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THE GLOBAL ENVIRONMENTAL MONITORING SYSTEM

Report of the Executive Director

Introduction

1. The present report is submitted in pursuance of decision 8(II) by which the Governing Council, among other things, decided (part II section 1 paragraph 6) to consider as a matter of priority the report of the Intergovernmental Meeting on Monitoring (IMM) held at Nairobi in February 1974 (document UNEP/GC/24) and a report of the Executive Director on the result of his studies and analyses of the IMM's report and on the progress in the implementation of GEMS.
2. The IMM report discussed in detail and made recommendations the objectives, principles, programme goals and general guidelines of GEMS. It is recommended that these recommendations (see Annex I) be adopted as such. The IMM report also recommended the pollutants, other environmental factors and other aspects of environmental monitoring that should fall within the purview of GEMS. They will be reviewed in the present report in the light of events since the second session of the Governing Council, of current plans for the implementation of GEMS and of paragraphs 3(a) and 4(g) of General Assembly resolution 3326(XXIX).
3. GEMS is a co-ordinated effort on the part of Member States, United Nations agencies and UNEP to ensure that data on environmental variables are collected in an orderly and adequate manner for the purpose of giving the Governing Council a quantitative picture of the state of the environment and of the natural and man-made global and regional trends undergone by critical environmental variables, and thus providing one of the tools that environment management requires at the national and international levels. The regional and global nature of GEMS is an essential feature of the System, and this makes it reasonably easy to identify those monitoring programmes that will be its main concern. They are basically those whose results may lead to concerted action by more than one or by all countries, or those that can only yield results, even of local import, if more than one country is involved in them.
4. Local programmes are those in which results are collected in the countries concerned primarily for their own benefit, rather than for that of the international community. Certain Agencies and all countries will

continue to devote much of their monitoring resources to such programmes. While these local programmes will normally not be regarded as falling under GEMS, they may yield information on the mechanisms underlying trends observed regionally or globally and on the magnitude of problems that, although handled locally, are common to more than one country. In the case of pollutants, local programmes may yield information making it possible to draw general inferences on the relation between source output and exposure, particularly in relation to human health.

5. GEMS will therefore, be concerned with the results of local monitoring programmes primarily for the purpose of ensuring that the information of regional and global significance that they yield is not ignored, and that problems at the interface between the local and the other levels are handled with the requisite amount of technical consistency. However, GEMS will also provide a framework within which Member States can exchange information on the monitoring experience that each has gained at the local level and ensure that their data are comparable with those collected for the same purpose in other countries.

6. The main tasks of GEMS will be:

(a) To select those variables which have been identified as falling within UNEP's programme of work and that can and should be monitored as a matter of priority. Because monitoring is not an end in itself, the list of variables to be monitored will need to be reviewed periodically to ensure that it is consistent with the goals of UNEP's activities;

(b) To frame the questions that monitoring of each variable is expected to answer and to justify monitoring activities on the basis of the guidance for action that the results are expected to provide;

(c) To ensure that monitoring of any variable is carried out properly (i.e. that results are comparable, that sampling or observation frequencies are adequate to achieve the resolution required and that the results are made available according to a predetermined format) and on a scale commensurate with the urgency of the need for information and with the overall resources for monitoring that are available internationally;

(d) To ensure that the individual readings are appropriately and uniformly processed and analysed so as to yield the information, rather than merely the raw data, required for environment management purposes

I. MONITORING PRIORITIES

7. A first semi-systematic attempt at establishing monitoring priorities was made by the meeting held in February 1974. For pollutants, these priorities are set out in a table reproduced as Annex II. For other aspects of environmental monitoring the IMM's recommendation was less definite. It envisaged that monitoring start "with the following global or regional priorities:

"(a) Monitoring of factors useful in predicting climatic changes and disasters, including natural disasters;

"(b) Monitoring of indicators of health status with particular emphasis on high-risk groups. Preparatory research will be necessary in this area before the initiation of the programme;

"(c) Monitoring of the desertification, degradation and depletion of soil and living resources such as forests, grasslands, wildlife and aquatic ecosystems. For certain aspects of this item some preparatory work may also be expected."

The next two sections of this paper will discuss the priority activities of GEMS in the light of the IMM recommendations and of their practical and immediate possibilities of implementation, and in the light of events that have intervened since the meeting.

8. A number of activities related to monitoring currently undertaken or planned by various organizations are mentioned in sections A and B by way of examples. It is not the purpose of this document to review these activities comprehensively.

A. Pollution monitoring

9. Concern about pollutants arises from the effects they may have on targets. For many pollutants the ultimate target is the human body, but some may affect natural or man-made resources either by damaging or destroying them or by making them unfit for human use. Resources are to be understood in the broadest sense, including, for instance, soils and wild life, and also climate, both regionally and globally.

10. With regard to environmental pollutants, action aims at protecting the target by controlling its exposure through intervention at any stage in the chain(s) linking the source or activity and the target. The purpose of pollutant monitoring is to determine the output of the chains in terms of exposure, wherever exposure is clearly defined, or of some parameter closely correlated to exposure in other cases; to identify those sources or activities that release pollutants to the environment and to determine for each of these which chains contribute most to the exposure; to identify existing reservoirs of pollutants, estimate their size and time constants, and so evaluate how their contents and output are affected by inputs; to observe trends in exposure and, by relating these trends to reservoirs and sources, set up predictive exposure models that will make it possible to determine the cost of certain activities in terms of exposure and ultimately of detriment to people and to the environment. This would assist the policy-maker in deciding, on the basis of criteria that monitoring cannot provide, whether, when and where in the chain to intervene to reduce the exposure.

11. The following paragraphs review in rather general terms the priority pollutants recommended by the IMM. Some, the interest of which is limited to their presence in the medium in which they are measured, will be mentioned in the discussion of media monitoring. The essential but ancillary hydrological, meteorological, oceanographic and other information without which it would be impossible to evaluate most of the results of pollutant monitoring is considered to fall outside the scope of this paper and will not be reviewed.

