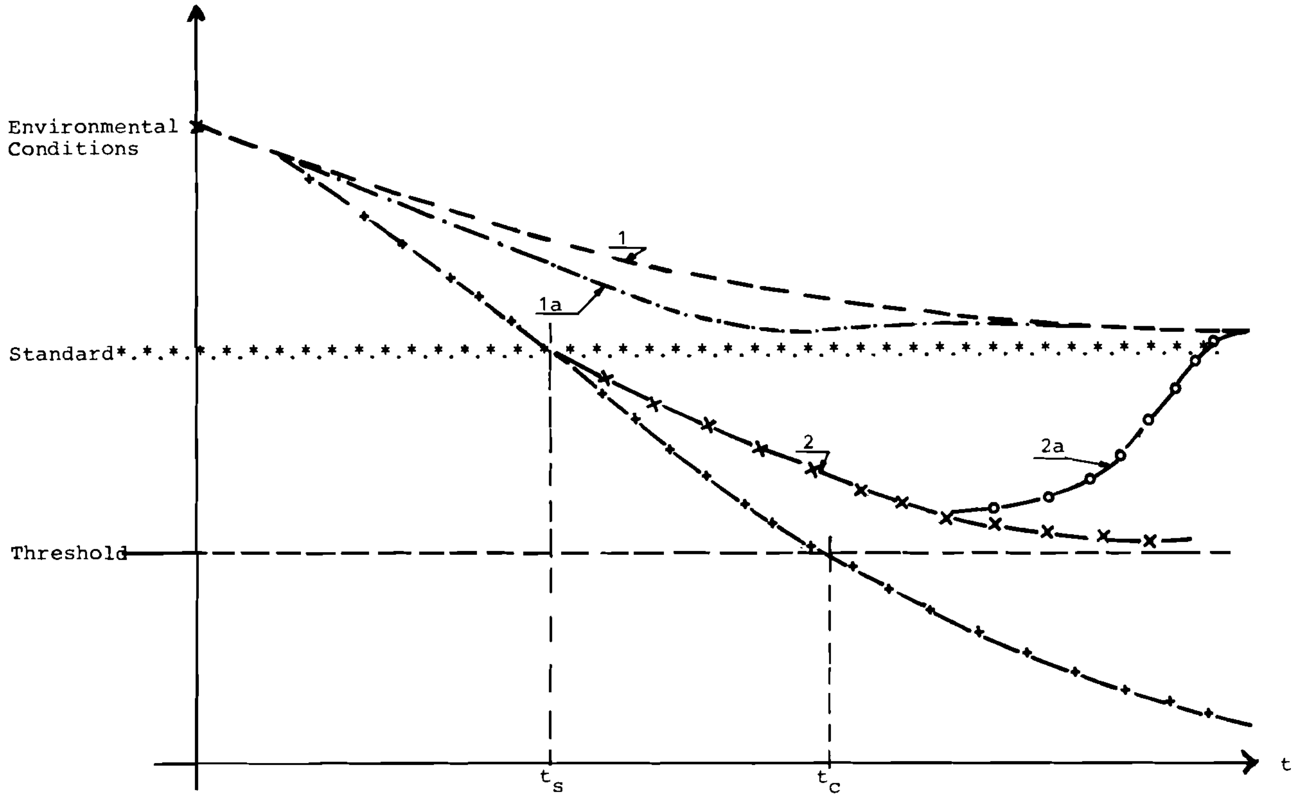
7. Evaluation of the Timing of Environmental Activities--When dealing with future scenarios, this becomes an important characteristic in the decision process. It should help to determine the ideal time to initiate environmental activities so that environmental quality remains within the determined standard.

Figures 1, 2, and 3 show how the above research problems could be combined to aid in decision-making. The figures should be considered as a unified whole. Figure 1 represents a conjectured schema which relates a decrease in environmental conditions, or environmental quality, to proposed action along time scale $\underline{t}$. Line No. 1 depicts actions taken at $t = 0$. In other words, environmental conditions are incorporated into a planning and decision process from the beginning of a planned project. It is assumed that if this is the case, environmental conditions may be allowed to deteriorate, but only to the level of a pre-determined standard. Line No. 1a in Figure 1 depicts a proposed action concerning the environment that is allowed to be taken at a later point along time scale $\underline{t}$. Again, environmental conditions are allowed to deteriorate, but not below the pre-determined standard.

Figure 2 relates the possible results of the actions shown in Figure 1. Line No. 1 depicts the additional costs attributed to including environmental quality aspects from the beginning of a proposed project. Line No. 1a depicts the likely increase in investment if action is delayed along the time scale $\underline{t}$. In order to stay within the limits set by the standard, intensive investments concerning environmental quality would have to be concentrated over a relatively short period.

Lines 2 and 2a depict action which is considerably delayed, and Figure 3 shows likely increases in costs which may be attributed to this course of action. It should be noted that lines 2 and 2a represent actions undertaken when environmental conditions deteriorate below the level of the pre-determined standard; 2a represents the increased activities and investments needed to achieve environmental conditions above the standard level, and 2 represents the efforts in activity and investments needed to avoid the catastrophe situation.

The scenarios presented are conjectures dealing with environmental conditions and corresponding investments. We do not have enough experience to assign actual values to the variables which would be utilized in compiling such graphs for the use of decision or policy makers for environmental management. It is becoming evident, however, that delays in incorporating environmental considerations in programs and projects may result in a much higher total allocation of funds than if environmental considerations were planned for and incorporated from the outset. Determining the real environmental costs and the resultant courses of action which may be attempted would benefit both the policy and decision makers and allow environmental management to become more than a nebulous term.



t_s = t Standard
t_c = t Catastrophe (irreversibility)

Figure 1.

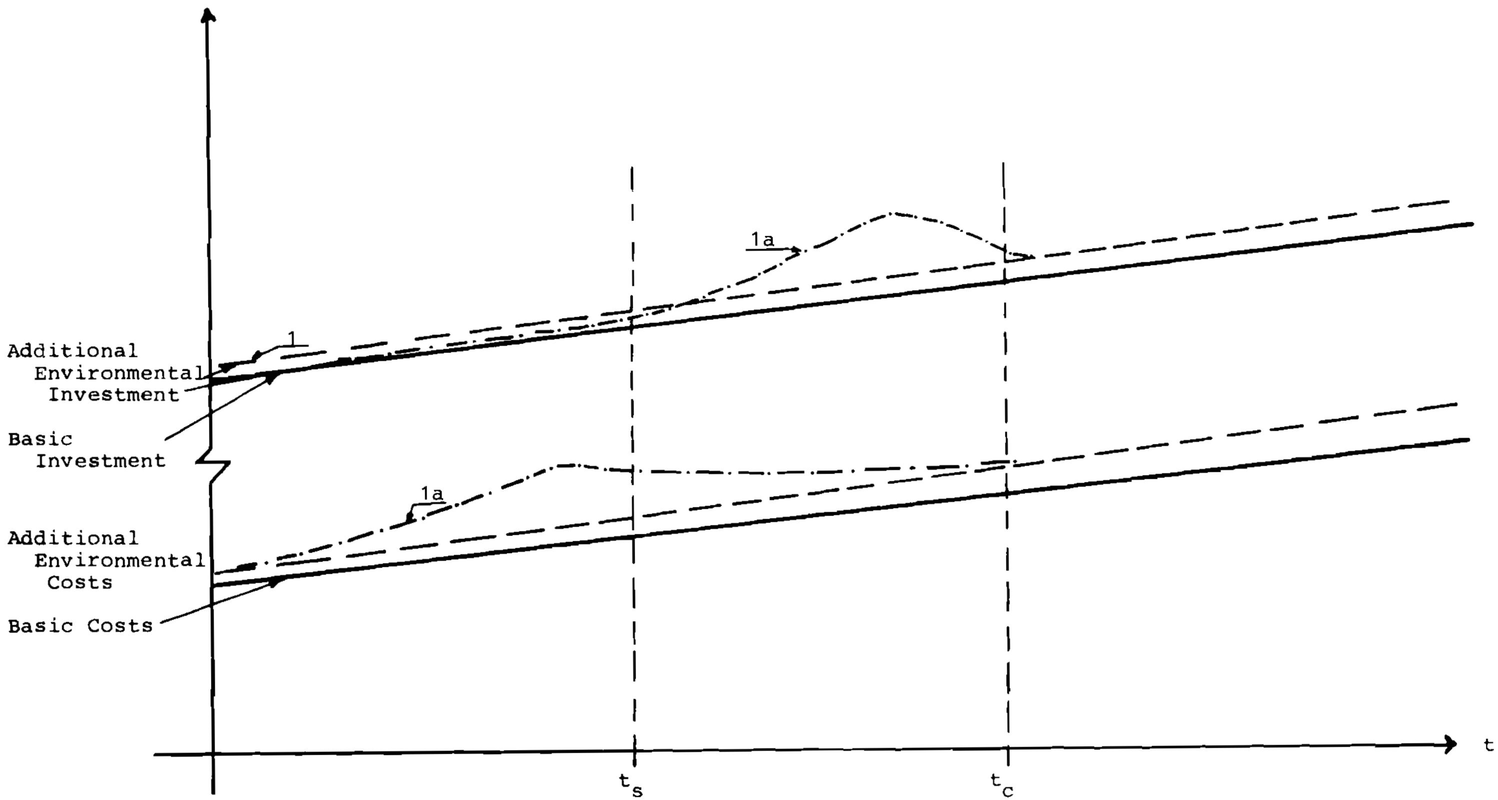


Figure 2. Relation to curves 1 and 1a.

