REGIONAL SEAS

UNITED NATIONS ENVIRONMENT PROGRAMME

Prospects for global ocean pollution monitoring

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PREFACE

Twelve years ago the United Nations Conference on the Human Environment (Stockholm, 5-16 June 1972) adopted a Declaration on the Human Environment, as well as an Action Plan for the Human Environment, including General Principles for Assessment and Control of Marine Pollution.

According to Principle 7 of the Declaration adopted at the Conference:

> "States shall take all possible steps to prevent pollution of the sea by substances that are liable to create hazard to human health, to harm living resources and man's life, to damage amenities or to interfere with other legitimate uses of the sea."

Recommendation 73 of the adopted Action Plan

> "recommended that governments actively support, and contribute to, international programmes to acquire knowledge for the assessment of pollutant sources, pathways, exposures and risks."

In the light of the results of the Stockholm Conference, the United Nations General Assembly decided to establish the United Nations Environment Programme (UNEP) to "serve as a focal point for environmental action and co-ordination within the United Nations system" (General Assembly resolution 2997(XXVII) of 15 December 1972). The organizations of the United Nations system were invited "to adopt the measures that may be required to undertake concerted and co-ordinated programmes with regard to international environmental problems", and the "intergovernmental and non-governmental organizations that have an interest in the field of the environment" were also invited "to lend their full support and collaboration to the United Nations with a view to achieving the largest possible degree of co-operation and co-ordination."

The Governing Council of UNEP chose "Oceans" as one the priority areas in which it would focus efforts to fulfil its catalytic and co-ordinating role. Recognizing that the contamination of the marine environment by pollutants is generally most severe in semi-enclosed seas and coastal areas, UNEP's efforts were concentrated on promoting regional marine pollution monitoring and control programmes in areas which for geographic, ecological or political reasons were perceived as forming a regional entity. On this basis the Regional Seas Programme was initiated by UNEP in 1974. Since then the Governing Council of UNEP has repeatedly endorsed a regional approach to the control of marine pollution and the management of marine and coastal resources and requested the development of comprehensive regional action plans to achieve this goal.

The Regional Seas Programme at present includes eleven regions [1/] and has over 120 coastal States participating in it. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassing a comprehensive approach to combating environmental problems through the management of marine and coastal areas. Each

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1/ Mediterranean, Kuwait Action Plan Region, West and Central Africa, Wider Caribbean, East Asian Seas, South-East Pacific, South Pacific, Red Sea and Gulf of Aden, East Africa, South-West Atlantic and South Asian Seas.

regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities 2/.

In the framework of the action plans adopted or being developed, the monitoring of the sources, pathways and effects of pollutants has a prominent role. UNEP, as the overall co-ordinator of the Regional Seas Programme, is ensuring that the monitoring is carried out with methods yielding comparable results on a global scale. This is achieved through generally applicable guidelines and reference methods for marine pollution studies as well as through emphasis on quality control of data including mandatory intercalibration of sampling and analytical methods.

It is hoped that this regional approach will gradually expand into a global monitoring system implemented through regional components and that it will ultimately become the ocean component of UNEP's Global Environment Monitoring System (GEMS).

At the same time UNEP has supported a variety of activities aiming at the assessment of environmental problems of the global oceans 3/ and at the development of a feasible concept of global ocean monitoring. Notably, support has been provided to GESAMP, GIPME, IGOSS and to the International Symposium on Integrated Global Ocean Monitoring (Tallin, 3-8 October 1983).

As a contribution to the Tallin symposium, two studies were commissioned by UNEP. One, the "Feasibility Study of BAPMoN Stations Monitoring Background Open Ocean Pollution" was prepared by Mr. C.C. Wallen. The other, the "Prospects for Global Ocean Monitoring" was prepared by Messrs. B.G. Bennett and D.J.A. Davies of the Monitoring and Assessment Research Centre (MARC). Both of these studies are reproduced in this document in their entirety.

In addition, this document also contains the final version of the "Summary Report and Recommendations" of the Tallin Symposium as well as the terms of reference of the GESAMP Working Group on Integrated Global Ocean Monitoring (Working Group No. 24), established at the Fourteenth Session of GESAMP (Vienna, 26-30 March 1984) at the request of UNEP.

2/ UNEP: Achievements and planned development of UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. UNEP Regional Seas Reports and Studies No. 1. UNEP, 1982.

3/ GESAMP: The health of the oceans. UNEP Regional Seas Reports and Studies No. 16. UNEP, 1982.

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FOR
GLOBAL OCEAN POLLUTION MONITORING

BACKGROUND

The oceans cover 70 per cent of the earth's surface and are thus a major component of the environment. They play a significant role in biogeochemical cycles, in stabilising climate, and in providing marine resources. It is recognized that the polluting activities of man must not be allowed to impair the health of the oceans. Therefore, it is necessary for man to obtain a fundamental understanding of marine systems and, whenever appropriate and feasible, to monitor the levels and effects of pollutants.

Enhanced levels of hydrocarbons, organochlorines and PCBs, heavy metals and radioisotopes are particularly evident in coastal areas and land-locked seas. Co-ordinated international programmes have been formulated to investigate and reduce contaminant levels in these regional seas. Broad coverage of coastal areas with wide participation of adjoining States has been achieved by the Regional Seas Programme of UNEP.

The open oceans do not seem to be seriously polluted. This is the conclusion of the UNEP review of the World Environment 1972-1982 (UNEP, 1982), and of the joint scientific expert group study of the health of the oceans (GESAMP, 1982). But this conclusion is tentative and based on indirect and poorly verified evidence, as monitoring techniques are still in the process of development. It is necessary to follow these developments and to evaluate many other considerations to determine the need, feasibility and practicalities of open ocean monitoring.

In this report a few thoughts are gathered together to assist in the evaluation process. Throughout the world, there is a great deal of research in progress in the marine environment, and there exists a complex array of international committees to co-ordinate the investigations and/or to evaluate the results. A very wide view is required to try and see the way ahead.

INTRODUCTION

A great deal of knowledge is needed to assess the effects of pollutants in the ocean, including information from the fields of physical and chemical oceanography, marine biology, ecology, geology and meteorology. There is a continuing need for further work, both surveying and basic research of input of pollutants into the sea. The basic processes to be understood are those of transport, distribution, accumulation and exchange of nutrients and toxic substances in the marine environment, the interplay of abiotic and biotic factors, and seasonal and geographic variabilities. There is a continuous transfer of energy and materials within the ocean and important interchanges occur at the air-sea and sea-sediment boundaries.

