4. Monitoring – basic considerations

A total system for environmental control includes three basic types of activity. The first involves measurements and observations directed towards a description of the state of the environment and its changes. The second activity is the evaluation and analysis of environmental data to determine possible trends and to develop a warning system related to pre-set criteria. This specifically includes functions such as predictions of the environmental consequences of planned actions, descriptions of the budget of contaminants and the analysis of ecosystems, determination of environmental criteria for specific pollutants, and the formulation of recommendations for actions. The third and final activity in the total system is that of action, designed to avoid environmental deterioration but in the overall context of achieving environmental management in the most beneficial way.

Global environmental monitoring or "monitoring" is used in this Report to describe activities of the first type listed above. Accordingly, monitoring is defined as, "a scientifically designed system of continuing measurements and observations." However, references throughout this Report to a global environmental monitoring system additionally include the evaluation procedures listed above as the second activity. There are no proposals included in this Report concerning the third, or action, phase of the total system.

Concern with environmental monitoring stems from man's preoccupation with his health and well-being, traditionally centred around his attempts to obtain shelter and food from crops, livestock and other biota, and to avoid disease and such natural phenomena as earthquake, fire, flood and hurricane. Man has always intended to improve his environment by increasing his control of it. However, an environmental modification orginally designed to improve the standard of living (e.g., land-drainage or deforestation for agriculture) has often generated unanticipated side effects which sometimes are harmful and occasionally irreversible or costly to correct (e.g., loss of soil fertility or topsoil and the extension of arid zones).

Traditional agents of modification such as fire, grazing animals and direct human labour have lately been enormously reinforced by modern technology. Mechanical power, explosives and chemical agents such as drugs and biocides have revolutionized the impact of man and increased his ability to modify the environment. In addition to the direct effects already evident, there remains the possibility that harmful environmental side effects, as yet unrecognizable, may appear in the future, triggered off by current human activities.

Four principle categories of environmental phenomena that affect man are: natural disasters; disease epidemics; agricultural and other biological resource productivity (forestry, fisheries, etc.); and undesirable side effects resulting from modern urban/industrial technology. The effects of floods, giant seawaves, earthquakes, hurricanes and other natural disasters requires constant attention. Many countries have traditionally operated information

gathering and warning systems, and more recently, predictive networks for weather changes, geological and oceanographic phenomena have been extended and refined. Likewise, public health authorities have been set up all over the world to investigate, evaluate and control disease and other human health problems. Survey, advisory and remedial services for agriculture, soils, forestry and fisheries have been operated for many years by nearly every government. Many of these national activities are co-ordinated internationally by organizations such as WMO, WHO, and FAO.

The concept of monitoring and early warning is thus not a new one. A great deal of excellent work has already been carried out, and continual efforts are being made to improve and co-ordinate the existing national and international systems.

However, the efforts to deal with man-induced phenomena on a world-wide scale are uneven and unco-ordinated. This is because most aspects of this field are relatively new or have become of serious concern only during the last century, particularly within the last thirty years. National concern with these problems seems to depend among other things on population density, degree of industrialization, consumption of products by urban societies, intensity of agriculture and on standards of living, public education and environmental awareness. However, as contaminants from the industrialized countries spread around the globe and as more areas become developed, more and more nations must face these problems.

Since all the components of the environment – air, water, soils and living things – interact through physical, chemical and biological cycles to form an interlocking unitary environment, a disturbance or modification in one of these components may have repercussions in all. In many cases man does not know the magnitude or nature of the repercussions, because he does not completely understand the interplay between these cycles.

There are many well known examples of clearcut effects of man's impact over the globe. Human disease vectors as well as crop and livestock pests have been transported by human agency into new territories, causing loss of life and biological productivity. Dust-bowl conditions and arid regions have been generated in different continents by defective agricultural practices. Local climates have been developed in large cities by waste heat.

Many chemical substances released in large quantities into air and water or spread on farmland become widely distributed. These substances can now be found in places where they have never been applied by man, even in remote wilderness regions and in the open seas. Many are known to be highly toxic in larger amounts, but their long-term effects on man and other living things in trace amounts have not yet been determined. We know, however, that man and many animal and plant species suffer from the effects of toxic substances in terms of population decreases or increased frequency of diseases. Once released, many of these poisonous substances persist for decades in the bio-environment because they either are not degradable or are broken down only with great difficulty. Lead, cadmium, mercury, radionuclides, organochlorine compounds like DDT and polychlorinated biphenyls are in this category. We do not know if their present world

distribution-patterns are equilibrium situations or whether, even if all urban-industrial and agricultural emissions ceased at once, some of these substances would still continue to circulate in the biosphere by transfer processes which are still inadequately understood.

Effects of other activities can only be theoretically surmized. The rise in the temperature of the earth's surface, expected from increased concentrations of atmospheric carbon dioxide due to the combustion of fossil fuels, could possibly thaw polar ice, raising sea-levels and flooding coasts. Dust particles, on the other hand, may lower the surface temperature of the earth by screening it from incoming solar radiation. So far, however, it is not clear to what extent man's activities have affected or are affecting the global climate.

The Report will emphasize the need for a global environmental monitoring system to include co-ordinated measurements of physical, chemical and biological parameters in the atmosphere, the hydrosphere, the pedosphere and in biota. Thus the budget, or pathways of a substance through the environment from start to finish, can be determined. Wellorganized, judicious surveys and monitoring of the substance at selected points throughout these pathways can aid in understanding its effects and in determining optimum control strategies.

The imperfectly understood cause and effect relations and environmental budgets of many substances have given rise to important questions about the complex interactions between man and the bio-environment. A programme must be initiated to obtain a picture of how all these processes occur, the rates at which they take place, the timing and nature of equilibrium situations, their effects on man and the life-support systems of air, water, soils, climate and biota. We also need to develop mathematical simulation models of environmental interactions that can predict the results expected from varying types and degrees of remedial action. The capability of advance-warning before an adverse situation becomes irreversible is absolutely essential.

The proposed system will have two basic functions: 1) It will establish existing, natural baseline values of the bio-environmental state against which contaminated states can be compared in relation to effect-levels on biota and man. 2) It will provide the basic information for the early detection and global extent of bio-environmental changes and their causes. The system visualized will be basically a service oriented function which gathers, collates, analyzes and interprets information from many sources, and presents this information to national and international agencies charged with the responsibility for managing the bio-environmental system. In addition to this primary function, the system must be supported by, and in turn, be supportive to, a continuing research programme directed to the causes and effects of bio-environmental change. This research need not necessarily be performed entirely within the monitoring system. However, the system should be responsible for mounting adequate and co-ordinated research programmes and for incorporating the results within and between the monitoring programme and for giving advice to governmental agencies.

Four considerations relevant to the basic system must be stressed initially:

a) The system which is finally evolved will be costly and time consuming and occupy the full attention of a large amount of scientific and technical manpower. For this reason the functioning of the monitoring system must be kept under careful and continuous review. This will also assist it to develop a rapid and flexible response to any new environmental situation which appears to merit investigation.

b) The most optimistic results that can be obtained from the monitoring process is that nothing significantly harmful is happening to the human environment, although beneficial trends may be recognized. Thus the justification for the system, as in law enforcement or any other "watchdog" activity, is a negative one.

c) The system will evolve from the initial fact-finding state to a state where models can be formulated and used to predict environmental trends. The development of this predictive capability will take time but will eventually provide governments with forecasts of the most likely consequences of any action programme with potential environmental impact.

d) The system itself will not have any executive authority, i.e., it will not render decisions on courses of action which are within the realm of political jurisdiction by national governments.