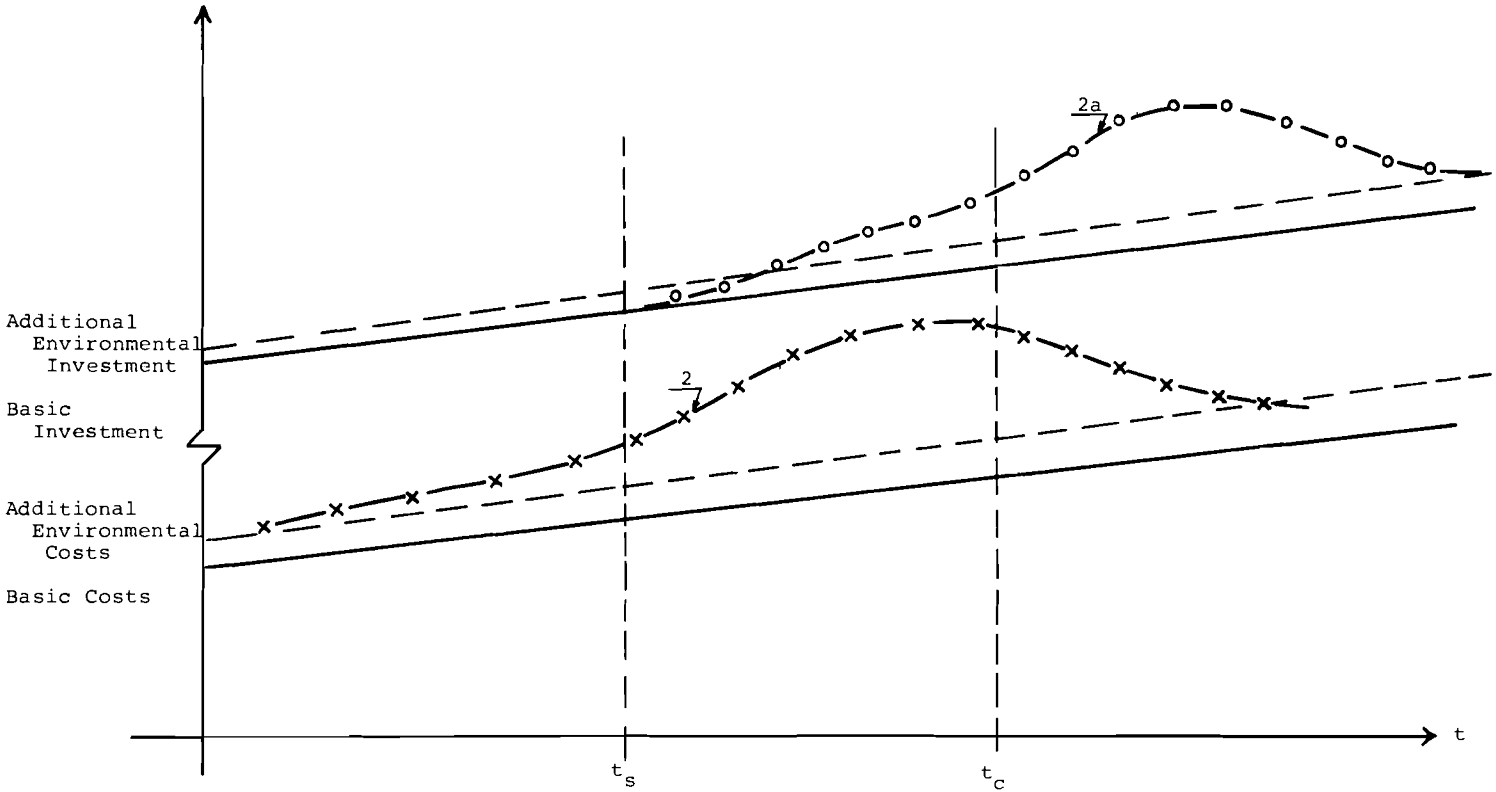


Figure 3. Relation to curves 2 and 2a.

WORKING GROUP REPORT

B. Bower, Chairman

The group's discussion focused primarily on how environmental considerations can be more adequately incorporated in all decisions, both those made by agencies directly reponsible for environmental management, such as a ministry of environmental protection, and those made by agencies and activities whose primary objective is to produce a product or service other than environmental quality, such as a ministry of agriculture, transportation agency, steel plant.

Environmental management comprises a set or some combination of technological options, implementation instruments, and institutional arrangements directed toward maintaining the productive capacity of ecosystems and toward achieving whatever goals are specified as "environmental quality" targets. Examples of such targets, expressed in quantitative terms, are: minimum dissolved oxygen content of rivers; maximum nitrate concentration in ground water; maximum concentration of SO_2 in the air; preservation of wildlife, wilderness areas, unique ecosystems; amount of space per dwelling unit or family, etc.

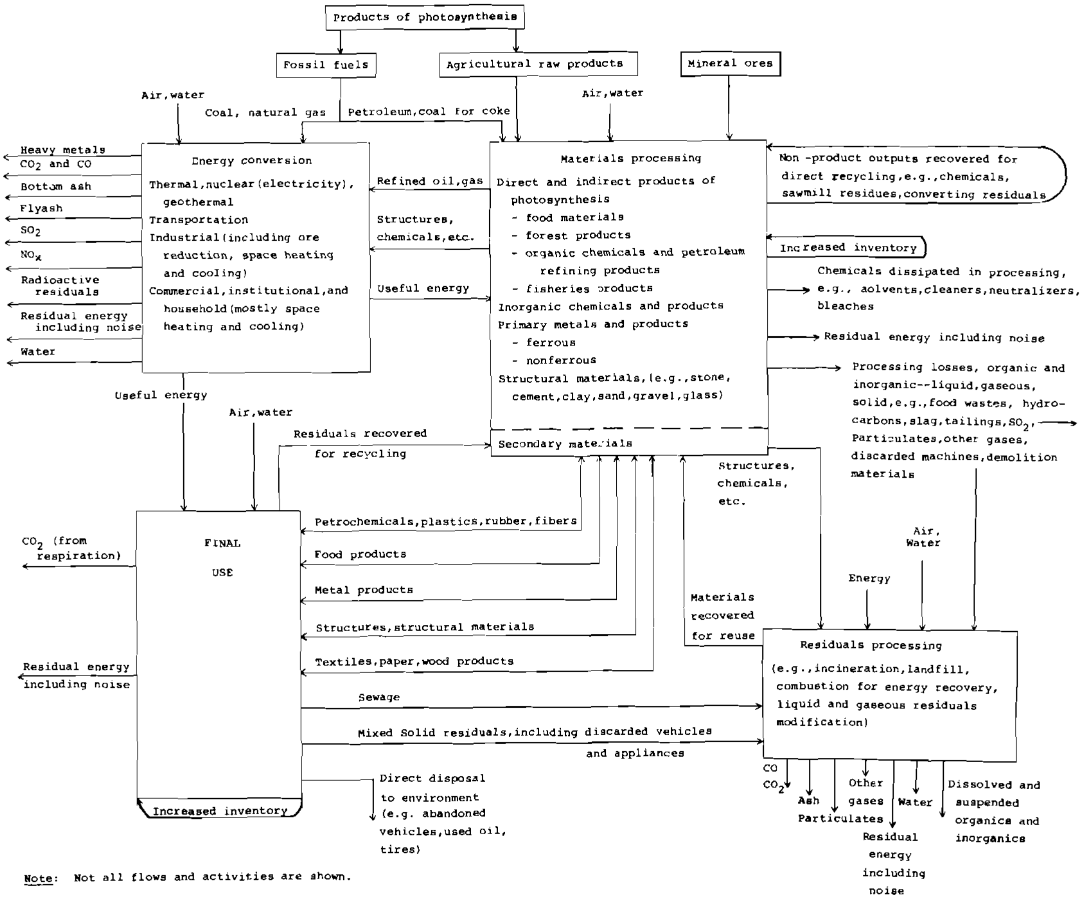
Decisions concerning environmental management are made at the following levels:

- Individual activity (industrial plant, mine, farm, household);
- Municipio or rural district;
- Region (however defined, i.e., in terms of political, hydrographic, or economic boundaries);
- National;
- Multi-national.

Decisions on each level interact. Thus, analysis at the microlevel of possible activities and responses, i.e., to environmental constraints, yields information for the elaboration and analysis of economic development and environmental quality management strategies at the regional level, which in turn provides information for interregional and national (macro) level analyses.

The environmental quality sector can be subdivided in various ways in relation to decision-making concerning environmental management; for example, occupation health (industrial hygiene), urban design, vector control, residuals management. In order to make the discussion more operational, assume that ambient environmental quality (AEQ) refers to natural environmental systems: biosphere, water bodies, surface and ground, and the atmosphere. The conditions of these systems can be described in terms of specific measures such as concentrations of materials and fish biomass, and in terms of aggregate measures such as stability and resilience (remembering that natural systems involve stochastic phenomena). All natural systems have some capacity to assimilate materials and energy discharged into them. These discharges are the residuals from human activities, where a residual is a non-product output whose value is less than the cost of collection, transport, and reuse in a society at a given point in time. (Thus, the definition of residual is time-dependent, as a function of the relative costs of alternative raw materials and the state of technology.) The "totality" of material and energy flows in a society--at whatever level of development--is illustrated in Figure 4.