Pollutants enter the oceans from airborne deposition, river outflows, off-shore oil or mineral exploitation, natural seepage, or shipping, waste dumping and direct discharges. The inputs are non-uniform and, therefore, the impacts may be variable. It is necessary to develop some concept of the capacity of the oceans to receive contaminants in order to foresee the potential effects on the health and stability of the marine environment.

Contamination of the marine environment is generally most severe in semi-enclosed seas and coastal areas and is correlated with the distribution of human populations and activities. A substantial proportion of the contamination in such waters arises form the discharge of sewage. The contents of sewage are highly variable, but usually include domestic and industrial wastes, storm water and surface run-off resulting in a heterogeneous mixture of organic matter, nutrients, micro-organisms, oils and metals. There is transfer of contaminants from coastal regions to the open ocean.

Over the last decade, increasing concern over the mounting anthropogenic inputs of pollutants to the marine environment has stimulated research by several countries with additional projects and reviews supported by a number of international organizations. Intensive studies of water circulation, chemical composition and distribution of basic pollutants and their effect on ecosystems and processes involved in sea-air interactions have been carried out. However, in most cases, these studies are individual research efforts and the measurements are not always interrelated or even intercomparable.

It has been suggested that in order to obtain a fuller understanding of global oceanic processes, additional monitoring activities must be undertaken, particularly with an integrated approach. The International Symposium on Integrated Gobal Ocean Monitoring (Tallin, USSR, October, 1983) is being convened to discuss this suggestion.

The objectives of integrated global ocean monitoring, as proposed by the Soviet convenors of the Symposium, (Israel, 1983), include:

1. The establishment of an effective system for ecological and physical monitoring of the world's oceans;

2. The organization and implementation of routine comprehensive long-term observations and of large-scale integrated experiments in the world's oceans;

3. The investigation of the most important thermohydrodynamic processes that influence marine ecosystems in hydrologically active zones of the oceans;

4. The investigation of the most important ecological processes characterizing the current state of the oceans, the negative effects of pollution and the natural self-purification processes in hydrologically active areas of the oceans, including:

   (a) studies on pollutant distribution and accumulation in marine organisms, bottom sediments and suspended matter;

   (b) identification of the structure and behaviour of marine biota, particularly primary production of organic matter, photosynthetic pigments, seston biomass and intensity of bioluminescent activity;

   (c) identification of microbial oxydation of organic pollutants; and

(d) identification of deposition by biosedimentation of suspended organic matter.

5. The assessment of the current biological state of the world oceans in different geographical zones;

6. The establishment of a system of ecological standardization and substantiated norms of impact on marine ecosystems in various geographical zones.

The objectives of the proposed programme outlined above are wide-ranging and of a general nature. In view of the complex problems involved, it is an ambitious proposal. Before approaching the question of feasibility, it is worth considering whether or not there is a need for such a programme at present. In this context it should be useful to briefly review past and present monitoring programmes and identify the major areas of interest in current marine oriented research.

REGIONAL AND GLOBAL OCEAN MONITORING PROGRAMMES

There has been considerable interest throughout the world in the study of the marine environment. Efforts have been made to discover fundamental processes of marine systems, to manage the living resources and to control pollution. As these efforts increased and the needs were recognized to promote and co-ordinate the work, international programmes were developed. Most co-ordinated research and monitoring efforts have been initiated and organized on a regional basis where problems are more easily recognized and co-operative efforts more easily arranged.

One of the earliest organizations to promote international co-operation in marine studies is the International Council for the Exploration of the Sea (ICES), which was established in 1902. Marine pollution studies began in the 1960s. The organization is active primarily in the North Atlantic Ocean, the North Sea and the Baltic Sea. The scientific organization of ICES has become aligned with various regional groupings, such as the Oslo and Paris Commission, the Helsinki Commission and with fisheries resource commissions. Since 1971 the ICES has been co-operating in studies in the Baltic with the Scientific Committee on Oceanic Research (SCOR), a committee of the International Council of Scientific Unions (ICSU).

The SCOR/ICES activities in the Baltic Sea have included baseline studies of pollutants such as petroleum products, halogenated hydrocarbons and metals. The inter-calibration of analytical techniques has formed an important component of these studies for the purpose obtaining meaningful and comparable data. The extensive measurement programme has made a significant contribution toward knowledge of pollution in the area. Subsequent to intitial intensive surveys, it was decided that this part of the programme could be scaled down and resources redirected to the more clearly identified impact areas in the coastal and estuarine environment.

Several organizations within the United Nations system are active in promoting cooperation for the study, control and solution of ocean-related problems, including the United Nations Environment Programme (UNEP), the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Meteorological Organization (WMO) and the International Maritime Organization (IMO).

The Regional Seas Programme of UNEP was launched in 1974. Its first project was the implementation and co-ordination of an integrated Mediterranean Action Plan.

Initiated in 1975, the Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MEDPOL) set out to analyse sources, amounts, levels, pathways and trends of pollutants such as oil, hydrocarbons, heavy metals, polychlorinated hydrocarbons and various micro-organisms in biota, sea water and sediments and to study their effects on ecosystems (UNEP, 1983a). The successful completion of various pilot studies laid down firm foundations for further long-term studies (UNEP, 1983b). Regions covered by broadly similar action plans now include the Red Sea, the Kuwait Region, the Wider Caribbean, West and Central Africa, the East Asian Seas, the South Asian Seas, the South-East Pacific and the South Pacific (UNEP, 1982a).

Much of the initial effort and expense of the Regional Seas Programme have gone into the development of methodologies and capabilities in the various regions. The experience in the most advanced project in the Mediterranean has shown rather meagre scientific results in some areas of study. The monitoring of heavy metals in marine organisms has generated good results; somewhat less satisfactory were the results obtained for the organochlorine compounds. Monitoring of effects on organisms or ecosystem changes due to pollution has failed so far, for the complexities of interactions preclude clear identification of cause-effect relationships.