1. Individual pollutant monitoring

12. Monitoring of sulphur dioxide (SO₂) and particulates is carried out in urban areas in a large number of countries. WHO has been engaged for a number of years in co-ordinating these activities on a pilot basis in a selected number of cities, to ensure that monitoring is carried out with reliable techniques and that the results of the measurements are comparable. WHO is also planning to study the effects of SO₂ and particulates by means of large-scale epidemiological surveys. While SO₂ and particulate monitoring in urban areas is basically undertaken to meet local needs, GEMS will need the resulting information concerning exposures whose effects on health have been clearly established, at least at high levels of pollutants. This will contribute to estimating the extent of a problem increasingly common to a number of countries, one that has a twofold implication from the point of view of an environment management policy aimed at avoiding exposure to these pollutants. On the one hand, authorities in certain countries have discouraged utilities from burning fuel with high sulphur content, and this has affected energy costs and policies. On the other hand, utilities have often tried to release smoke through high stacks, thus reducing the problem locally, but magnifying it at the regional level, and sometimes giving it clear international connotations. Knowledge of local emission rates and impact levels is needed to evaluate the results of regional monitoring.

13. Regional monitoring of sulphates, and of many other pollutants in precipitation, is being co-ordinated by WMO through a global network of regional stations, of which about 50 are at least partly operational. This network is primarily aimed at studying long-term trends that may be related to changes in land-use. In the context of GEMS, regional monitoring of sulphate ions is also relevant because of the acidification of precipitation to which they give rise, with consequent damage to soils, surface waters, vegetation and building materials - a phenomenon that may, in the future, assume increasing proportions and call for co-operative preventive measures. Soil and fresh water acidity are routinely monitored in many places, but there appears to be no systematic effort to relate them to the acidity of precipitation. This is also an aspect of monitoring that GEMS should encourage. The OECD pilot project on transport of pollutants in Western Europe has provided considerable information that will be of great value when it is decided to establish more operational monitoring schemes related to the long-range transport of pollutants.

14. WMO is also planning to measure carbon dioxide and turbidity in air and, to the extent possible, sulphate ions in precipitation and in atmospheric particles at a number of baseline stations, in order to determine the secular trends in the levels of these pollutants. The identification of these trends, besides being invaluable in providing a reference against which to compare regional and impact variations, may gain additional importance if it is proved that man-made particulates, whether introduced directly into the atmosphere or arising from chemical transformations of sulphur oxides, may significantly affect the radiative balance of the planet and thus contribute to bringing about climatic changes. The measurement, when feasible with currently available techniques, of background levels of various pollutants in air samples collected at baseline stations has also been envisaged.

15. With regard to radio-nuclides, the IMM assigned highest priority to ^{90}Sr and ^{137}Cs monitoring in food at regional and impact level. Since the United Nations body primarily responsible for planning the world-wide collection of data on radio-active contamination of the environment from all sources and for receiving and evaluating these data on a global basis is the Scientific Committee on the Effects of Atomic Radiation, the views of that Committee were sought on this matter. At its twenty-third session in October 1974, the Scientific Committee considered decision 9(II) of the Governing Council as well as the priority to be assigned to the monitoring in the environment of various categories of radio-nuclides, including ^{90}Sr and ^{137}Cs . The Scientific Committee expressed its views on these matters in its report to the General Assembly (A/9632), relevant excerpts from which appear in Annex III.
16. At the same session, the Scientific Committee also outlined the data on radio-activity in the environment and on other sources of radiation exposure that it requires to pursue its assessment of radiation risks. The Committee's requests were communicated to Member States by its Secretary in a letter that will be made available to the Governing Council.
17. The General Assembly considered the report of the Scientific Committee at its twenty-ninth session. By resolution 3226(XXIX) the General Assembly requested the Scientific Committee to continue its work, including its important co-ordinating activities, to increase knowledge of the levels and effects of atomic radiation from all sources, and noted with appreciation the Scientific Committee's feeling that its work could contribute significantly to UNEP and its hope that active co-operation with the Programme could be firmly established and maintained in the future.
18. It is suggested that the field of radio-active contamination - including that from nuclear explosion - will be adequately covered by the Scientific Committee maintaining the watching brief received from the General Assembly in 1955, and it is assumed that the Committee's evaluations will continue to be made available to UNEP, thus providing the required input to GEMS on these matters.
19. Ozone must be considered as a pollutant at ground level and as a resource in the stratosphere where it provides the earth surface with a shield against the incoming ultraviolet radiation. Ozone must be monitored in the stratosphere to ascertain whether its amount is constant or tends to decrease, possibly as a result of interference by human activities with the processes leading to its production and destruction. The possibility of systematic measurements of ozone in the stratosphere is being considered by WMO.
20. In urban areas ozone is monitored on a much less extensive scale than SO_2 . Since it is produced locally, mostly as a result of photochemical reactions involving nitrogen oxides and hydrocarbons, it would most usefully be monitored in conjunction with these substances, which present much greater technical difficulties than the monitoring of ozone alone. Ozone is, with other oxidants, a component of the photochemical complex (smog) that largely results from the emissions of petrol engines. Control of the photochemical complex can be achieved by suitable changes in car engine design and specifications or by developing transportation policies

less dependent on the motor vehicle. The implications of those changes beyond the areas concerned, though real, do not appear to justify involving GEMS in monitoring ozone and related pollutants in urban areas at this stage, particularly in view of the technical difficulties involved and of the limited number of urban areas in which ozone causes serious problems. Similar considerations apply to carbon monoxide and, in a different context, to asbestos.