Therefore, AEQ = f(SP, FD, POS, RM, T, REQM St), where SP = spatial distribution (pattern) of economic activities; FD = final demand, i.e., the total bill of goods and services desired by society at any point in time; POS = the specific characteristics of the products and services composing FD; RM = quality of raw materials; T = technology; and REQM St = the residuals-environmental quality management strategy adopted. The technology variable can usefully be subdivided into technology of production process, technology of raw material extraction, technology of materials recovery, technology of by-product production, technology of residuals modification, etc. This subdivision is illustrated in Table 2.



Note: Not all flows and activities are shown.

Source: Modified from 1969 Annual Report, Resources for the Future, Washington, D.C., p.26

Figure 4. Materials and energy flows.

Table 2. Preliminary Taxonomy of Technology.

TPP = Technology of "basic" production processes, where a production process typically consists of a set of unit processes and operations.

Examples: Steel making--open hearth, basic oxygen furnace, electric furnaces, ingot casting versus continuous casting;

Pulp manufacture--sulphate, magnefite (magnesium sulphite), refiner groundwood;

Logging--drag by tractor, high-line, balloon;

Agricultural production--monoculture, multiple cropping; dry, irrigated; settled, "slash and burn" shifting; artificial fertilizer, natural fertilizers; synthetic pesticides, biological pest controls;

Energy generation--solar, wind, geothermal, fossil fuel steam, nuclear steam;

Fish production--natural water bodies, hatcheries, aquaculture.

TMRI = Technology of materials recovery by changes in internal processes and/or operations.

Examples: Chemical recovery in sulphate pulping, recirculation of flume, water for conveying peaches in canning peaches.

TMRE = Technology of materials recovery by processes at "end-of-the-pipe."

Examples: Lime particulate recovery by venturi scrubber from lime kiln of sulphate pulp mill; fiber recovery in white water system associated with paper machine.

TBPP = Technology of by-product production.

Examples: Monosodium glutamate from beet sugar production residuals; yeast from sulphite pulping waste liquor; pet food from tomato pulp; animal feed from cheese whey.

TRESRH = Technology of residuals handling before processing or modification (other than of volume).

Examples: Design of facilities for separation of solid residuals at the point of generation, i.e., paper residuals in an office building; compactor units for solid residuals for use in apartment buildings; design of solid residuals collection equipment.

TRESP = Technology of residuals processing to produce a raw material or energy.

Examples: Technology for stripping used wire; technology for removing impurities from obsolete steel products; technology for baling used corrugated containers; design of power plants to use mixed solid residuals as component of fuel; technology for generating methane gas from manure; reclamation technology.

TRESWT = Technology of residuals modification by "waste treatment," with no materials or energy recovery.

Examples: Conventional sewage treatment plants; oxidation ponds.

TEQM = Technology of direct modification of ambient environmental quality.

Examples: Augmenting flow of rivers during low-flow periods; artificial aeration of rivers and lakes; planting trees for wind barriers.

Notes

1. There is a continuum with respect to which technological changes can be installed, abstracting from any capital availability problems of the individual plant (enterprise, firm) and from any problems of equipment and installation availability. There are those technological changes which can be made in a few months--in some cases in even less time--such as changing the catalyst used in the production of a chemical, or the installation of a recirculation pump and pipe on a fluming operation in a cannery. At the other end of the continuum are those technological changes involving large capital investment and relatively long installation time, such as a shift from open hearth to BOF steel-making, or from ingot casting to continuous casting.

2. "New" technology or "available" technology can be categorized: (a) those technological options which exist, in full-scale operation, in one or a few operations--industrial, agricultural, silvicultural; (b) those which have been demonstrated in full or partial scale pilot plants; and (c) those which have been demonstrated only in laboratory operations.

I. Decision-Making Process with Respect to Environmental Management on the Regional Level

Objective: Ensure that environmental quality considerations are "adequately" taken into consideration in development planning.

Current efforts to take environmental impacts into account in planning and development decisions often are ineffective because environmental factors are "put on the table" too late in the decision-making process. If they are introduced only at the end (after other objectives have been "optimized"), and stated--as a practical matter--in the form of constraints, the "environmentally better" options are unlikely to be considered at all. The plan will have acquired a form and a backing that discourage any but the most superficial change in the choices already made. Yet fundamentally different options may be exactly the least cost development alternatives to assure sound environmental management.

Possible starting points for the analysis are:

A. Specification of a set of outputs to be produced in the region, based on preliminary interregional allocation made at national level, by a more or less rigorous procedure (preliminary, to permit revision based on effects on interregional location decisions of meeting AEQ targets);

B. Open-ended regional development, i.e., possible sets of outputs which might be produced in the region; and

C. Specification of an objective, such as: increase available food per capita with specified composition, for whatever population level in the region is desired (or is projected).

For each of these starting points, a set of environmental quality targets is specified.

Procedure A:

1. For the specified set of regional outputs, project the related spatial distribution of activities in the region over the time horizon of the planning, for whatever set of values of the decision variables is used. (Thus, alternative scenarios, i.e., different combinations of values of the decision variables, should be developed for analysis.)

2. For each scenario, determine the environmental impacts, including both short-run and long-run risks, under whatever residuals management strategy is assumed. Both immediate and cumulative impacts need to be assessed, with special attention to the question of irreversibility.

3. Compare the resulting ambient environmental quality (AEQ) with the desired AEQ, or AEQ_T (the target values).

4. If the resulting AEQ does not meet AEQ_T, analyze alternative management strategies to achieve AEQ_T and estimate the costs of each. The alternative strategies should be evaluated not only in terms of total costs, but in terms of distribution of costs and distribution of benefits among population groups.

5. Select a strategy for residuals management based on specified criteria, such as minimization of direct and indirect costs to achieve AEQ_T with some specified degree of certainty; equitable or politically selected distribution of costs; desired equitable or politically selected distribution of benefits; effectiveness; administrative costs.

Procedure B:

1. Specify a desired set of AEQ_T.

2. Specify alternative scenarios for the region, i.e., combinations of SP, FD, POS, RM, T, REQM St. These scenarios reflect alternative types and levels of development, "life style," residuals management strategy, etc.

3. Analyze each scenario to see whether or not AEQ_T is achieved.

4. Propose and analyze alternative sets of AEQ_T, thereby providing information on trade-offs among different outputs, including environmental quality.

For all procedures an essential and difficult problem is to ensure that the range of possible options[1] is included in the analysis. For example, a final demand for a quantity of food should not be taken to prescribe an unalterable mix of rice, wheat, animal protein, etc., as a constraint on planning.

---

[1]Broadening the range of options is necessary for both the "planner" and the decision maker. The latter can sometimes be convinced to change his perspective if he can be shown that the proposed REQM St will achieve the desired goals at less cost, and with minimal disturbance to the political system, than the "traditional" strategy. With respect to the planner, the problem is to broaden his perspective to include all of the technological options--from simple to complex--which are available to his society at the time.

So taken, it could unnecessarily limit the range of choice of land use and/or of cropping systems, possibly making the goal of environmental management technically infeasible or prohibitively expensive. Similarly, alternative technologies of production need to be considered alongside and in close interaction with technological options for handling residuals and with alternative specifications for products, alternative spatial distributions of activities, etc. The typical result on costs of broadening the range of options is illustrated in Figure 5.

In many cases it will be impossible to estimate even the short-run effects on AEQ, because of a lack of environmental models predicting how residuals discharged into the air, water, and land over time and space will affect AEQ through the various transformation mechanisms involved. Nevertheless, some rough indication of relative impacts on AEQ can be derived from determination of the amounts and types of residuals discharges under alternative strategies. In some cases the AEQ at a previous point in time can be used as a qualitative reference point or baseline. If, for instance, air quality in Los Angeles in 1940 is considered acceptable, the quantities and types of gaseous residuals discharged into the Los Angeles airshed at that time can be estimated and established as a target limit for discharges under alternative scenarios for the future.

Analytically, both AEQ_T and such variables as SP, FD, POS, can be considered constraints, and the opportunity costs of each constraint calculated. Thus, the opportunity cost of any particular set of AEQ_T can be estimated, as can the opportunity cost of any particular FD. While conceptually there is no problem in analyzing virtually all of the variables as constraints, too often in practice defining, for example, a particular production function technology as a constraint has resulted in the failure to consider alternative technologies.

In some situations the environmental management strategy is comprised of imposing specific discharge standards--or other direct constraints--on all point and non-point sources, i.e., kilograms of phenols discharged per ton of steel produced, kilograms of suspended sediment per hectare of forest harvested. In such situations the types and quantities of residuals discharged, and the associated residuals management costs, can be determined directly for any scenario chosen for analysis. If environmental models exist, the resulting AEQ can be estimated and compared with the AEQ_T.