There has been one prime example of a global ocean monitoring project. This was a programme of observation of petroleum residues organized by the IOC and WMO with considerable support from UNEP. In the early 1970s these organizations saw the need for a marine pollution monitoring programme directed at certain physical and chemical parameters and concluded that the Integrated Global Ocean Station System (IGOSS) of the IOC and WMO would provide a suitable framework for such a programme. A pilot project - the Marine Pollution Monitoring Pilot Project (MAPMOPP) - was organized, which included visual observations of floating oil slicks and tar balls, measurements of dissolved or dispersed residues in the water column and the assessment of tar on beaches. The methods and techniques employed were generally limited to a low level of sophistication to enable wider participation by both developed and developing nations. The project began in 1975.

The pilot monitoring project (MAPMOPP) was intended to demonstrate the feasibility of monitoring certain aspects of petroleum pollution in the ocean on a global scale. Although considerable sums of money were invested in the project, there were only limited returns of any scientific value. It was shown that floating forms of oil pollution were closely associated with the tanker lanes and other major areas of ship activity. This rather obvious conclusion was obtained from visual observations. There was little evidence, based on limited experience, of residues in more remote, less travelled regions. Only an incomplete overview was obtained of tar stranded on beaches and of the distribution of dissolved and dispersed residues. The analysis of the residues was complicated by the fact that the water samples contained complex mixtures of oils, degradation products and hydrocarbons from various other sources. The lack of fully satisfactory reference samples and adequately specific analytical procedures added to the difficulties.

The project indicated that in order to obtain a complete picture of petroleum pollution in the marine environment, it would be necessary to study the concentration of petroleum residues in the sea surface microlayer, in sediments and in marine organisms. Clearly, more sophisticated measurement methods would be required. A final report on the pilot monitoring project was issued in 1981 (IOC, 1981). An operational extension of some of the monitoring activities has been proposed - the Marine Pollution Monitoring Programme for petroleum (MARPOLMON-Petroleum). The experience may well be useful in improving organizational procedures, but until adequate methodology has been developed, it is doubtful that the goal of establishing a spatially and chemically detailed baseline for petroleum hydrocarbons in the world's oceans can be achieved with any reasonable degree of reliability.

In 1976 the IOC published a Comprehensive Plan for the Global Investigation of Pollution in the Marine Environment (GIPME) (IOC, 1976), which proposed a systematic scientific approach to determine the extent of marine pollution. The major stages identified in the Plan were mass-balance computations (which include baseline measurements), contamination and pollution assessment, and regulatory action. Certain requisites for the collection of data for mass balance computations were outlined; these included the development and testing of techniques for the collection of baseline and boundary flux data for given contaminants.

Recently, a working committee of GIPME considered the continued applicability of the Comprehensive Plan and reviewed the priorities and strategy for current and planned activities within the GIPME Programme (IOC, 1982). It advocated that methodological developments for the analysis of the three main classes of contaminants (trace metals, petroleum hydrocarbons and organohalogens) be completed before undertaking baseline surveys. The Scientific Committee on Oceanic Research (SCOR) of ICSU expressed support for a mass-balance approach in a recent document on future ocean research but indicated that, in order to assemble a quantitative chemical description of the ocean, a wider understanding of marine processes was needed (SCOR, 1982).

Further discussion of ocean monitoring programmes, both regional and global, their development, progress and achievements, are given in a separate UNEP Regional Seas Publication (UNEP, 1982a).

DIRECTIONS OF CURRENT MARINE RESEARCH

The ocean environment is a complex system controlled by a variety of physical, chemical and biological processes. There is wide scope for research and much activity going on. The few topics to be mentioned here include air-sea interactions, the surface microlayer, marine ecosystems and sedimentation processes.

An area of research that has received a good deal of attention in recent years is the sea-air interface, as it has unique properties which may influence the geochemical cycles of many environmental pollutants. Elevated trace-metal concentrations, especially those of particulate and organic forms, occur in the surface microlayer. Dissolved and particulate organic carbon, pollutant hydrocarbons and chlorinated hydrocarbons are also enriched.

Particulate-bound metals and hydrocarbons usually enter the microlayer through dry deposition and atmospheric precipitation. Rising bubbles are also a probable source of trace metals and organics in the microlayer, although bubble droplet formation and sinking of particles are considered to be important particle removal processes (Lion and Lecki, 1981). The microlayer provides a habitat for diverse and abundant flora and fauna (the neuston) which have the potential to serve as important transfer sites for elements and compounds moving between the atmosphere and the water column or vice versa. An acceleration or slowing of fluxes could occur as a result of changes in composition of the microlayer.

Since little is known about the interrelationships between the trace metal, microbial, particulate and organic constituents of the sea-air interface, research needs abound. Studies to determine chemical and biological components would be desirable, as would be those investigating the effects of neuston communities on element or compound fluxes between the atmosphere and the water column. Further research directed at determining the importance of the microlayer in quantitative

terms, either as a source or as a sink for anthropogenic materials from the atmosphere or water column, would also be appropriate.

With regard to biogeochemical cycling, appropriate areas for further research include work on processes involved in decomposition and accumulation of contaminants in the water column such as adsorption, desorption, solution, mineralization and biological and chemical oxidation. Studies on the chemical and biological composition and sedimention rates of suspended substances would also prove useful. Evaluations are required of the mechanisms of transfer of materials from the coastal zone to the deep sea by such means as eddies or sediment slumping.

There are a number of joint research projects concerning the marine environment, but participation is generally limited to institutions having the required sophisticated facilities and expertise. A major co-ordinated research programme investigating sea-air exchange processes - the Sea-Air Exchange Programme (SEAREX) - was initiated in 1977, (one French and eight U.S. institutions are participating). The basic objectives of SEAREX include measuring trace substances in the atmosphere, identifying their atmospheric concentration and the rate of removal to the open ocean by dry deposition and precipitation of a number of substances, identifying their sources in the marine atmosphere and investigating the mechanisms of exchange, in both directions, across the sea-air interface.

The Geochemical Ocean Sections Survey (GEOSECS) has been a large-scale programme of tracer measurements in the major oceans. The natural radionuclides tritium and carbon-14 and radionuclides produced in atmospheric nuclear explosions, such as caesium-137 and plutonium-239, have been measured at various depths in the water. Estimates of the rate of downward mixing of particulates and of the surface water have been obtained. The results have been particularly useful in evaluating the geochemical cycle of carbon (Takahashi et al., 1980).