21. DDT and other organochlorine compounds comprise both pesticides and industrial products used mainly in cooling systems and power transformers, and to a much lesser extent as additives to various other industrial products. These compounds are long-lived, highly mobile, distribute through all media and have a variety of effects on ecosystems and human health. Particularly with DDT, the practical implications of policies aimed at reducing their use are vast and immediate, yet no useful predictive model is available relating target exposure to the amount released to the environment. Partly, this is due to ignorance of DDT distribution, rates of transfer through various media and ultimate sink. Only data collected across media on at least a wide regional basis and coupled with a research effort will make progress possible toward a less blind awareness of the fate and consequences of DDT releases than we have had so far.

22. Measurements of DDT are carried out in a number of countries, but with little co-ordination except for food and animal food monitoring and, in OECD countries, for monitoring in wildlife. These measurements are usually aimed more at measuring levels in a particular medium than at understanding DDT's fate in the environment. Few data are available on the DDT content of, and rate and mode of release from, its two main reservoirs, soils and atmosphere. It is felt that DDT monitoring should be part of the initial plan of action of GEMS. Because of the similarity of the analytical techniques required to monitor them and of their greater potential harmfulness, other organochlorine compounds, the fate of which is even less well known than DDT's, could also be included in the programme. Such a multi-media and multi-agent programme will be difficult to plan and set up and will require much preparatory work and expert advice. This should not interfere with or hinder current international programmes of monitoring, particularly in food, which may merely need to be slightly adjusted to yield results of value to and consistent with those of the multi-media programme.

23. Similar considerations apply to mercury, lead, cadmium and arsenic, the reservoirs and the fate of which are still incompletely known. Large-scale use of these elements is perhaps less immediately justified by concern for the health and well-being of mankind than with DDT, but since they also offer less opportunity for substitution they may in the long run confront us with a problem similar to that provided by some of the organochlorine compounds other than DDT. In the case of these elements and their compounds, preparatory work will also be required before launching a multi-media monitoring programme, but such a delay should not hamper international efforts already planned or under way, particularly in relation to food and ocean monitoring.

24. The importance of petroleum hydrocarbons monitoring is mainly in relation to water, particularly oceans, because these compounds present a special hazard to the living resources of the oceans and their shore - including aquatic birds and mammals - to amenities and possibly to human health. Petroleum hydrocarbon monitoring should provide information on the amount and type of contamination of the oceans and on the contributions made by outfalls, including rivers, to the total ocean inventory. The first aspect is covered within the WMO/IOC/IGOSS pilot project on marine pollution monitoring, which is already operational as far as petroleum hydrocarbon monitoring is concerned; for the second, pre-programming steps have already been taken by UNESCO in connexion with the world register of rivers discharging into the oceans, while studies on the processes in estuaries that may affect transport and input of pollutants are being carried out within the River Inputs into Ocean Systems project of SCOR.

2. Monitoring in different media

25. The foregoing paragraphs have briefly reviewed a number of the priority pollutants identified by the IIM and their monitoring requirements across the media so as to indicate the type of information that is ultimately required on each of them. In practice, however, monitoring is and will continue to be carried out separately in different media. Indeed, most monitoring is currently performed for the sole purpose of determining the levels of pollutants in individual media, particularly when, as in the case of air, water and food, levels determine the intake of pollutants per unit volume inhaled or ingested and can therefore be directly related to the rate at which man is exposed.

26. Media, however, must also be regarded as vehicles for pollutants from their sources through their reservoirs to their sinks. Seen in this context, monitoring has different - and sometimes simpler - requirements. However, because it is at present seldom carried out to meet them, GEMS will, in many instances, need to take advantage of monitoring activities carried out for different purposes, and suggest minor or major modifications to these activities in order that they may suit GEMS' purposes as well.

27. Food and animal feed (food for short unless otherwise indicated) are monitored in order to determine the presence and amount of pollutants in commodities likely to make a major contribution to the intake of individual agents. Because the intake of a given pollutant depends both on its concentration in certain foodstuffs and on the intake of these foodstuffs, information on the composition of the diet consumed by the population will have to be collected so that the results of food monitoring programmes can be interpreted.

28. Food monitoring is primarily aimed at ensuring that derived working limits are not exceeded, i.e. at protecting the health of the local population. However, the international dimension of food contamination is provided by the fact that food and animal feeds are traded internationally on a large scale. Monitoring will provide the data necessary for objective control measures to protect the consumer from contaminated foodstuffs and, in the exporting countries, to protect the producer from having his produce rejected by the importer.

29. In addition, monitoring should serve as a means of gaining knowledge on the fate of pollutants in food chains: therefore, it should be so adapted (e.g. by including in the results of monitoring, wherever possible, simple indications of the origin and time of harvest of the produce and by expressing the results quantitatively) as to yield information on those selected pollutants that are being tracked down in the environment to understand their fate. As in the case of any other medium, however, food monitoring may include certain pollutants that contaminate food only, and for which therefore no attempt at multi-media collation will be required.

30. A co-operative project on food monitoring that will ensure compatibility and comparability of monitoring results among a number of countries and storage of selected data in a central data bank is currently being prepared by WHO and FAO with UNEP's support.

31. Water monitoring also is undertaken largely to ensure that its quality in relation to various uses is not impaired by unacceptable levels of chemical and biological pollutants. As such, its results are of essentially local interest except in cases in which waters are shared by two or more countries, as with international rivers and river basins. Water, however, is also one of the main vehicles whereby pollutants are removed from land through run-off and carried to lakes and oceans. Much as in the case of food, where the results of monitoring must be interpreted with the help of the results of dietary surveys, the use of the results of water monitoring requires, in order to determine the pollutant inputs to lakes and oceans, a knowledge of the discharge volumes of the relevant streams and rivers.