II. Implementation in Environmental Management

Environmental management requires a combination of implementation instruments plus institutional arrangements to impose them, in order to induce the residuals-generating

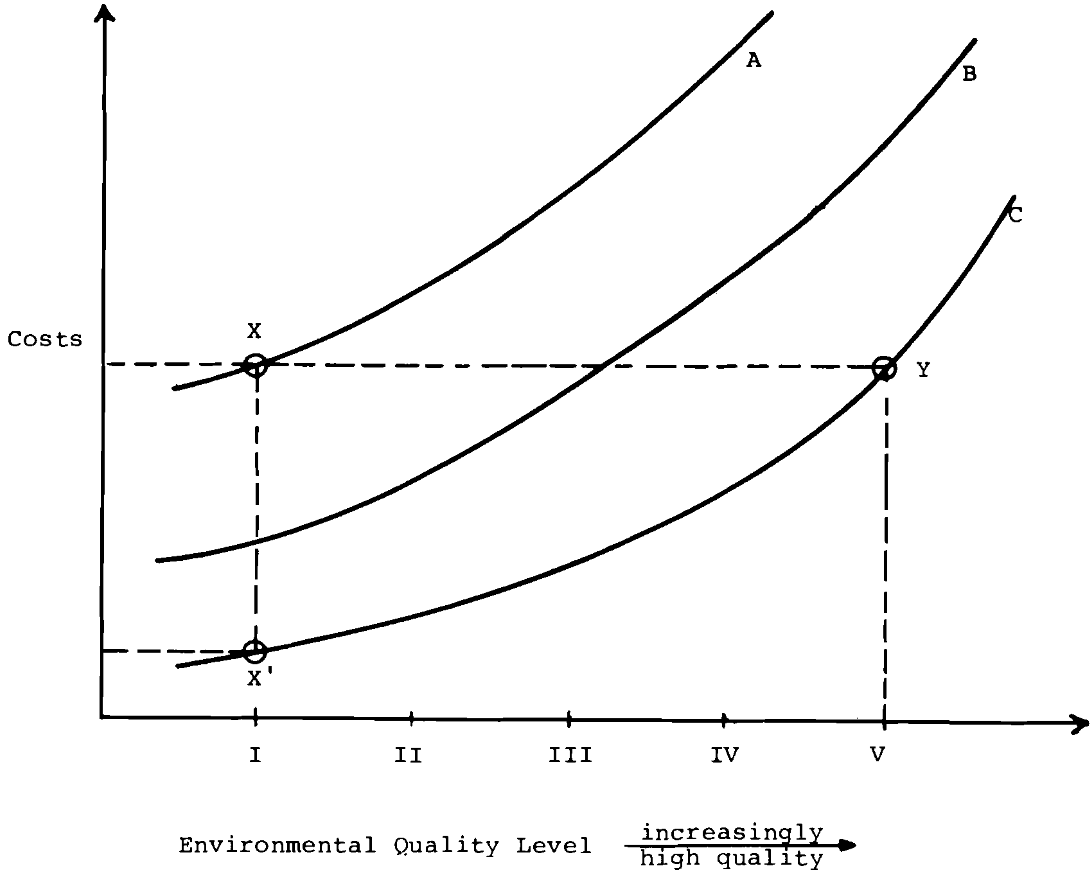


Figure 5. Relationship between level of environmental quality and costs.

Note: 1. Each environmental quality level, i.e., I,II,etc., represents a vector of indices.

2. Curve A represents a scenario which assumes no changes in SP, FD, POS, and T. Curves B and C represent scenarios which assume consideration of an increasingly wide range of technological options and modification of "life style", i.e., production processes and final demand, which impose fewer demands on ecosystems.

3. The same level of environmental quality can be achieved with wide differences in costs, i.e., X' compared to X. The same cost can yield widely different levels of quality, i.e., X compared to Y.

activities to adopt the optimal set of technological options[2] (that set which will control residuals within selected limits, reduce risks, and maintain or--especially in developing countries--increase, output). Figure 6 illustrates the elements in the development of regional environmental management strategies. (The same elements are involved at other levels, i.e., municipio, national.)

Implementation instruments (means to effect management decisions) can usefully be divided into direct and indirect. Direct instruments are those which prescribe, proscribe, specify particular behavior: e.g., install a secondary sewage treatment plant, keep cattle off certain range lands, do not produce non-returnable containers, cut no more than so many hectares per year of a forest area, put no more than 8% phosphates in detergents. Indirect instruments are those which attempt to induce desired responses either by appropriate monetary rewards or penalties, or by affecting behavior through education, propaganda, appeal to social norms, example, etc.

The availability and effectiveness of various implementation instruments and related institutional arrangements will clearly differ according to what is to be done by whom in what social, political, cultural context. The world as a whole has relatively little experience with the deliberate use of indirect implementation instruments to achieve goals of environmental management. Generally, nations have depended so far on the more obvious of direct measures. Little is known about the applicability to developing countries of even the few incentive schemes, in the form of charges or taxes, that have been tried in some developed countries. Thus there are several important questions. What types of implementation measures and institutional arrangements are most relevant to developing countries, and to developed countries? What criteria should be used for choosing among the possible implementation instruments: administrative costs, equity, economic efficiency, effectiveness, flexibility, etc.? How do implementation measures at the municipio, regional, and macro (national) levels interrelate, and are there some instruments which are more relevant at some levels that at others? These are, as noted below, appropriate issues for study and perhaps experimentation.

III. Research Topics of Importance in Improving Environmental Management

What measures of general welfare are available which explicitly incorporate environmental aspects, and how can they be used as internationally comparable measures of development,

---

[2]It should be emphasized that the optimal set may include prohibition of use of some types of technology and the production of some types of products.

PROBLEM ANALYSIS AND IDENTIFICATION		ALTERNATIVE STRATEGY FORMULATION			EVALUATION
SOURCES	RESIDUALS	TECHNOLOGICAL MEASURES FOR CHANGING, MAINTAINING AEQ	IMPLEMENTATION INSTRUMENTS	INSTITUTIONS	EVALUATIVE CRITERIA
POINT: Industry Energy Conv. etc. LINE: Transportation etc. AREA: Agriculture Residential Mining Silvaculture etc.	GASEOUS: CO HC NO TSP SO_2 etc. LIQUID: SS TDS BOD DO Pesticides etc. SOLIDS ENERGY: Heat Noise etc.	Final Demand Modification Raw Material Input Changes Energy Input Changes Production Process Changes Product Output Changes Environmental Control Technology Application Spatial/Temporal Redistribution of Activities/Residuals Assimilative Capacity Modification Environmental Quality Specification Modification etc.	Tax Policy Economic Incentives Grants Subsidies Zoning Capital Improvements Programs Standards-setting Emissions/Effluents Limitations Emissions/Effluents Charges Specifications Permits Compliance Schedules Education Social Norms etc.	Public: Federal State Region Local Executive Legislative Judicial Private	Environmental Effects inter/intra-media energy use land use ecosystem Economic Impacts private social Timing Considerations Administrative Consid. Legal Considerations Political Considerations Public Responsiveness etc.
Describing and predicting the residuals generations and discharge patterns over space and time		Defining <u>where</u> management interventions can be made in the residuals generation/discharge "system"	Specifying <u>how</u> and through <u>what mechanisms</u> the controls can be implemented	<u>Who</u> has or can <u>obtain</u> the legal authority to implement	How effective? At what cost? Distribution of costs and benefits

Figure 6. Regional environmental management.

as infant mortality and illiteracy rates have been used as measures of societal health and education, respectively? For example, could the GNP measure be modified to serve such a purpose by subtracting residuals management costs and environmental damages (where residuals management costs include both the cost to reduce the discharge of residuals and defensive expenditures, i.e., those costs incurred to protect oneself against adverse environmental quality)?

In developing countries, the overriding social objective may be to increase production of food and shelter. The indices of AEQ often used in developed countries are considered irrelevant under such conditions. Instead of asking what are the environmental quality implications of alternative development patterns to achieve the desired increases in production, the question should be framed: what are the implications for long-run (and short-run) "productive capacity" of the alternative development patterns? The research problem is to develop an operational concept of productive capacity which would include such elements as yield over time, the susceptibility of the system to extreme oscillations, ability to assimilate residuals, etc.

We can estimate the "environmental implications" of alternative development patterns, where a development pattern is some combination of SP, FD, POS, T, RM, and where environmental implications are measured in terms of the quantities of different residuals generated and discharged, a proxy for environmental effects (quantity of material and energy residuals discharged per unit of output, e.g., per ton of steel; or per unit of raw product processed, e.g., per barrel of crude petroleum). Similarly, the environmental implications of alternative development patterns can be assessed in terms of the total materials and energy throughput required--both aggregate, and per capita and per unit of product and service.

What are the political and bureaucratic conditions, in countries at different levels of development, that facilitate or hinder the embodiment of environmental goals in economic development, in both planning and implementation? (Included are regulatory agencies at all levels; educational activities; governmental structure and staffing; review procedures in decision-making processes; environmental ombudsmen; advisory committees/task forces; etc.)

What are the advantages and disadvantages of alternative implementation instruments for different societies, and at different levels--municipio, regional, national--within a given society, with respect to:

- Flexibility;

- Effectiveness;

- Equity;

- Economic efficiency;

- Administrative costs;

- Second, third, nth round effects--economic and environmental?