An advisory body, the Joint Group of Experts on Scientific Aspects of Marine Pollution (GESAMP), provides scientific advice on marine pollution problems to a number of international organizations. GESAMP is sponsored by the United Nations (UN), the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO), the World Metreological Organization (WMO), the International Maritime Organization (IMO) and the International Atomic Energy Programme (IAEA).

The current work programme of GESAMP includes a review of the health of the oceans (published reports on this topic are Goldberg (1976) and GESAMP (1982)), reviews of potentially harmful substances, the evaluation of the hazards of harmful substances carried by ships, biological effects of thermal discharges in the marine environment, interchange of pollutants between the atmosphere and the oceans, land-sea boundary flux of pollutants, and methodology and guidelines for the assessment of the impact of pollutants on the marine environment (Pravdic, 1981). These topics encompass reviews of current research investigations.

REQUIREMENTS AND FEASIBILITY OF OPEN OCEAN MONITORING

In the light of the previous discussion, there are several areas of investigation to which open ocean monitoring could contribute. It is well not only to note the recommendations for measurements, but also to realize the difficulties and limitations in obtaining meaningful results.

Monitoring implies repeated measurements and therefore the use of soundly based, well proven methods to obtain comparable data. The low levels of contaminants in the open ocean and the difficulties in sampling from the surface microlayer or from several depths impose severe limitations. Projects may be undertaken for research, but considerable further development would be required to suggest similar activities for monitoring.

The air-sea interface

Guidelines for a measurement programme for the determination of air-sea fluxes of pollutants have been prepared by a Working Group of GESAMP (1980). Two criteria must be met before long-term monitoring for any substance can be considered worthwhile. The first is that there must be a scientifically substantiated indication that significant changes in the distribution or flux of a particular substance will result in serious disturbance of physical, chemical or biological processes in the environment. The second criteria is that expected changes in the concentration of such a substance with time must be statistically distinguishable from natural fluctuations, taking into account the analytical precision of the concentration measurements themselves.

On this basis, the Working Group concluded that a continuous large-scale, long-term monitoring programme for measurement of air-sea fluxes of such substances as heavy metals, petroleum hydrocarbons or heavier chlorinated hydrocarbons, may not be warranted at present. Further, it was suggested that considerable development and standardization of collection and analytical methodologies for such substances are required before the measurements could be carried out with needed precision and accuracy.

It was recommended, however, that a measurement programme for specific pollutants be initiated in some open ocean regions, if such a programme can be developed carefully and within a research framework. A further recommendation was that the measurements should not be undertaken on a continuous basis but rather for a short period of time, perhaps one to two years, with additional measurement periods being undertaken at subsequent intervals of between five and ten years to evaluate long-term changes in the distribution and flux of these materials. It was stressed that these recommendations should be specifically concerned with measurement of air-sea fluxes of pollutants and should not necessarily be applied to present or planned programmes for more general monitoring of pollutant levels in the marine environment.

Biogeochemical cycles

The biogeochemical cycles of a number of elements and compounds have been studied for some time with greatest attention being directed to the major constituents of organic matter and those pollutants thought to be most harmful (e.g. mercury, cadmium). A Working Group of GESAMP, while reviewing the health of the oceans, recently drew the following conclusions concerning biogeochemical cycles and the marine environment (GESAMP, 1982):

- Man-made sources have substantially increased the flux of many elements to the marine environment via the atmosphere, surface run-off and direct discharge;

- The increased fluxes to the marine environment (except via the atmospheric route) give rise mainly to increased local concentrations in coastal areas;

- Direct acute toxic effects may result from these increased concentrations, especially when they are accompanied by changes in local environmental conditions. In extreme cases, these increased concentrations may give rise to local problems that may reach epidemic proportions, as for example, at Minimata, where the sequence of increased mercury flux, increased local concentration and increased production of methylmercury, combined with a special human diet, has been unequivocally identified;

- Chronic and other longer-term effects are more difficult to substantiate when they occur on a major scale in the marine environment although specific effects, such as the inhibition of metabolism by enzyme reaction with heavy metals have been detected.

A subsidiary body of the IOC Working Committee for GIPME, the Group of Experts on Methods, Standards and Intercalibration (GEMSI) has a variety of ad hoc groups investigating certain subject areas which feature strongly in the overall picture of biogeochemical cycling. The GEMSI ad hoc Group on Marine Sediments is assessing the feasibility, within the context of the Comprehensive Plan for GIPME, of using marine sediments to locate, quantify, assess and control contamination. The GEMSI ad hoc Group on the Identification of Gaps in Fluxes and Mass-Balance Calculations in Marine Systems is working to identify existing gaps in mass-balance/flux information for various classes of contaminants in the world ocean and in some regional marine areas.

The ad hoc Group on River Inputs (in MARPOLMON) will begin its work during 1983 and liaise closely with the SCOR Working Group (Number 46) on River Inputs to Ocean Systems which has similar interests in the topic. There is also a GEMSI ad hoc Working Group on the Use of Marine Organisms (in MARPOLMON) which concluded that while marine organisms could be included in the MARPOLMON programme, it had evidence that the capability and facilities for the collection and analysis of organisms were insufficiently widespread to justify their immediate inclusion in the programme.

Biological monitoring

Any comprehensive plan for monitoring the levels and effects of marine pollution must include a component of biological monitoring (i.e. monitoring in living matter). If observations to relate levels in water or sediments with tissue concentrations and effects in organisms, populations and ecosystems are lacking, adequate assessment is not possible. The use of biological variables in this context has attracted much attention in recent years and several reports addressing a variety of relevant issues have appeared in the literature.

GESAMP recognized the problem of defining clear cause-effect relationships between changes observed in marine communities and specific contaminants and emphasised the value of experimental studies, in the laboratory and in situ, for establishing links between the body burden of contaminants in organisms and levels of these contaminants in the sea water (GESAMP, 1974). A Working Group of GESAMP has extensively reviewed material concerned with the monitoring of biological variables related to marine pollution and noted that a consistent strategy for monitoring biological effects has not been developed and that the procedures for implementing such a strategy have not, so far, been clearly set out in a unified account (GESAMP, 1980a).

The Group, therefore, proposed a three-part strategy and provided guidelines for implementing it. The purpose of the first phase is to pinpoint "hot-spots" of pollution, thus allowing efforts in later phases to be concentrated at sites where

biological effects are most likely to occur. The second phase involves the examination of ecologically more significant variables, such as benthic community and population structures and physiological and biochemical indices in selected widespread species. The elements of the final phase include specific chemical analysis of water, sediments and organisms to determine the cause of the observed effects.