32. With oceans, the problems of pollutant monitoring are due in part to the difficulties of separating the contributions of sea-based and land-based sources of pollution and of allowing for the transfer of pollutants between ocean and atmosphere and vice versa. They also result to a large extent from the very complexity of the ocean itself - a medium divided into seas or basins and into layers, each with different physical, chemical and biological characteristics and with very diverse rates of exchange. Extensive monitoring in the ocean, particularly at depth, often involves the use, at considerable cost, of specialized resources and equipment. Since an increasing number of ocean surveys are being carried out within various national research programmes, GEMS should endeavour to maintain, through the machinery existing within the United Nations system, a close liaison with the activities of national research programmes, thus ensuring that the fullest and most economic use of these programmes is made for the purpose of collecting adequate data on the priority pollutants.

33. The global role of IGOSS in monitoring petroleum hydrocarbons has been mentioned in paragraph 24. It is envisaged that IGOSS may, in the future, undertake the monitoring of other pollutants as well. Other ocean monitoring has been or is being started on a geographically limited - regional - basis. First steps in that direction have been taken by the North Sea and Baltic countries under the ICES programme. UNEP, together with the specialized agencies concerned, is setting up a comprehensive monitoring programme in the Mediterranean, and has asked the oceanographic institute in Goa (India)

to undertake pre-programming activities for the monitoring of the Indian Ocean. GEMS will ensure that pollutant monitoring in the Mediterranean and the Indian Ocean, and in any other sea in which multinational monitoring activities are launched under its auspices, is properly co-ordinated and provides the information needed to follow the flow of pollution from and into land, sea and atmosphere.

3. Background (baseline and regional) monitoring

34. Only air monitoring has been explicitly planned, and is being carried out by WMO at baseline and regional stations. The purpose of the former is mainly to study the long-term trends, unaffected by the short-term fluctuations that are recorded at impact stations, of pollutants (especially carbon dioxide) that may influence the weather. The latter aim primarily at studying long-term trends which may be related to changes in land-use practices. As mentioned before, the results of regional monitoring may yield information that is important in determining the effects of pollution on the environment. It would seem desirable to have some of the regional and baseline stations located within the biosphere reserves to be established under the MAB programme of UNESCO. This possibility is currently being explored. It is planned that UNEP should give strong support to both baseline and regional stations, particularly to those to be established within biosphere reserves.

35. While the distinction between baseline and regional monitoring is seldom possible in media other than the atmosphere, monitoring in circumstances in which the variable is not exposed to short-term fluctuations remains of great interest to ascertain secular trends. Special monitoring of food, for instance, in areas distant from sources of pollution or in seas remote from industrialized or heavily populated shores would have great interest. A knowledge of the state of pollution before the days when systematic monitoring was started would be equally valuable, particularly in the case of such naturally occurring agents as heavy metals. Within the GEMS project, the Scientific Committee on Problems of the Environment of the International Commission of Scientific Unions is undertaking to explore the possibilities of reviewing literature records for that purpose and of analysing preserved samples.

B. Other aspects of environmental monitoring

36. Under this heading the IMM listed (see paragraph 7 above) a number of variables basically unrelated to pollution. As recommended by the IMM and reaffirmed in paragraph 4(g) of General Assembly resolution 3326(XXIX), Assembly monitoring of these variables is considered a matter of priority because it will facilitate the solution or prevention of environmental problems that affect or affect principally developing countries.

37. As with pollutant levels, GEMS will only be concerned with the systematic measurements of those variables that will help provide the description, and ultimately the understanding, of the long-term time and space trends that are among the requisites for deciding, on the basis of criteria that monitoring alone cannot provide, whether and when corrective action should be taken or at least recommended.

38. Most of the variables labelled "other aspects" are discussed at some length in document UNEP/GC/31, and the discussion here will be limited to a few considerations on the appropriateness of monitoring them internationally and on the actions that are envisaged to that effect.

1. Health monitoring

39. The most systematic source of information on the health status of a population is provided by properly collected and analysed vital and health statistics. Their reliability varies notoriously from country to country, and intensive efforts have been and continue to be made at the international level to improve their reliability, their completeness and their comparability. Where this has been achieved, statistics such as those on infant mortality on morbidity and on causes of death reflect, among other things, the environmental sanitation standards of a population. By providing broad indicators of the population's health state, these statistics can serve as non-specific pointers to priorities for environmental policies, particularly when the information they yield is interpreted in the light of other evidence. International statistics of animal health present problems similar to those of human health statistics, and may also serve the purpose of providing non-specific indicators of the impact of the environment on the health of domestic animal species.

40. Although there are at present no specific indicators of the impact of the environment on human health that can be monitored systematically in any population, the incidence of certain birth defects or of certain malignancies is likely to be related to environmental factors and should be recorded in national vital and health statistics as well as in specific disease registers. The adaptation and development of health statistics and disease registers for environmental health purposes is being undertaken by WHO under its environmental health monitoring programme, which is being closely co-ordinated with GEMS.

41. The identification of specific indicators of the health impairment of a population resulting from environmental agents is still in the realm of research, particularly of epidemiological research on groups of individuals at high risk because of the levels of toxic agents to which they are exposed (as in certain locations or in certain occupations) or because of their sensitivity to certain agents owing to age or to nutritional or health status. While such research appears to fall outside the scope of GEMS, it is of course urgent that it be carried out on a wide co-operative basis, as planned under the UNEP programme related to health.

2. Monitoring of the degradation of natural resources

42. Most readily accessible natural resources are quite firmly under the natural jurisdiction of individual States. Monitoring of their depletion or degradation amounts to making periodic inventories of these resources, particularly in those areas in which changes, natural or man-made, occur rapidly and which can therefore be identified as being critical. To be carried out on an international basis such inventories must be justified

not only by the global or regional interest of the information sought but ultimately by the uniqueness and importance, for the countries directly involved, of information that can only be acquired by an international effort. Under this type of monitoring only changes in forest cover, arid land spread and soil degradation will be briefly discussed. These are the areas in which the possibility of systematic monitoring was under consideration within the UNEP secretariat at the time of preparation of the present report.