More and more studies addressing the issue of economic development and environmental quality, such as the U.N. "Study on the Impact of Prospective Environmental Issues and Policies on International Development Strategy," involve the use of coefficients to characterize inputs to, and product outputs and residuals from, various production processes and other activities. Because of the lack of data for coefficients for the developing countries, recourse in such studies generally has been to use U.S. and/or European coefficients, modified by judgement. Even where the basic level of technology utilized by the developing country is similar to that in developed countries, the different conditions can lead to very different coefficients. In addition, and perhaps more important, the range in technology in developed countries does not include many of the options in use in the developing countries, with respect to both basic production processes and residuals management options. An example is the individual dwelling unit or village oxidation-fish pond. Thus what is needed is a program to develop and compile such coefficients for a wide range of activities in the developing countries. Although not a "research" task in the strict sense, it is an important task and one which will require major effort and ingenuity to accomplish. It would provide essential inputs into the plethora of analytical efforts currently under way and others which will be undertaken in the future.

WORKING GROUP REPORT

A. Ciborowski, Chairman

I. Environmental management we would like to understand as the management of the development of the environment undertaken by man for human benefit, and therefore as the art of balancing socio-economic, technological and ecological forces in the development of resources to fulfill human needs of present and future generations.

II. The management of environmental development consists of:

A. An analysis of the environmental situation and its feedback on man by a cognitive evaluation system and translation of the results into social and economic goals;

B. A translation of social economic goals of development into environmental patterns of development;

C. Formulation of a balanced program for the evolution of man-made and natural environment;

D. Guidance and supervision of the implementation process of such a program.

III. The program for physical evolution of environment consists of:

A. Addition of new man-made components to the environment;

B. Protection of those existing components and qualities important for human well-being;

C. Restoration of those components and qualities damaged by past human and natural actions.

The sequence of the environmental management process has to start with the identification of the problem. This implies taking cognizance of the lack of satisfaction of basic human needs of an environmental character. In order to do so, it will be necessary to systematically observe and analyze the interdependencies of the many factors and outcomes as well as the effects on human satisfaction. These observations need to be integrated into the decision-making processes; up to now this has not been the case. Even some informal increased awareness of environmental information on the part of decision makers would be an important first step in overcoming these shortcomings. In the long run, however, systematic monitoring and assessment will be essential if decision-making is to take account of environmental issues (see Figure 7).

Needless to say, the process of decision-making will depend on the socio-economic and political system. However, irrespective of the system (see Figure 7a), it is essential that project makers (or planners) put forward alternative projects offering alternative technologies and sites which are ecologically appropriate.

The national economic policy of any country may be translated, depending on the socio-political system, into national, regional and local comprehensive physical development plans and/or into specific projects for single investments. In some cases, the process of translation is indirect, using legal and fiscal pressures (see Figure 7b).

Policy makers should consider, amongst the factors that affect environmental conditions, the influence that different technologies and other development instruments might have on the balance between population and natural resources through its effects on the productivity and employment structure of less developed countries.

The environmental development programs represent some internal conflicts. They should be solved through the managerial process of planning and development. Examples of such conflicts are:

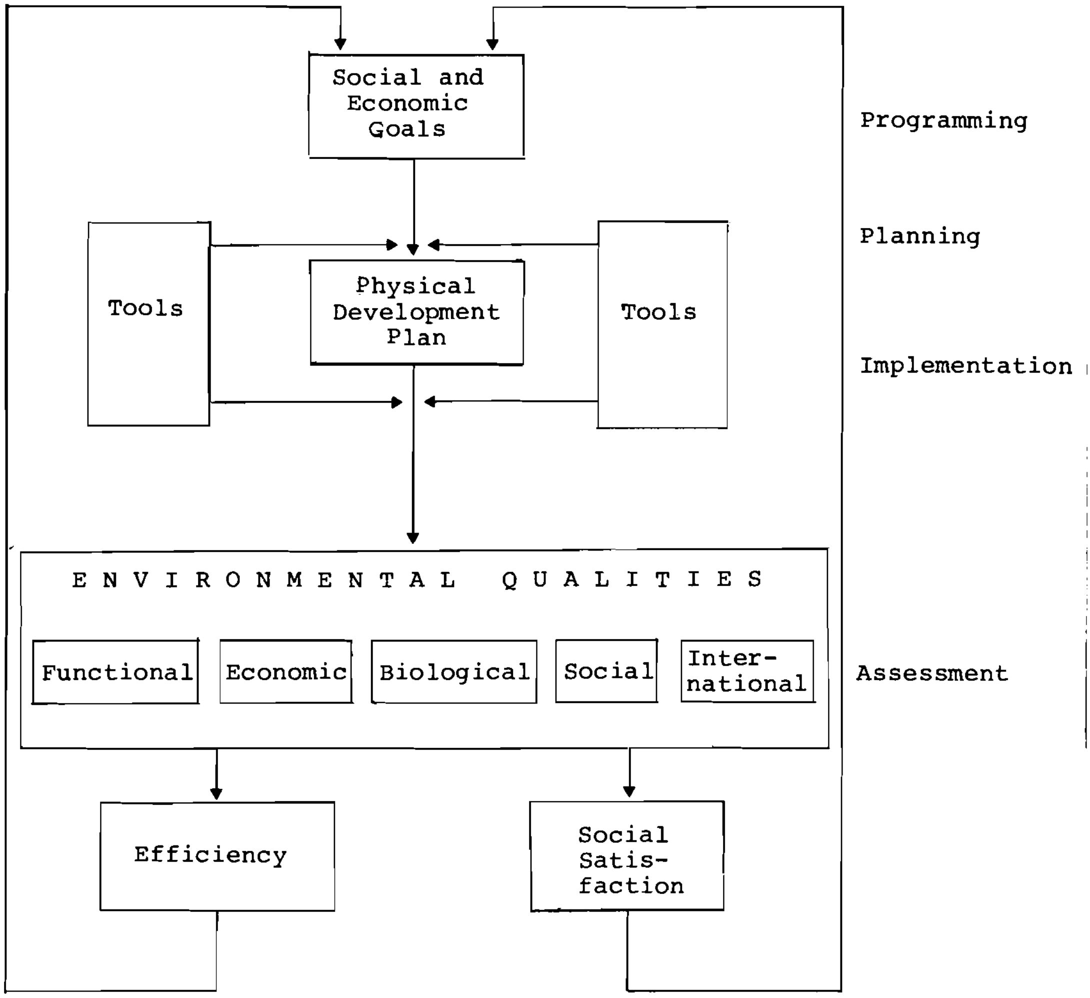
1. Conflicts between short- and long-term aims, needs and possibilities (specifically intergeneration conflicts);

2. Conflicts among different development goals;

3. Conflicts among different levels of interest, such as global, national, regional, local, and group or individual;

4. Conflicts between man-made and natural components of the environment;

5. Conflicts between those who share the benefits and those who bear the costs.



Source: Prof. Adolf Ciborowski

Figure 7. Possible sequence of an environmental development process (according to Prof. Adolf Ciborowski.)

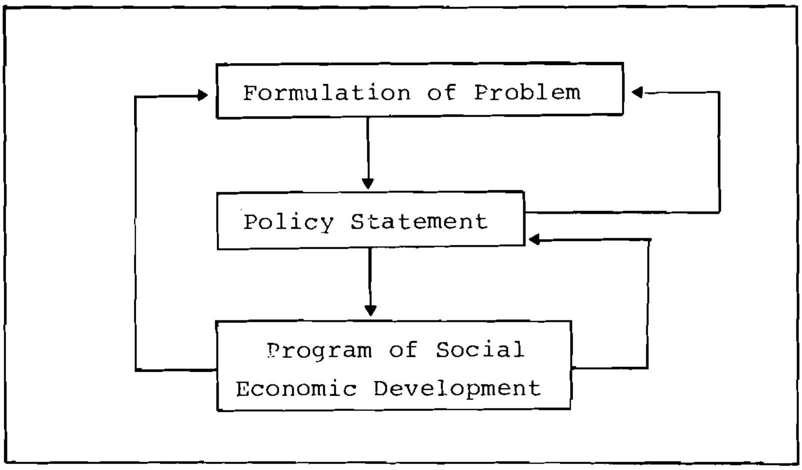


Figure 7a. Box of social and economic goals (detail).

Tools - Institutional	Tools - Technical
- Rules of decision-making	- Know-how
- Administrative structure planning machinery	- Norms, standards
- Legislation	- Technologies
- Fiscal machinery	- Eco-geographical structure
- Investment machinery	- Investment
- Public participation	

Note: In addition, specific policies in economic, social and cultural fields determine the proper kind and use of tools.

Figure 7b. Tools (detail).

Some of these conflicts may appear to be superficial; some arise from a lack of appropriate knowledge and criteria of assessment. To resolve such conflicts, appropriate trade-offs must be defined. The quality of the man-made environment of a settlement may be assessed by the level of opportunity for inhabitants who achieve biological, economic, social and intellectual-aesthetic success. There is a close interrelation of the four kinds of success, and in some cases a conflict between those levels may even arise.

There is some question about the value of standards in planning or monitoring envrionmental quality. Although some explicit numerical quantities may be useful as thresholds of biological and social catastrophe, we believe that standards must exist in the form of continuous functions of environmental observations, so that environmental costs could be properly integrated into existing cost-benefit calculations made during the course of development decisions. The starting position for formulating any standards related to environmental quality must be a definition of basic human needs and a confrontation of those needs with the possibilities for satisfying them at a given time and in given conditions.

Formulating the basic needs--biological, economic, social and intellectual--is one of the most important tasks in further research to be undertaken on both the international and the national level, taking into account data on economic, climatic and cultural aspects. Those basic needs must cover such factors as food, water, health, education, social participation, employment opportunity and freedom of expression. Therefore, the relevant paragraphs of the Cocoyoc Declaration should be taken as a starting point, but expansion is necessary so as to include aspects of the environment not directly the products of development--i.e. natural environmental processes.