In terms of geographic scale, it was concluded that the strategy was appropriate for application to local and regional situations, but that it would need modifying for use at the global level. The Working Group recommended that open-ocean monitoring, if it is carried out, should be focused on the examination of deep benthos and confined to a few selected sites, preferably covering each major ocean and located where physical conditions and the ocean floor are relatively stable, and where synoptic observations on inputs to the detritus are being made.

Disturbed by the rise in use and concentration of pesticides and PCBs in the environment in the southern hemisphere, Goldberg (1983) has recently proposed a "single shot" monitoring of chlorinated hydrocarbons of the world oceans in order to compare their levels with those in the 1960s and 1970s that caused impacts on the higher trophic levels of the marine environment.

Background monitoring

The background air pollution monitoring network (BAPMON) is a project begun in 1971 by the World Meteorological Organization (WMO). The regional and baseline stations of the network are used to monitor long-term trends in atmospheric composition which could have an impact on climate.

In 1974 it was decided by the Executive Committee of WMO that background air pollution stations should, whenever practical and feasible, be used for monitoring in media other than air, particularly in the oceans and biota. To date, none has taken on this expanded role. In a recent report, the feasibility of using the stations for open ocean monitoring has been considered (UNEP, 1983).

The feasibility study suggested that it would be possible, particularly at baseline stations situated on islands, to arrange for ocean water monitoring. The regional stations are less suitable for this purpose since they are generally less well equipped and staffed.

Ocean weather ships may also be appropriate platforms for certain aspects of open ocean monitoring. However, they also may be sources of contaminants such as metals and oils. Few such ships are presently deployed, e.g. four in the North Atlantic (UNEP, 1983). Limited oceanographic measurements may be made from time to time. The feasibility for extension depends on the identification of suitable measurements, the availability of acceptable sampling and analytical methods, costs, etc.

Monitoring of fisheries resources

When considering the impact of chemical contamination on fisheries it is important to note that pollution concentrations are highest in coastal areas and land-locked seas and although they represent, together with the relatively small areas of oceanic upwelling, only about 10 per cent of the total ocean area, they yield over 90 per cent of the world's marine fish catch (UNEP, 1982). Also, many commercially important species of fish depend on estuarine environments for their survival and it is in such areas that discharges of pollutants are most concentrated. Fishing

practices, particularly overfishing, may give rise to effects which substantially exceed those due to pollution.

Assessment of the impact of pollution on fisheries resources is complicated by a number of factors such as the effects of fishing intensity and changing natural environmental conditions. An example of a natural phenomenon affecting fisheries is provided by the oceanographic condition known as "El Niño" which occurs off the Peruvian coast every few years. An increase in water temperature results in the death of a significant number of fish. Similar conditions are also thought to occur off other upwelling coasts.

The lack of evidence of pollution effects on fisheries resources, except in particularly impacted areas, as well as large variations from other causes, speaks against using fisheries resources for monitoring purposes.

Remote sensing

Remote sensing measurements by satellite are beginning to provide promising methods for monitoring. Techniques for monitoring wind stress and ocean surface elevation or topography were successfully demonstrated by the U.S. SEASAT-A satellite in 1978. While earlier satellites provided a certain amount of oceanographic information, SEASAT was the first satellite built with the purpose of obtaining oceanographic data. Certain aspects of visual scanning of surface productivity and turbidity may be relevant to pollution monitoring. Other possibilities, however, seem quite limited at the moment.

Further research is required to improve remote sensing capabilities for ocean monitoring and also to improve the techniques of obtaining parameters from sea-based sites needed for the adjustment or calibration of satellite-derived data.

CONCLUSIONS

Open ocean monitoring is perceived as a means of understanding the physical, chemical and biological processes of the oceans and applying this knowledge to prevent impairment of ocean quality and other adverse effects on marine resources due, particularly, to pollution. The importance and scale of the needs indicate that international collaborative efforts would be required. However, as is always the case, desire for action must be weighed against the technical feasibilities, practicalities for collaboration, priorities and costs involved.

It must first be noted that, at the present time, there is clearly no demonstrated need for a global open ocean pollution monitoring programme. The levels of contaminants are extremely low and pollution effects would clearly be impossible to identify. The results from the regional projects, particularly in the Mediterranean and Baltic Sea, where considerable experience exists, sufficiently establishes this fact.

Accurate and reliable sampling and measurements in the open ocean are extremely difficult. While improvements in sampling and analytical procedures are continually being made, a high degree of sophistication is necessary to avoid contamination of the samples and to achieve adequate sensitivity. While measurements of concentrations of contaminants in samples of water, sediments or biota collected in a single instant are difficult, measurements of dynamic processes, such as settling

rates or air-sea interchanges, present even greater challenges. There are limited capabilities for performing useful but complex measurements.

The nature of the technical problems of ocean monitoring points to the need for further research efforts. Methods must be simple and reliable, especially for monitoring programmes. Intercalibration programmes and reference samples must be available. Suitable sampling locations must be identified. At the present stage of development, capabilities for useful measurements exist only at specialized centres. It may be expected that, at the moment, open ocean monitoring programmes could receive only limited participation from the countries of the world.

The high costs of open ocean monitoring will also limit widespread participation. The ongoing regional programme in the Mediterranean was begun with a 9 million dollars contribution from UNEP and much greater sums expended by individual countries. The greater scope and increased difficulty of open ocean monitoring will cost even more. The IGOSS pilot monitoring project and GIPME cost UNEP alone approximately 600,000 dollars. An ocean research ship may require this amount for only a few week's operation. Monitoring objectives must be clearly defined, and the standards must be maintained at a high level in order to contribute useful results. Low-cost, less sophisticated measurements can reduce costs and encourage wide-range involvement, but the results are then of less or no significance.

With regard to pollution assessments, most countries will rightly consider that the more apparent problems in inland seas and coastal regions are deserving of immediate attention. UNEP's Regional Seas Programme will require continued encouragement and support to bring to fruition the work that it is now sponsoring and co-ordinating. If a major contribution from the Environment Fund of UNEP were to play a role, the initiation of a serious programme of open ocean monitoring would necessitate a change of priorities and a significant shift in resources that the 127 countries participating in the Regional Seas Programme may not welcome. The regional approach should develop into a system which will eventually yield a global picture and, at the same time, deal with the priorities as they really are.