(a) Forest cover

43. The extent and type of forest cover is a characteristic of the earth's surface that affects global climate because of the influence it has on the earth's albedo and on evaporation processes, and therefore on the heat balance of the planet; that plays an important role in regional and local hydrological processes and in the conservation of soils; and that provides an essential repository of highly diverse plant and animal species. At the local level however, the economic and social importance of forests as suppliers of timber and of potential arable land provides a powerful incentive to disregarding their geophysical and biological role.

44. The pressure of economic needs and of population growth has thus resulted in the progressive encroachment of man on the forests and led in many cases, as in most Mediterranean areas, to their virtual destruction. The process has particularly accelerated in recent years in the major remaining forested areas of the world, namely those lying within the tropical belt in Africa, Oceania, Latin America and South East Asia.

45. The rate and extent of the deforestation process has, however, proved extremely difficult to assess with any precision, despite such international efforts as the World Forest Inventory that FAO has conducted through questionnaires for a number of years. This effort proved very slow and difficult to conduct; despite all efforts, the information supplied by the respondents lacked standardization, and the results of national inventories were difficult to collate because of heterogeneity due to different objectives, definitions, classifications and methodology.

46. To overcome both the relative inefficiency and the low reliability of the methods so far employed, new approaches are required. These must yield, in any one area and at any one time, objective results that can be compared with results obtained in other areas and at other times and do not overtax the human and financial resources of the countries concerned. An FAO expert consultation conducted with UNEP support concluded that only a long-term monitoring project organized on an international basis could provide the knowledge required to enable the countries concerned to size up the problem that they and the world face, and to make informed decisions on the policies they want to adopt.

47. The survey would make full use of the results, in many cases already available, of current techniques of remote sensing both from aircraft and, where feasible and acceptable, from satellites, and compare these results with the few reliable records of the state of the forest cover

collected during the last two or three decades. The survey would continue in the future to provide information on further changes in forest cover. The proposal of the expert meeting for a staged implementation of such a programme by FAO and UNEP is now under consideration.

(b) Soils

48. The global distribution of soils and their condition has been the object of long-term projects undertaken jointly by FAO and UNESCO and by ISSS and UNESCO for the preparation, respectively, of the Soil Map of the World and of the World Map of Salt-Affected Soils. These projects are providing useful inventories, but do not directly contribute to knowledge of the rate at which soils are being degraded and lost through various processes such as erosion, salinization, alkalization, etc. To gain such knowledge, which is essential in order to determine land potentialities for agricultural and other uses and to plan actions aimed at restoring or at least maintaining soil quality, new techniques for assessing soil changes must be devised.

49. An expert consultation convened by FAO and UNEP has recommended the development of a methodology and the establishment of uniform criteria that will permit the utilization of existing data for the assessment of soil degradation. This will involve the processing and analysis of data already stored in connexion with the establishment of the soil maps, supplemented by meteorological data and by information that might be gathered through remote-sensing techniques. Based on the recommendation of that consultation, a project is now under consideration that envisages the preparation - on a limited basis at first - of a map of soil degradation. This might eventually be expanded, when the relevant methodologies have been properly worked out, to cover the world.

(c) Arid and grazing lands

50. Monitoring of arid and grazing land will mean determining the trends in productivity and the extent and rate of loss of agricultural and range land to deserts in semi-arid areas, and identifying the role that various processes (from erosion to overgrazing to bush fires) play in bringing that loss about. As in other fields, the information available at present is patchy and the integration of results obtained in different areas through different methods and on different aspects of this problem is extremely difficult. There is, here also, a great and urgent need for monitoring surveys that will provide a much more unified and comprehensive picture of this situation as it evolves at the interface between agricultural land, range land and deserts. Since desertification is of vital importance to a number of adjacent countries, monitoring of this process will best be achieved on a regional basis by pooling resources that few of the countries affected can provide alone.

51. Several projects are being considered, each approaching the problem from a different angle. One of the tasks of GEMS will be to focus on those that, suitably co-ordinated and interlocked, will supply the data needed for rational management.

(d) Other resources

52. The previous paragraphs singled out three areas in which monitoring, or work preparatory to it, is likely to be undertaken shortly with UNEP's support. The IMM also mentioned wildlife and aquatic ecosystems. The need for international monitoring of these and possibly other resources such as animal, plant and microbial genetic resources, will be considered in the near future.

3. Monitoring related to climatic changes

53. WMO is currently considering various aspects of monitoring in relation to studies of climatic change. To that effect a conference on "The Physical Basis of Climate and Climate Modelling" was held in 1974, with UNEP assistance, under the WMO/ICSU Global Atmospheric Research Programme. This brought to light the complexity of the variables that must be monitored in such media as the oceans and the cryosphere, in addition to those already monitored in the atmosphere, to determine the parameters of any predictive model of climatic changes. A coherent plan for the monitoring of those variables that merit priority from this point of view is expected to be available in the near future.

4. Monitoring related to natural disasters

54. Monitoring of certain variables discussed in earlier paragraphs is indirectly related to warning against natural disasters. Thus forest cover monitoring will provide information related to flood warning and monitoring of soils and of arid and grazing lands will provide information related to droughts and famines.

55. There are in addition a number of variables and phenomena which themselves can be the causes of disasters, and should be monitored on a global or at least regional basis in order to obtain information that could help in warning against or preventing disasters, and could in some cases lead to more effective relief and rehabilitation measures when a disaster has occurred. Examples are the monitoring of the earth's crust, which may lead to earthquake prediction; of volcanic activity, which may make the prediction of eruptions possible; of snow cover, for flood warning, and of cyclonic storms, as is being done within the World Weather Watch programme. In certain cases remote sensing can prove of critical help in the immediate assessment of the extent of a disaster that only inefficient and time-consuming field surveys could otherwise achieve. A detailed exploration of these possibilities had not been made at the time of the preparation of the present report, but will be carried out with UNDR0 in the near future.