We recognize the need for establishing a new set of economic criteria and indicators for evaluation of environmental quality, quality of life and progress in human welfare. The GNP indicator is no longer adequate for this purpose. The danger of the current practice of using cost-benefit analysis in directing development consistent with environmental needs lies in the narrow definition of benefits, and costs, which tends to disregard those that do not fall within the scope of fiscal calculations. It is necessary to embrace environmental values and social considerations. Further, as a possible goal of environmental and economic policies we suggest the maintenance of conditions allowing ecological, economic, and social reproducibility. The elaboration of concrete prerequisites of such reproducibility constitutes a major challenge to research in the social and natural sciences.

WORKING GROUP REPORT

C. de Laet, Chairman

The following is a series of statements concerning environmental management which were prepared for discussion in a general session of the expert meeting on environmental management.

I. Environmental Management

Environmental management should be considered an integrative ecological, cultural, economic, and social process addressed to achieving global development of the human environment through the optimal use of existing and potential resources of the biosphere. The concept should also include provisions for the ultimate improvement of human well-being in different systems of environmental and political conditions.

II. Development

Development is the meliorative management of structures and energy flows within a framework of sustained (if not improved) yield. It must also be construed to be within the limits of the highest allowable risks that can be taken while maintaining the stability of natural and human ecosystems. All human communities, as the ultimate cost bearers, must be satisfied at least in terms of their basic needs--food, clothing, shelter, health, education, etc.--and be allowed to play significant roles in the search for greater opportunities, both individual and collective.

III. General Comments

Man is faced with the necessity of a scientific revolution in technology, where wisdom, ingenuity, and knowledge will be called upon to by-pass apparently unsurmountable limits created by current engineering and economic practices.

Old and almost forgotten wisdoms must be revisited. Man should be at least as effective as nature in processing natural materials, goods, resources and services. Bio-ecological processes have proven to be efficient; man-modified and man-made processes are generally not. To become more efficient, in a global ecological sense, man must be mindful not to transgress critical thresholds. Much remains to be done to identify these thresholds and the mechanisms which control boundary conditions. We must constantly monitor structures and systems under man's control, to enable us to raise alarms that must be heeded when these irreversible boundaries are approached. If the impact is an effect beyond the resilience capacity of a system, the system is effectively destroyed. If we want to avoid such impacts, we must monitor system "loads" such as the following:

- The human load on the environment (ecological responses to human intervention);
- The load of natural and man-controlled activities on human environmental health;
- The load of change (social, cultural, economic, technological) sustainable by human communities.

Increased efficiency is to be directed towards improved well-being. This can be achieved by the following:

- Permitting greater access to, and enjoyment of, the development process, at the same time maintaining man's legacy and culture;
- Designing appropriate structures and institutions which will facilitate the flows of information and energy throughout the development process, and maintain the capacity of man to create and innovate;
- Developing productive systems which will both take into account the long-term effects and side-effects of man's activities, and internalize the attendent responsibilities in day-to-day processes, even at the peril of increasing the global cost of such activities.

IV. Controls

As an indicative but not prescriptive aid in ensuring that the main elements of environmental management can be controlled in the cybernetic sense, we suggest an interactional matrix to keep essential elements under constant monitoring and study.

AXIS 1

- Goals and objectives;
- Population to be served;
- Kind of economy to do so;
- Required education and technology;
- Human and natural ecology, internal and external domains of stability and resilience;
- Geophysics.

AXIS 2

- Goals and objectives;
- Policies;
- Programs;
- Projects;
- Changed conditions;
- Effects;
- Corrective measures;
- Evaluation;
- Decision (absolute or conditional);
- Monitoring and compliance;
- Post-audit.

V. Main Thrusts

From the previous statements, it appears that there are four areas of research and application which require priority attention:

- Critical states;
- Monitoring;

- Technology;

- Education.

VI. Comment

If the ultimate test of development is sustained stability, having internalized all risks and costs and secured all opportunities within reach in an integrated global manner, then the world is made up of:

- Developed regions;

- Non-developed countries;

- Badly developed countries.

FINAL REPORT OF THE UNEP/IIASA EXPERT MEETING ON ENVIRONMENTAL MANAGEMENT

Preface

The report which follows is the final report of the results prepared by the members of the Expert Meeting on Environmental Management. It must be emphasized that the report is a combination of the efforts and ideas on environmental management of all the delegates to the meeting. A difficult topic was treated and discussed in a very short period of time, and the report should not be considered to totally define or resolve the issue of environmental management.

Consider the report as the first phase in the delineation of characteristics and attributes of environmental management, and as a start for the indentification of needed research and tools to further clarify and define environmental management.

A special word of thanks is extended to Dr. Ashok Khosla for his dedication and perseverance during the closing days of the conference; as Chairman pro tempore, he accomplished the difficult task of combining opposing views and diverging ideas into a document which adequately expressed the joint ideas of the delegates.

The editors of the proceedings also wish to thank those individuals who contributed their ideas and feelings on the meeting itself. Their input should help towards the success of future meetings in the realm of the environment and environmental management.

Report of the Expert Meeting

The expert group meeting was convened by UNEP, in cooperation with the International Institute for Applied Systems Analysis (IIASA) at Laxenburg, Austria, from 11 to 14 March 1975. The meeting was called in response to the Governing Council recommendations stressing the importance of environmental management, calling for an integrated approach to the planning and management of development, and asking for progress to be made in all components of environmental management.[3] It was conceived as the first in a series of actions aimed at clarifying and bringing greater precision to the concept and process of environmental management, the meaning of which seems to have generated considerable differences of view, and even confusion and misunderstanding. As such, the meeting should be also seen in the broader context of UNEP concerns with patterns of development, resource use, and environment strategies.

I. Environment and Management

Suggestions are still sometimes made to the effect that there is a basic conflict between the process of development and the need to protect the biosphere. It was the considered view of the group that this is not the case, since both the environmental and developmental concerns aim at the same basic objective of improving overall human welfare, and together constitute an integrated strategy and process.

This convergence of aims at the general level obviously does not preclude certain conflicts between environmental and developmental objectives at the lower levels of decision-making and choice of options. Such conflicts and the problems of reconciling the two sets of goals often result from our institutions and our approaches to problems, and even some of our values, which have not radically changed from the times when environment was a non-concern. The group felt, however, that using a rational, consistent, and comprehensive approach to the overall management of the society, and with imaginative procedures for the generation of alternatives, the two interests can be brought together and reconciled. In any event, both sets of objectives must be jointly considered in any balanced and integrative approach to societal problems.

Management of society must then give due attention to the various environmental factors. The process of management, including the setting of goals and the planning, the implementation and the operation of specific projects designed to achieve these goals, and the detection and solution of emergent problems, should therefore incorporate environmental considerations at all stages. Only by internalising the environmental dimension into the decision-making process will it be possible to minimize the undesirable side effects which are responsible for most environmental problems.

Many societal decisions are made on the basis of an inadequate consideration of the full set of goals and this can lead to outcomes which are less than fully efficient. By a

---

[3] See Governing Council Decision 1 (I) in A/9025, and 8 (II) in A/9625.

process of creative generation and consideration of a wider set of policy options, embodying particularly the environmentally relevant values, actions can be taken which contribute to improvement of the human condition in its widest sense.

A. Environmental management aims at the development of the environment for human benefit; it is the process of balancing the socio-economic, technological and ecological forces in the development and allocation of resources in order to fulfill the needs and aspirations of present and future generations. In doing so, environmental management should work to preserve the maximum evolutionary potential of the biosphere.

B. Environmental management is the integrative ecological, cultural, economic and social process by which the human environment is developed in a holistic systemic manner through the optimal use of existing and potential resources of the biosphere, for the ultimate improvement of human well-being. It aims at the maintenance of the long-term sustained yield from the biosphere and should be designed to provide greater personal and social opportunities, for present and future generations.

C. Environmental management consists of the set of activities aimed at choosing appropriate institutional arrangements, technologies and incentives for achieving whatever goals are specified as "environmental quality" targets.

No matter how the concept of environmental management is defined, the attainment of its objectives will necessarily require significant changes in the values, attitudes and behavior of those concerned with the management of society. In many cases, it will also require deep and radical changes in present structures and methods of management. Institutions for environmentally sound management need to be developed that are based on wider concerns than traditional monetary values.

A more restricted approach, but one which could be institutionalized more quickly, is that of a structure for environmental management which attempts explicitly to introduce into the existing decision-making process the kinds of broader considerations that help not only to promote actions which are environmentally more acceptable, but also gradually to overcome the resistance of administrators and managers to see the full consequences of their actions.

There are several broad areas and, within these, a number of hierarchical levels at which management decisions are made. The effects of these decisions on the environment--at any level--can be quite significant. At functional levels of management, the broad policies formulated by a government, the programs worked out to achieve these policies, and the projects chosen within the programs, all have major environmental ramifications and implications. So does the manner in which the subsequent operations are conducted. Similarly, groupings (such as individuals, municipal, provincial, national, and transnational regions) and administrative frameworks (such as departmental jurisdictions and bureaucratic positions) will often determine the kinds of action possible in a particular situation. Hierarchical considerations are also involved when considering technologies (e.g., transportation, transportation/communication, etc.) and social systems.