Although continuous open ocean monitoring is, at present, neither feasible nor justified in terms of pollution problems, specific wide-scale research or survey projects are viable alternatives. There is a framework of international marine research programmes from which such projects can develop. On a scientific level, GESAMP has been providing technical reviews and advice on marine studies. The general view of the IOC (GIPME) on monitoring developments seems fundamentally sound. The primary pollutant categories are specified (trace metals and metalloids, petroleum hydrocarbons, organohalogen compounds) and stages in the assessment process are set forth, beginning with mass-balance determinations for individual contaminants. The prerequisite steps in the mass-balance computation are recognized, namely, the development and testing of techniques for collection of baseline and boundary flux data. The technical committee of the IOC (GEMSI) has plans to recommend measurement procedures and to examine deficiencies in the mass-balance assessments. At the moment, the GEMSI Working Group concludes that monitoring of marine organisms is not yet fully practicable due to insufficiently widespread capabilities and facilities for collection and analysis. Further inter-comparison methods and training are required.

It will be important to recognize the stages at which limited or more wide-scale open ocean monitoring should proceed. A great deal of consultation will be required to design a co-ordinated international effort. Abilities must be developed, and the willingness to participate and to provide financial support must be generated. The goal to increase understanding of marine processes and provide improved assessments of pollution impacts will be well worth achieving.

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FEASIBILITY STUDY OF BAPMON STATIONS MONITORING BACKGROUND OPEN OCEAN POLLUTION

BACKGROUND

1. The WMO background air pollution monitoring network (BAPMoN) was launched by the Executive Committee in 1970 and endorsed by Sixth Congress in 1971 (see Annexes 1 and 2).

2. In a Resolution of EC 1970, Member countries were urged to establish two types of stations for monitoring background air composition in their territory: regional and baseline.

3. Regional stations should be located in rural areas, sufficiently far away from industrial sources not to be affected by the day-to-day variations in emissions. They should measure precipitation chemistry analysed from wet samples, turbidity and, in some cases, suspended particulate matters (SPM). Some regional stations, mainly on the continents, operate an expanded programme with measurements of CO_2 and pollutants in air.

4. Baseline stations should be located in very clean air, far away from pollution sources and in areas where no change in land-use is expected to take place over several decades. They measure the same elements as the regional stations and, in addition, carry out continuous measurements of CO_2 air. Furthermore, they monitor on an optional basis various pollutants in clean air such as SO_2, NO_x and CO.

5. From the start the aim of the network has been to monitor long-term trends in atmospheric composition which could have an impact on climate. However, as early as in 1974, the Executive Committee adopted a resolution which encouraged Members, for scientific and economic reasons, to arrange monitoring in media other than air, particularly in the oceans and in the biota, at those BAPMoN stations where it would be practical and feasible to carry out such monitoring (see Annex 3).

6. It is important, for the purpose of this report, to note that the principle to use background air pollution stations, whenever practical and feasible, in order to monitor other media than air was accepted by WMO as early as 1974. This principle has been further stressed, especially by the USSR during the following years. In fact, the more recent idea of integrated monitoring which involves air, fresh water and ecosystems, stems from the principle that background monitoring of several media be carried out at the same stations.

7. Although the principle to monitor background ocean pollutants at the same stations that monitor atmospheric pollutants was accepted in 1974, there is no station within the BAPMoN system presently doing so, as far as the facts available to WMO have claimed. This does not mean that pressure to organize such integrated monitoring has not existed. The USSR has argued successfully that at least at ocean weather ships this type of two-media monitoring should be arranged. At this moment, WMO recommendations (see Annex 4) call for NAOS (North-Atlantic Ocean Ships) to organize, as far as possible, the monitoring of pollutants in both air and oceans. Very little is known at WMO about the actual procedures being taken to adhere to these recommendations.

8. The fact that no station has carried out monitoring of background pollution in both air and ocean water does not imply that no stations exist where such monitoring would be feasible. It seems that, in the case of the island baseline stations where air monitoring is actually taking place, it would be possible to arrange for ocean water monitoring simultaneously. The stations listed in Table 1 appear to be ideally located to encourage ocean pollution monitoring without too much of an additional effort.

9. Each one of the stations mentioned in Table 1 will now be discussed from the point of view of their location, present arrangements and feasibility for undertaking ocean pollution monitoring.

NORTH ATLANTIC

Godhavn (long. 53.30W; lat. 69.15N). This regional station is situated at 26m above msl on the island Disko on the west coast of Greenland. . It is administered by Denmark (the Danish Meteorological Institute, Charlottenlund, Denmark). At present, it carries out sampling and analyses of wet precipitation. Sampling is made by the Finnish AAPS-type instrument and the analysis of the sample is made by the Norwegian Institute for Air Research.

Although this station carries out only the minimum programme of a BAPMoN regional station it may be possible to interest the Danish authorities (perhaps through ICES) to start ocean monitoring. No details are available regarding the exact siting of the station. Details may be obtained from:

Dr. Hans Buch
Danish Meteorological Institute
DK-2100 Copenhagen

Caharciveen (long. 10.15W; lat. 51.56N). This regional station is situated at 28m above msl on a small island off the west coast of Ireland about 20 km from Valentia. It is administered by the Irish Meteorological Service in Dublin. It takes precipitation samples in bulk (wet and dry deposition) which are analysed by the Meteorological Service Laboratory in Dublin. It also carries out turbidity measurements by means of a Volz sunphotometer. Data are sent to NCC in Asheville, USA. Measurements of condensation nuclei are carried out for research purposes and plans for the future monitoring of SPM have been made.

This is one of the oldest (1970) and most reliable of all BAPMoN stations. It may be possible to arrange for certain measurements in the ocean perhaps through the intervention of ICES and/or oceanography institutions in Ireland. The question should be addressed to:

The Director
Meteorological Service, Department of Transport
Glasnevin Hill
Dublin 9, Ireland

Sable Island (long. 60.01W; lat. 43.56N). This station is situated at 4m above msl on the east coast of Sable Island which is located off Nova Scotia in the Atlantic. It is administered by the Atmospheric Environment Service, Canada. The nearest city is Halifax in Nova Scotia.