II. THE IMPLEMENTATION OF GEMS

56. The implementation of GEMS has so far consisted primarily of provision of support for a number of projects related to development of the monitoring system and to the assembling of an embryonic staff. The projects are listed in document UNEP/GC/32, and many of them were referred to in Part I of this report. Most aim at preparing the ground for actual monitoring projects or for projects involving active co-ordination of monitoring activities. As they come to completion, the pre-programming projects will give rise to operational projects requiring larger outlays than those approved so far. Most of the projects related to GEMS are being, and will continue to be, undertaken by United Nations organizations, thus putting into effect many of the proposals made for the IMM by the Inter-Agency Working Group on Monitoring in document UNEP/IG.1/2.

57. Monitoring activities are aimed at producing information. Since the analysis of information of global or regional scope is one of the tasks of GEMS, decisions will need to be made at an early stage as to the type and amount of information to be sought, processed and stored. Because many national monitoring programmes predate GEMS, in making these decisions account will need to be taken of the information already collected throughout the world. For each monitoring activity relevant to GEMS it will therefore be necessary to take the following steps:

(a) To identify those laboratories and institutions currently engaged in the activity;

(b) To enquire in detail about the information they collect;

(c) To determine the information that can be sought by GEMS with a minimum of disruption to national programmes; and

(d) To initiate direct requests for such information by the GEMS staff or through United Nations agencies or other organizations, as appropriate. In either case this will require increasingly close co-operation with Member States, as the major suppliers of data, and full utilization of IRS facilities.

58. It is planned to undertake step (a) as soon as possible by asking those United Nations organizations that have direct contact with national monitoring programmes to forward to UNEP the relevant information available to them. This would then be sent to UNEP focal points for verification of its accuracy and completeness. In the meantime, a questionnaire or questionnaires would be prepared by UNEP and sent [step (b)] directly, or through UNEP focal points, to the national institutions identified under step (a). This would make it possible to map out in reasonable detail the activities that are being carried out in individual countries and thus lay the ground for a meeting of an ad hoc group of government experts [step (c)] to advise UNEP on the data that it will need to secure from Member States. These data would then be requested accordingly [step (d)].

59. Knowledge gained under steps (a) and (b) on the extent to which monitoring operations are carried out in Member States, will also make possible a first determination of the gaps in coverage that must be filled and of the needs for intercalibration and for training and other forms of assistance. The Governing Council will, at its fourth session, be informed in detail of the results of these preliminary activities. By the time of the fifth session of the Governing Council it can be expected that the collection and analysis of information under the aegis of GEMS will have been initiated.

60. The meeting of an ad hoc group of Government experts was mentioned in paragraph 58. It is likely that other expert meetings may prove necessary in the near future, for instance, to identify the requirements for training of technicians and experts in monitoring, with particular regard to the needs of the developing countries. When GEMS is fully under way, however, it will need to receive, directly or indirectly, more detailed guidance from Member States than the Governing Council can provide during the necessarily brief debate that it can devote to problems of monitoring, and more consistent guidance than ad hoc groups of experts can provide. One way of obtaining this guidance would be to use a standing advisory group of experts on matters related to monitoring, appointed by the Executive Director in consultation with or on the recommendation of Governments. Alternatively a steering committee of Government representatives could be selected on a basis determined by the Governing Council. Both alternatives have obvious merits and drawbacks. It is suggested that one of the tasks of the ad hoc group of Government experts referred to in paragraph 58 should be to make concrete proposals on this matter to the Governing Council at its fourth session.

61. Whether an advisory group is appointed or a steering committee established, its main functions will be to set broad policies for GEMS within the UNEP programme as approved by the Governing Council and to review and analyse, on the basis of working documents prepared by or at the request of the GEMS staff, the results of monitoring operations performed by Member States. The purpose of the reviews will be:

- (a) To provide the Governing Council with quantitative information on the state of the environment and on the trends it undergoes;
- (b) To point out the flaws (gaps, redundancies, lack of calibration, etc.) in current regional or global monitoring activities;
- (c) To make recommendations to the Governing Council on how to expand, reduce or improve monitoring activities; and
- (d) To suggest possibilities of training and technical assistance in the field of monitoring.

62. The role of the GEMS staff has already been mentioned in paragraph 58 in connexion with the requests for data from Member States, and in the previous paragraph in connexion with the preparation of working documents as a basis for the reviews to be sent to the Governing Council. Three further functions should be mentioned here:

- (a) To ensure that the views and decisions of the Governing Council, as interpreted by the advisory group or steering committee on monitoring that may be established, are followed in the implementation of GEMS;
- (b) To advise the Environment Fund on the financial support it should give to monitoring projects;
- (c) To maintain contacts with national institutions and laboratories and with United Nations and other organizations.

63. Contacts with national institutions and laboratories will be maintained through focal points. Whether these should simply be the UNEP national focal points or whether GEMS focal points will be needed cannot yet be said. Most of the Government departments engaged in monitoring already communicate with the relevant United Nations agencies through established official channels, and only experience will tell whether these channels and the UNEP focal points may suffice to ensure communication between the GEMS staff and national institutions and laboratories, without adding a further component to an already complex network.

64. With regard to United Nations organizations, contact will be maintained by the GEMS staff both directly and through participation in the meetings of the GEMS Sub-group of the Inter-Agency Working Group on Earthwatch ^{1/} a subsidiary body of the Environment Co-ordination Board. The task of the Sub-group is to ensure participation of its members in GEMS and to provide for exchange of information on, and for co-ordination of, planned and ongoing activities related to monitoring. Interested agencies would also attend any meetings of expert groups or committees related to GEMS.

65. No separate formal machinery is envisaged to maintain contact with other governmental and non-governmental organizations. The GEMS staff will, however, keep Member States and United Nations organizations informed of any development in this regard.