To complicate matters, links and levels of decision sometimes overlap and often result in interactive effects which can, on occasion, produce unanticipated and perhaps counter-productive decisions. Members of the group considered the variation possible in decisional levels of this type and suggested that environmentally sound management at a given level could only be achieved by viewing and acting from the vantage point of a higher level.

Keeping in mind the objectives of the meeting, the expert group, both in the plenary sessions and in smaller working groups, took up a variety of issues relating to better environmental management. Among the topics touched upon were the need to identify the underlying values, such as the need to:

- Increase human welfare, including an equitable distribution of costs and benefits;
- Keep open future options;
- Safeguard and/or restore the environment;
- Utilize resources at minimum social cost;
- Aim at sustainable yield in resource conversion processes;
- Obtain an "optimal" mix of products and amenities.

Problems of measurement, definition, and choice of variables were also discussed. The techniques of benefit-cost analysis were analyzed, and considered to be inadequate in their present form for taking account of most of the environmental factors important in project appraisal.

Finally, the group acknowledged that any system and/or program of environmental management will by necessity vary among countries, depending on their level of development, their political and socio-economic system, geographical location, physical and ecological characteristics, and socio-cultural goals. Consequently, environmental management strategies should be designed so as to allow for the attainment of the development objectives of a given country, without trying to impose techniques or technological "solutions" developed in other contexts and not applicable to the local situation.

The group took note of the Cocoyoc Declaration, and in particular of the need of diversity of patterns of development and self-reliance in the developing countries. The group was fully aware of the crucial importance of the connection between international economic relations and all efforts at environmental management, whether national, regional or global. It noted that the "New International Economic Order" should take full cognizance of the environmental dimensions of development.

II. Characteristics of Environmental Management

The characteristics of environmental management became increasingly evident during the course of the discussions of the group. Prominent among these was the fact that environmental management was a more than usually complex exercise which cuts across a large number of disciplines, sectors, interests and instituions. Moreover, those affected by the decisions as well as the decision-makers involved are usually ill-defined. The number of conflict situations and alternatives to be considered is usually quite large and the trade-off choices and decisions to be made involve many unquantifiables, uncertainties and risks.

Protection and improvement of the physical environment consists of: a) addition of new man-made components to the environment which contribute to human welfare; b) protection of those existing components and qualities important for human well-being; c) restoration of those components and qualities damaged by past human and natural actions.

The management of the environment in general, and of the development process in particular, requires the following steps:

a) An analysis of the existing environmental situation and behavior and interactions of the various components of the environment, including man;

b) A study of the dynamics of boundary conditions to yield an understanding of thresholds (outer limits);

c) The setting of social, economic and environmental goals, and specific objectives by which to achieve them;

d) The formulation of a balanced program for the evolution of both the man-made and the natural components of the environment;

e) The development of criteria for evaluating and ranking programs, e.g., equity, economic efficiency, administrative costs, effect on political structure;

f) The promotion, guidance and supervision of the implementation of such a program, which includes the continuous monitoring of the economic, ecologic and social impacts (outputs) of the program, and their postautet.

Environmentally acceptable development can be achieved in several different ways, of which one is presented in Figure 8, reflecting lengthy discussion by the group. Among the most important elements in this procedure, the instruments available for including the appropriate action were considered in depth. The group identified several kinds of tools--institutional, technical and others.

The environmental management process has to start with the identification of the problem. This implies taking cognizance of the lack of satisfaction of basic human needs. In order to do so, it will be necessary to analyze systematically the interdependencies of the many factors and environmental outcomes and their effects on human satisfaction.

These observations need to be integrated into the decision-making processes; up to now this has rarely been the case. Even some informal increased awareness of environmental data by the decision-makers would be an important first step towards overcoming these shortcomings. In the long run, however, systematic monitoring and assessment will be essential if decision-making is to take account of environmental issues.

Needless to say, the process of decision-making will depend on the socio-economic and political system. However, irrespective of the system, it is essential that project makers (or planners) put forward alternative projects offering alternative methods, technologies and sites which are environmentally appropriate. Physical development plans must be consistent with social, economic and environmental aims in the broad sense defined above. The implementation of these plans will affect favorably or unfavorably various aspects of environmental qualities (as indicated in Figure 8). The resultant environmental qualities must be viewed and evaluated in terms of economic efficiency and the individual and social satisfaction derived therefrom. Unfortunately, current evaluative methods such as cost-benefit analysis do not give proper weight to these outcomes. Finally, proper environmental management must provide for the continuous formulation and reformulation of social, economic and environmental aims by way of a built-in feedback process.

At any point in time in a given society, there is a wide range of physical/technological options for maintaining or improving ambient environmental quality. These options include not only the range of production processes, from traditional processes to high complex modern technology, but also changes in product mix and product output specifications, changes in raw materials used, changes in location and timing of activities, production of byproducts. The problem of environmental management is to select and implement the "optimal" mix of such options to achieve the environmental goals desired, recognizing that nations have different responsibilities for environmental management among their various agencies.

Tools for implementing environmental management decisions consist of a wide variety of economic, social and environmental policies. They include, apart from institutional and administrative arrangements and procedures, legislation, new norms and standards, and new modes of public participation related to the formulation, assessment and evaluation of environmental goals and objectives.

The two boxes in Figure 8 representing tools are intended to indicate possible ways of classifying these tools, which may be either direct or indirect, or a combination of both.

Some tools for implementation might be classified as follows:

a) Planning tools; information systems, analytical methods, organizational links, procedures for public participation in the planning process, valuation machinery.

b) Implementation instruments; tools which are applied by institutions to induce behavior by the activities involved, such as mines, farms, households, industrial plants.

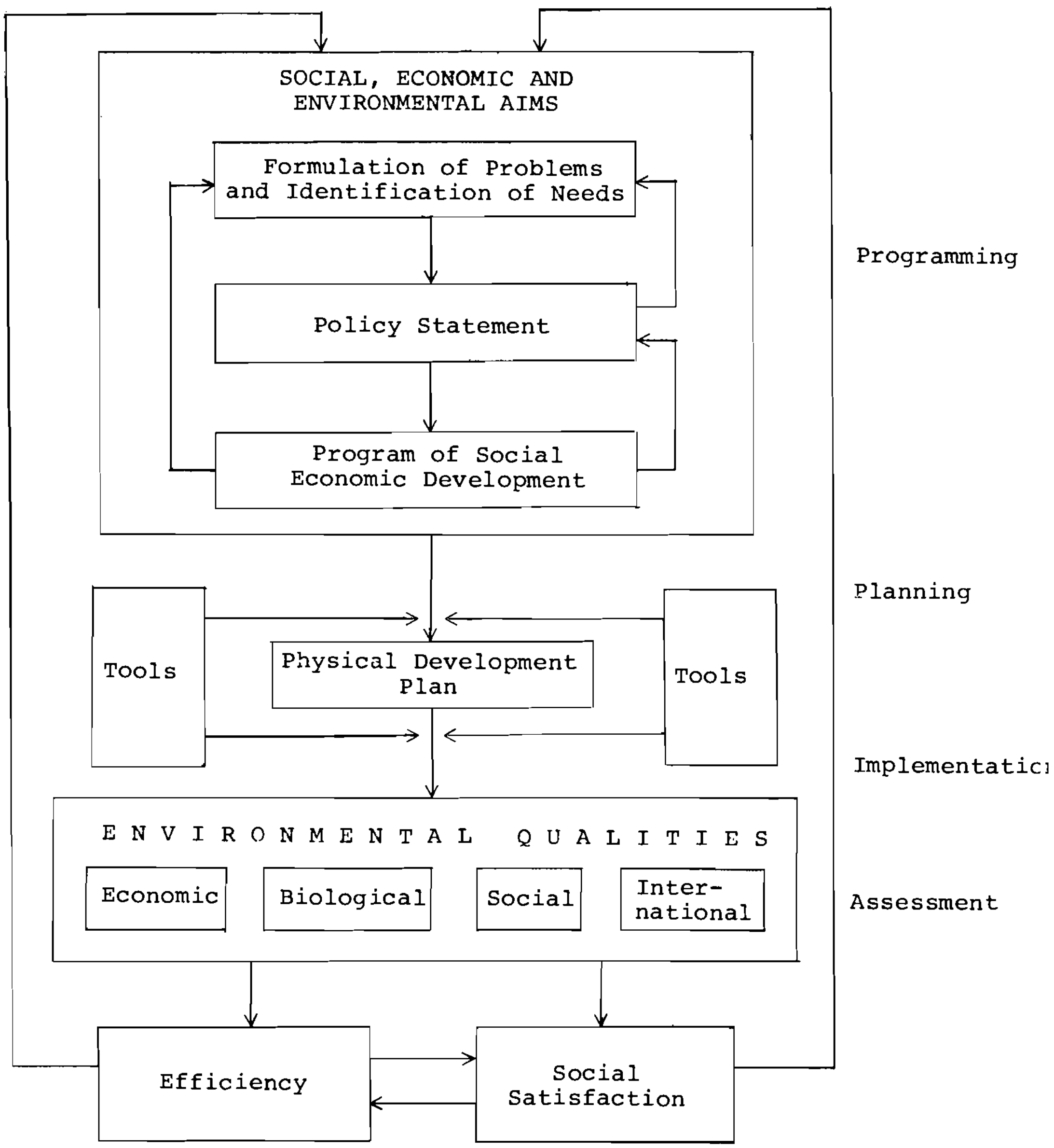


Figure 8. Possible sequence of an environmental development process.