The station carries out sampling of wet precipitation by an automatic gauge, type SANGAMO A. Samples are analysed by the Water Quality Branch, Inland Waters Directorate, Burlington, Ontario. Turbidity is measured by means of Eppley sunphotometer and CO_2 is sampled in flasks which are sent for analysis in the NOAA laboratory, Boulder, USA.

This station is considered a baseline station although its location is not ideal due to influence from the industries in the East of the U.S.and Canada. It should prove quite useful for ocean monitoring in view of its location near Halifax where the Beford Institute could take care of samples. Contact for consideration of arrangements should be made through:

Mr. Malcolm Still
Atmospheric Environment Service
4905 Dufferin Street
Downsview, Ontario M3H 5T4
Canada

Tenerife (long. 16.30W; lat. 28.18N). This baseline station is located at 2370m above msl on the peak of Tenerife. It is being established under a bilateral project between Spain and FRG. Although the station is not yet in operation, it is expected to start operations in the latter part of 1982. It will measure CO_2 in the air, precipitation chemistry and turbidity on a continuous basis.

Although this station is located at the top of the Tenerife peak, arrangements could perhaps be made through the Spanish Meteorological Service to have observations made in the ocean surrounding the island. It seems advisable, however, to not approach the Spanish authorities before operations have started. WMO would be prepared to give information when this has happened. Contact authority:

Director-General
Instituto Nacional de Meteorologia
Apartado 285
Madrid

Barbados (long. 59.37W; lat. 13.9N). This regional station is located at 113m above msl and is now equipped with instruments for measuring precipitation chemistry (ERNI), turbidity (sunphotometer) and suspended particulate matters (SARTORIUS). It has not yet started operations but is expected to do so in 1982. The suspended particulate matter will be monitored on the outside of the island of Barbados from where ocean monitoring can also take place. Analysis of precipitation chemistry is made by the Chemical Department of the University of West Indies.

Approach of the authorities in Barbados should await explicit information from WMO that operations have started. Authority to contact:

A. Seraphin
Technical Officer
Caribbean Meteorological Institute
P.O. Box 130
Bridgetown, Barbados
W. Indies

SOUTH ATLANTIC

Trinidad Island (long. 29.19W; lat. 20.30S). Plans to establish this regional station are being made only by Brazil and it is unclear where it will be located. According to the latest information, the station will be at 5m above msl on the island, which would make it appropriate for arranging open ocean pollution monitoring from a suitable ship.

Brazil has shown interest in getting some stations operational but apparently one of the stations faced some trouble recently. Hence, there is no information as to when this station, and

Fernando do Noronha (long. 32.25W; lat. 03.51S), will start operating. It is, therefore, premature to approach the authorities in Brazil on the subject of ocean monitoring. The two sites should, however, be kept in mind if and when they become operational as BAPMoN stations. Authorities to approach:

Director-General
Instituto Nacional de Meteorologia
Praça 15 de Novembro 2/5
20010 Rio de Janeiro
Brazil

INDIAN OCEAN

New Amsterdam (long. 77.32E; lat. 37.48S). This baseline station is operated by France and is situated at 55m above msl on the island of New Amsterdam. It monitors wet precipitation by automatic gauge, SPM by high volume sampler, CO_2 by continuous analyser and turbidity by sunphotometer. There are plans to monitor SO_x and halocarbons in the air.

This station should be ideal for monitoring open ocean pollution in the Indian Ocean. It may be concluded from the programme presented above that the station is a fully equipped baseline station with highly qualified staff. It would seem reasonable, therefore, to approach the authorities concerned in order to find out whether or not taking up ocean pollution monitoring would be possible. The authorities in this case are:

Dr. A. Gandry) Centre des Faibles Radioactivité
Dr. G. Lambert) Domaine du CNRS
91190 Gif sur Yvette
France

or

Dr. B. Morlet, Territoire des TAAF
27 Rue Gudinot
75700 Paris, France

Minicoy (long. 73.00E; lat. 08.18N). This regional station, operated by India, is located on the island of Minicoy at 2m above msl. It has been monitoring precipitation chemistry as well as atmospheric turbidity for a number of years.

Staff may not be highly qualified at this station but as it has been working satisfactorily for a number of years it may be worth while to approach the Indian authorities to investigate what could be arranged. Since Minicoy is situated near Goa, arrangements could perhaps be made with the marine pollution experts at the Oceanographic Center at Goa. Authorities to approach regarding the use of this station:

Dr. Krishna Nand
Office of the Deputy Director General
of Meteorology
Air Pollution Section
Pune 411005
India

NORTH PACIFIC

Chici-Jima Island (long. 142.12E; lat. 27.06N). Only the Japanese authorities are planning to establish this station. No details are presently available with regard to site or programme of operation. It is premature at this stage to approach the Japanese authorities. However, the station should be kept in mind, for the island is ideally situated for future open ocean pollution monitoring. Authorities are:

Director-General
Japan Meteorological Agency
Ote-Machi
Chiyoda-Ku
Tokyo, Japan

Hawaii island (long. 155.35W; lat. 19.32N). The baseline station on the island of Hawaii is located on the Mauna Loa volcano at 3397m above msl and operated by the US NOAA. It is the oldest of all baseline stations (establishe in 1958) and a true research station with highly qualified staff and an extensive programme of operations including monitoring of CO_2, wet precipitation and turbidity as well as a number of additional parameters including halocarbons.

Of course, open ocean monitoring cannot be operated directly from the station located on the volcano. NOAA, however, maintains a scientific base with various kinds of facilities and logistics for staff at Hilo, the main town on the island which is located at sea-level. There are good reasons to believe that operations of open ocean pollution monitoring could take place from the NOAA center at Hilo. Hence, the following authorities can be contacted for this purpose:

Director, Global Monitoring for Climate Change
ERL/NOAA, R329
325 Broadway
Boulder, CO 80303, USA

Since NOAA is an administration responsible for both the atmosphere and the oceans, the NOAA ocean authorities should probably be contacted together with the above-mentioned authorities. Perhaps an informal approach to the ocean authorities would be advisable before any official proposal is made. It may very well be that some oceanic activities are already under way at Hilo under NOAA auspices.

Point Barrow (long. 156.37W; lat. 71.19N). This baseline station is situated on the north coast of Alaska at 3m above msl and operated by the US NOAA. It belongs

to the first established baseline stations and has been in operation since 1973. This station also has an extensive programme and is operated by highly qualified scientific personnel. It monitors CO_2, precipitation chemistry and turbidity plus a number of other parameters in the atmosphere.