III. CONCLUSIONS

66. It is recommended that the Governing Council:
- (1) Adopt the objectives, principles, programme goals and general guidelines for GEMS as proposed by the IMI (see Appendix 1);
 - (2) Decide that GEMS
 - (a) Being primarily concerned with global and regional matters, will encompass monitoring programmes providing information that:
 - (i) May lead to concerted action by more than one or by all countries; or
 - (ii) Can only yield results, even of local import, if more than one country is involved in them;

^{1/} The Sub-group held a first two-day meeting in January 1975 and considered, among other things, an early draft of the present report. The report owes much to the comments and suggestions made during that meeting.

(b) Will also provide a framework within which Member States can exchange information on the monitoring experience that each has gained at local level and can ensure that their data are comparable with those collected for the same purpose in other countries;

(3) Interpret the monitoring priorities listed by the IMM in the light of sub-paragraph (b) above, as exemplified in part I of the present report;

(4) Note the action taken so far in the implementation of GEMS;

(5) Authorize the Executive Director to continue in the implementation of GEMS, including the provision of training, having regard to the varying needs of countries in different geographical and economic situations, and especially to the needs of developing countries;

(6) Ask the Executive Director to ensure that the work of GEMS is suitably co-ordinated with the other elements of the programme and that the maximum amount of feedback obtains between GEMS and the other elements of the programme, and vice versa;

(7) Note with satisfaction that the Environment Co-ordination Board has established an Inter-Agency Working Group on Earthwatch and that its Sub-group on GEMS has begun to work;

(8) Authorize the Executive Director to appoint a small ad hoc group of Government experts to assist him in defining the data to be sought from Member States and to make recommendations on the standing machinery that may be required to provide UNEP with continued advice and guidance on matters related to monitoring.

Annex I

Excerpts from the report of the Intergovernmental Meeting
on Monitoring contained in document UNEP/GC/24

I. DEFINITION OF OBJECTIVES AND PRINCIPLES
(agenda item 4)

21. On the basis of a draft prepared by a working group presided by the Vice-Chairman, Dr. Odhiambo (Kenya), the Intergovernmental Meeting, after considering certain amendments proposed to that draft, approved the objectives and principles set out below:

Objectives

22. The objectives of the Global Environmental Monitoring System (GEMS) are:

To provide information necessary to ensure, in conjunction with evaluation and research, the present and future protection of human health, well-being, safety and liberty and the wise management of the environment and its resources by:

- (a) (i) Increasing quantitative knowledge of natural and man-made changes in the environment and of the impact of these on man's health and well-being;
- (ii) Increasing understanding of the environment and, in particular, of how dynamic balance is maintained in ecosystems, as a basis for managing resources;
- (b) Providing early warning of significant environmental changes (including natural disasters) in order that protective measures may be organized;
- (c) Making it possible to check the effectiveness of established regulatory mechanisms and to plan optimal technological development.

Principles

23. The principles governing intergovernmental co-operation in monitoring are:

- (a) Intergovernmental co-operation in monitoring should build on the basis of existing national and international systems to the maximum possible extent, while making all useful arrangements for eliminating, as far as possible, the existing gaps;
- (b) Existing United Nations specialized agencies should be used to the maximum extent possible as the institutional base for co-ordinating and implementing monitoring programmes. It is essential to improve co-ordination mechanisms within the United Nations framework;

- (c) With regard to monitoring on an international basis, priority should be given to global and regional (multi-national) problems;
- (d) The exchange of information about local problems that are of wide occurrence, and about the methods used to monitor them, is of high importance;
- (e) Special emphasis should be given in global monitoring to the variables of most critical importance that are capable of adequate scientific measurement at the present time. Where the measurement techniques for variables of critical importance are deficient, special attention should be given to their development and to arrangements that make it possible to ensure the comparison and homogeneity of measurements;
- (f) Monitoring systems should be designed to meet clearly defined objectives, and arrangements for the evaluation of the data must be an integral part of the design of the system;
- (g) Nations that agree to participate in a system of global or regional monitoring incur an obligation to exchange promptly appropriate data or evaluations of data, especially in relation to the early warning of natural disasters or disasters occurring as a result of human activities affecting regional or subregional resources;
- (h) As international monitoring implies the participation of many nations without regard to their stage of economic development, assistance should be given, where necessary, especially in the field of training and equipment, to ensure effective involvement of the developing countries;
- (i) Nations should share the responsibility for implementing international monitoring systems in areas outside national jurisdiction, such as oceans and space. Activities carried out on national territories will be the responsibility of the nations concerned.

Programme goals

24. Programme goals provide the focus for a global environmental monitoring system so that it can be responsive to priority subject areas of the United Nations Environment Programme. Programme goals are intended to ensure effective co-ordination and integration of the component monitoring systems, adaptation of the global system to all levels of development, and utilization of monitoring results to facilitate action. These programme goals, not listed in priority order, include:

- (a) An expanded human health warning system;
- (b) An assessment of global atmospheric pollution and its impact on climate;

- (c) An assessment of the extent and distribution of contaminants in biological systems, particularly food chains;
- (d) An assessment of critical environmental problems relating to agriculture and land and water use;
- (e) An assessment of the response of terrestrial ecosystems to pressures exerted on the environment;
- (f) An assessment of the state of ocean pollution and its impact on marine ecosystems;
- (g) An improved international system allowing the monitoring of the factors necessary for the understanding and forecasting of disasters and the implementation of an efficient warning system.

General guidelines

25. There is a need to co-ordinate the development of national, international and sectoral guidelines for each of the programme goals listed above and for the overall objectives of GEMS. This is essential in order to elucidate pollutant pathways, sinks and impacts, to control existing pollution and its spread to hitherto clean areas and to optimize the use of natural resources.

26. These guidelines relate to:

- (a) The establishment of relevant national focal points required for co-ordinating, accessing and transmitting the results of monitoring;
- (b) The design and implementation of national, regional and global monitoring programmes including data collection, processing, reduction and assessment;
- (c) The improvement of data exchange and processing within and across sectors and at varying levels of detail;
- (d) The development of sound planning and an adequate scientific and technical basis before any new monitoring programme is established.