Direct	Indirect
Prescription or proscription of behavior: housing codes, product and raw material specifications, effluent standards, permits, direct investment.	Tax policies Zoning Effluent charges Subsidies Pricing policies for factor inputs, i.e., energy raw materials Education.

Direct instruments are prescriptive or prohibitive, aiming at particular action (or non-action) with respect to economic activities with a manifest environmental impact. Indirect instruments are designed to induce behavior or action pattern by such means as general appeals, education, persuasion, new social norms, or such fiscal measures as effluent charges, subsidies, taxes, etc.

The actual choice among the different tools for implementing environmental management decisions will depend upon the level at which environmental planning and implementation take place, as well as the type of problems under consideration, and, last but not least, upon the traditional rules of decision-making in different socio-economic systems. The important criteria for the selection of specific tools should be based on their relative efficiency in bringing about the desired environmental effects or outcome.

In using these tools policy-makers should consider the influence which different technologies and investments will have on the balance between population and resources and their effects on the productivity and employment structure, particularly in developing countries.

Environmental management problems and programs are characterized by a variety of desired outputs, which may result in conflicts necessitating choices. Examples are:

- Conflicts between short- and long-term aims, needs and possibilities, e.g., the intergeneration conflicts;

- Conflicts among different levels of interest such as global, regional, national, local, and interests of individuals and of groups;

- Conflicts among different goals (for example, alternative uses of land);

- Conflicts among man-made and natural components of the environment;

- Conflicts among those who share the benefits and those who bear the costs.

Some of these conflicts arise out of the lack of appropriate knowledge and/or criteria of assessment. Others arise from the physical limitations of the environment to produce desired outputs.

Appropriate trade-offs must be defined and analytic and political methods found to help resolve these conflicts. The quality of the man-made environment may be assessed by the level of opportunity for all citizens to achieve biological, economic, social and intellectual-aesthetic-spiritual satisfaction. There is, however, a close interrelation among these "satisfactions" and often conflicts will arise in the process of choosing among them.

Environmental management should explicitly take into account the uncertainties and risks associated with "developmental" factors: changing technology, resource availability, population changes; effects of the discharge of unused materials and energy on natural ecosystems; the probability of damages from natural phenomena. Because the level of risk in terms of impact on natural ecosystems cannot be estimated accurately, cost-risk reduction relationships should be developed as aids to environmental management decision-making.

The multi-disciplinary, transsectoral and interinstitutional nature of environmental problems makes it necessary to devise problem-solving machinery of new types. The question of externalities and side effects further complicates the problem of making socially optimal choices. In the development of environmental management strategies, consultants (public or private firms, individuals) have often been used. Explicit consideration needs to be given to:

a) The procedure for selecting consultants;

b) The types of consultants;

c) The role of consultants in developing such strategies.

Particular attention must be given to whether or not the consultant understands the context and conditions in which he is to operate; whether or not the interests of the consultant coincide with those of the client. For example, adverse consequences may occur where the consultant may provide the "answer" the client wants to hear, so that he will be invited to return, or where the consultant may benefit directly or indirectly from his recommendations, which include adoption of particular hardware, for example. Thus the process of environmental management turns out to be an exceedingly complex excercise. Although, as described earlier in this report, it would be ideal if the process of developmental management could be optimized by internally taking into account the broad social and economic goals (including the environmental factors), presently available methodologies unfortunately do not allow this. Consequently, it sometimes becomes necessary to use an iterative procedure of making developmental proposals, assessing their impact and setting up a feedback loop of modifications which will hopefully converge to a satisfactory solution. Unfortunately, institutions and structures, created to meet the simpler procedures of yesterday, are sometimes not able to respond to iterations and feedbacks in sufficient time for their intervention to be fully beneficial.

Another consideration to meet adequatly the requirements of environmental management, and this possibly to a more significant degree than in any other activity, is the capacity to generate realistic and viable alternatives. Such alternatives can apply, for instance, to the location of economic activities, to the choice of technologies, and to the consideration of the appropriate levels of aggregation in terms of bureaucratic hierarchies and structures, regions and societal objectives.

The natural assimilative capacity of the environment is a basic resource. At present almost all ecosystems can be defined as highly complex systems formed by natural environmental components and processes, and man-made material for transformation, transportation and storage processes driven by solar, human and physical form of energy added to their complexities. Each component of the natural bio-system is considered to have a limited capacity for processing restricted classes of man-made materials and energy, depending upon the level of quality to be maintained. For management purposes, these limited capacities represent ecological constraints against which the technological and spatial features of man-made processes in agriculture and industry and human habitat must be designed. From an economic point of view they represent serious constraints in regional and national economic development. From an ecological point of view the mass-energy features of the production/consumption processes of the economy must be in dynamic equilibrium with a heterogeneous pattern of biological communities as parts of ecological systems; from a social and cultural viewpoint these limited capacities represent adaptive and sociological constraints that are determined for a given style of life of the affected human populations.

Man has to start in recognizing the existing relative tolerance of ecosystems and regional environments to accept the residual of production and consumption as an economically valuable resource of the region, and to treat it with the same respect as its material producing capabilities.

III. Possible Areas for Future Work

In its deliberations, the group identified a number of areas where work is required, and made proposals intended to help fill some of the gaps in our knowledge and to encourage reorientation in current practice. While it was guided by the mandate to contribute to the further development of UNEP's program activities in the area of environmental management, many of its suggestions have a much wider relevance to international organizations, individual countries and scientists.

Given that environmental management strategies will vary among countries, and that, because this is a relatively new concern, there may be a shortage of experienced personnel, manuals and other aids for developing such strategies should be developed. These should include practical "how to do it" documents, which would describe in detail the planning process, the types of data to be obtained, the methods of aggregation and analysis of the data, the process of impact assessment, and the types and formats of outputs. Each manual should naturally be based on the conditions in the region to which it applies and on proved experiences in the region. The contents should not be simply and mechanically transferred from one context to another.

Among the areas for further action and study mentioned were the following:

1. Systematic R and D efforts should be undertaken to develop appropriate technologies which have low environmental impact, are adaptive to local conditions, and make use of local materials and manpower resources.

2. Basic research should be promoted for developing concepts and theories relating to basic human needs.

3. Methods and examples are needed to assist in the formulation of societal goals which take full account of environmental problems and the quality of life.

4. Methodologies and procedures are needed for the identification of direct, indirect and delayed effects.

5. Improved indicators of environmental quality should be developed.

6. Improved methods for evaluation of environmental damage and/or hazards are needed.

7. More effective methods and practical procedures should be elaborated in an attempt to internalize environmental factors in cost-benefit analysis.

8. Obstacles to sound environmental management arising out of institutions, such as certain values, the market mechanism, pressure groups, etc., should be identified. Having identified the major obstacles, means should be developed to overcome them.

9. A major effort should be devoted to the study and definition of new instituional structures for improved environmental management. Although social, economic and political diversity should be given full consideration, the possibility of developing a set of general guiding principles should be explored.

10. New procedures for project appraisal are needed, especially for use by international organizations. Research should be initiated by UNEP in this field to supplement and improve existing procedures.

11. The prerequisites for maintaining the stability, resilience and the reproduction of ecological systems and subsystems should be identified.

12. The behavior and constitution of non-permanent, flexible teams should be studied to overcome the problems of communication which often prevent efficient circulation of information and carrying out of transdisciplinary analysis at all levels of decision-making.

13. A series of case studies should be carried out under the auspices of UNEP. These case studies should aim at a variety of environmental situations and illustrate the conflicts between short-term and long-term goals, different levels of interest, natural and man-made environment, the divergence of interests between those who share the benefits and those who bear the cost, etc. These case studies should provide examples of ways for the resolution of the problem identified.

14. Methods should be developed to improve the systematic gathering and collecting of information and its packaged presentation in a manner to make it directly useful in the decision-making process.

15. Working out improved principles and practical ways of educating the public should be given high priority. Better mechanisms for public participation in environmental management should also be created and developed.

16. In environmental management the early identification and forecasting of possible conflicts is very important, and it is suggested that research be carried out on this subject.

17. Estimates should be made of environmental implications and productive capacities of alternative development patterns.

18. Studies should be carried out on the institutional conditions, for different countries and/or those with different socio-economic systems, at different levels of development, which ensure that environmental considerations will be embodied explicitly in socio-economic development (both planning and implementation).

19. In-depth study and analysis is required of the value and role of environmental impact statements as practised in certain industrially advanced countries, and their function within existing institutional frameworks.

20. The role of consultants, including private consultancy firms, in environmental management, particularly for developing countries and in the programs of international organizations, requires urgent analysis.

21. It is necessary to study how equitable international economic relations might contribute to sound environmental managment at all levels.

22. Research efforts are needed to formulate methodologies for theoretical and computational procedures for a coordinated analysis (multidisciplinary models of analysis) on the trade-offs in the mass-energy and economic characteristic of alternate ecosystems (life-support systems) and subsystems.

23. Research is needed to assess the mass energy processing capacities of natural ecosystems as one of the prerequisites to the practical application of environmental design and environmental management.

24. Research is needed to identify boundaries--especially those which represent (in a probabilistic sense) irreversible states, and which delineate relevant threshold limits for long-term human activities.