Recommendation

27. The Intergovernmental Meeting on Monitoring recommends that the Governing Council adopt the definition of objectives and principles, programme goals and general guidelines, as presented in paragraphs 22, 23, 24, 25 and 26 above.

Annex II

Table 1 from document UNEP/GC/24/Corr. 1

List of Priority Pollutants^{a/}

Priority Order	Pollutant	Medium ^{b/}	Type of Programme ^{c/}		
I	(SO ₂ + suspended particulates	Air	I	R	B
	{ Radionuclides (⁹⁰ Sr + ¹³⁷ Cs)	Food ^{d/}	I	R	
	{ O ₃ ^{e/}	Air	I		B ^{f/}
II	{ DDT and other (organo-chlorine compounds	Biota, man ^{g/}	I	R	
III	{ Od and compounds	Food ^{d/} , man, water	I		
	{ (Nitrates, nitrites ^{h/}	Drinking water, Food,	I		
	{ (NO, NO ₂	Air	I		
IV	{ (Hg and compounds	Food ^{d/} , water	I	R	
	{ (Pb	Air, food	I ^{i/}		
	{ (CO ₂	Air			B
V	{ (CO	Air	I		
	{ (Petroleum hydrocarbons	Sea		R	B
VI	fluorides	Fresh water	I		
VII	{ (Asbestos	Air	I		
	{ (As	Drinking water	I		
VIII	{ (Mycotoxins	Food ^{d/}	I	R	
	{ (Microbial contaminants	Food ^{d/}	I	R	
	{ (Reactive hydrocarbons	Air	I		

^{a/} This list should be reviewed periodically.

^{b/} Measurements in air should include measurements in precipitation where appropriate.

^{c/} I = impact; R = regional; B = baseline.

^{d/} Food includes animal feed.

^{e/} Global distribution high in the stratosphere, low in the troposphere.

^{f/} Concerns ozone in the stratosphere.

^{g/} In designing the programme, consideration should be given to including food monitoring.

^{h/} No adequate techniques available for multi-media analyses of nitrosamines.

^{i/} In designing the programme, consideration should be given to including regional stations.

Annex III

Excerpts from the Report of the United Nations Scientific Committee
on the Effects of Atomic Radiation (A/9632)

IV. CONSIDERATION OF DECISION 9(II) OF THE GOVERNING COUNCIL
OF THE UNITED NATIONS ENVIRONMENT PROGRAMME AND RELATED MATTERS

11. The Committee noted decision 9(II) of 22 March 1974, by which the Governing Council of the United Nations Environment Programme (UNEP) decided that the Programme, in co-operation with the Scientific Committee and other relevant bodies of the United Nations system, should assign high priority in its Global Environmental Monitoring System to the monitoring of radio-nuclides resulting from nuclear tests and report regularly on this matter to the Governing Council. In this connexion, the Committee recalled that it had no operational responsibility for monitoring radiation, but that since its establishment in 1955 it had actively sought, and kept under continued review, data on levels of radio-activity in the environment collected by Member States. While paying special attention to the assessment of radiation doses resulting from radio-active contamination by nuclear tests, the Committee had always evaluated these doses and the attendant risks along with those due to other, and in many cases quantitatively more important, sources of radiation exposure.

12. As indicated in paragraph 19 below, the Committee planned to continue in the future its activity of review and assessment of doses, effects and risks of radiation from all sources, and felt that its work could contribute significantly to UNEP. It expressed the hope that active co-operation with the Programme in these matters could be firmly established and maintained in the future, thus helping to ensure the continued effectiveness of the programmes of the two bodies and avoiding unnecessary duplication.

13. The Scientific Committee also considered the list of those pollutants that the intergovernmental meeting on monitoring, held at Nairobi in February 1974, had recommended to be monitored as a matter of priority in the framework of UNEP.

14. The Committee did not regard it as appropriate to comment on the ranking within the list, but noted that the monitoring of strontium 90 and caesium 137 in food, at both "impact" and regional level, had been assigned the highest priority. The Committee considered that, as long as the contamination of food by these nuclides was overwhelmingly due to atmospheric nuclear tests, measurements of strontium 90 and caesium 137 in food were still valuable when part of a continued series of measurements going back several years, as was the case with many of the surveys still currently being carried out. These surveys made it possible to observe the trends in food levels and to verify the consistency with actual observations of the values predicted on the basis of transfer models and the estimated inventories of the relevant nuclides.

15. However, as indicated above, the depositions of strontium 90 and caesium 137 produced by recent atmospheric tests in both hemispheres less than balanced the decreased availability of older deposits of strontium 90 and caesium 137 released during earlier series of tests, resulting in a world-wide levelling off of the concentrations of these nuclides in food at values far lower than those that had been observed in the past. In the circumstances, the Committee felt that it would be unfortunate if the ranking given to those measurements by the intergovernmental meeting on monitoring were to encourage the establishment of new surveys of strontium 90 and caesium 137, thus diverting resources that could be applied to more pressing monitoring needs.

16. The Committee would rather recommend that, among the nuclides to be monitored after atmospheric nuclear tests, priority be given to iodine 131 in milk in areas exposed to fresh fall-out and where fresh milk is an important component of the infants' diet, and to selected gamma emitters in air and precipitation. Short-lived gamma emitters, in particular, can be important contributors to the external radiation dose that may be received by the populations exposed to fall-out in the few weeks following an atmospheric test. At the same time, the global inventories of strontium 90, caesium 137 and other long-lived radio-nuclides should continue to be kept under surveillance, as is currently being done.

17. With regard to the contamination of food with strontium-90 and caesium 137 from controlled uses of nuclear energy, the Committee was of the opinion that the contribution to current food levels from these uses was too low to be detected except at special locations in the vicinity of nuclear energy facilities and that the priority to be given to surveys of strontium 90 and caesium 137 from these sources in food should accordingly be very low but would have to be determined and justified in the light of local situations.