There is hardly any doubt that this station could also operate a programme for the monitoring of open ocean pollution if there were sufficient staff. A similar approach to authorities is suggested, as in the case of the Hawaiian island where an informal contact with the ocean authorities and NOAA should preceed any final contact with the authorities in charge of the station:

Director, Global Monitoring for Climate Change
ERL/NOAA, R329
325 Broadway
Boulder, CO 80303, USA

SOUTH PACIFIC

Cape Matatula (long. 170.34W; lat. 14.15S). This baseline station is situated in the American Samoa at 82m above msl and operated by the US NOAA. It has been in operation since 1976 and monitors CO_2, wet precipitation and turbidity as well as a number of other variables in the atmosphere. It seems probable that the scientific staff at this station would also be capable of running a programme for monitoring open ocean pollution.

It is suggested that ocean authorities of NOAA be approached on an informal basis to discuss the feasibility of arrangements with the baseline station. Later, final contact should be taken with:

Director, Global Monitoring for Climate Change
ERL/NOAA, R329
325 Broadway
Boulder, CO 80303, USA

Rarotonga (long. 159.46N; lat. 21.13S). This regional station, operated by the New Zealand authorities, is situated at 22m above msl on the island of Rarotonga among the Cook Islands. It is newly established and expected to become operational only in late 1982. The station will monitor precipitation chemistry and turbidity, which is the minimum programme for a regional station. Analysis of the wet precipitation will be made by the Water Quality Division of the Ministry of Works and Development at Hamilton, New Zealand.

In this case, there seems to be a good possibility for some open ocean pollution monitoring since chemical analysis of flask samples (or similar analyses) could be done by the same institution that monitors wet precipitation. Authorities to approach:

New Zealand Meteorological Service
P.O. Box 722
Wellington, N.Z.

Easter Island (long. 109.26W; lat. 27.10S). This regional station operated by Chile is situated at 41m above msl on Easter Island. It has obtained instruments for measuring wet precipitation, turbidity and SPM, but the station is not yet operational. It is expected to become operational at the latest in 1983. The station already takes flask samples of CO_2 for a NOAA national programme.

It may be premature to request authorities in Chile to start open ocean pollution monitoring before the station is operational for atmospheric monitoring. The station should, however, be kept in mind as a location providing staff and opportunities for open ocean pollution monitoring. Authorities to approach:

Cmdte. F. Roll
Director
Direccion Meteorologica de Chile
Casilla 717
Santiago, Chile.

The person in charge of the station is:

Sr. L. Farias
Isla de Pascua.

Cape Grim (long. 144.41E; lat. 40.41S). This baseline station operated by CSIRO in Australia is located at 94m above msl on the north west coast of the island of Tasmania. It has been operational for about five years monitoring CO_2 in air, precipitation chemistry, turbidity and SPM. In addition, radiation conductivity, aerosols, surface ozone, halocarbons (freons) and N_2O are monitored. In situ, measurements for NO_x and SO_2 are expected to be introduced.

Since this station is a full-fledged research observatory with highly qualified staff, chances would be good that open ocean pollution monitoring could be arranged. Authorities to approach:

Dr. R.J. Francey
Scientific Director
Cape Grim Baseline station
P.O. Box 346
Smithton, Tasmania, 7330

Baring Head (long. 174.52E; lat. 42.25S). This station, operated by New Zealand, is located at 79m above msl on the northern coast of the south island of New Zealand. It is suitable only for CO_2 measurements, which are made by means of a continuous analyser.

With its location near the open sea, this station could perhaps make open ocean pollution monitoring but it seems that staff is limited and the possibilities cannot be investigated without a direct enquiry with the authorities:

Dr. M.R. Manning
Institute of Nuclear Sciences
Private Bag, Lower Hull
New Zealand

GENERAL POLICY OF APPROACH TO GOVERNMENTS

10. It should be noted first of all that most of the stations mentioned in the above listing are run by the National Meteorological Services of the countries concerned (NMS). In most cases, the NMS is not responsible for oceanographic affairs, including the monitoring of pollutants in open oceans; the U.S. and USSR are the outstanding exceptions to this rule. Due to this situation, the question

arises whether it would be advisable to approach the NMS first in order to request their consent in making arrangements for open ocean pollution monitoring, or if it would be better to first approach the oceanographic authorities to ask about their interest in such arrangements. Since the regulations are different in each country, decisions on which approach to take will have to vary in every case.

11. Generally, there is no doubt that baseline stations are the ones most suitable for arranging global ocean pollution monitoring. The reason for this is that baseline stations most often are real research stations with highly qualified staff and, in many cases, sophisticated equipment and logistics. First priority should, therefore, be given to baseline stations. Some of the regional stations should also be given high priority in view of their excellent location.

12. As a general rule it seems that staff at baseline stations, if acceptable to the marine authorities, could carry out the activities involved in open ocean pollution monitoring. This is not the case with regional stations where trained and qualified staff in oceanography would have to be brought in from outside to carry out the necessary monitoring activities. In many cases, special arrangements for sampling from small ships will also have to be made.

13. The question remains as to whether or not UNEP or WMO should approach the government authorities involved with the proposed BAPMoN stations project. According to WMO regulations, no UN agency other than WMO can, in principle, approach governments on matters concerning WMO stations. In this particular case, however, both ocean affairs authorities and the National Meteorological Services are involved. In view of the special circumstances, the following procedure was proposed after consideration with the WMO Secretariat:

(1) in cases where both oceanographic and meteorological authorities need to be contacted, UNEP should write to the oceanographic authorities presenting a proposal that a BAPMoN station under the auspices of the NMS be used for open ocean pollution monitoring. At the same time, UNEP should write a letter to WMO referring to the present report and suggesting that the BAPMoN station in question be used for open ocean monitoring of pollution provided the oceanographic authorities agree. WMO, with a copy of the UNEP letter, would then approach the NMS, or the station directly, asking upon which conditions open ocean monitoring could be arranged;

(2) in cases where the same authority (i.e. NOAA) is in charge of both the oceans and the atmosphere, the procedure would preferably be the same even if in those cases co-ordination could, in principle, be arranged within the administration directly upon an approach from UNEP.

14. In such a way, the initiative to take up contact with BAPMoN stations for open ocean pollution monitoring rests with UNEP RS/PAC, both in terms of making direct contact with WMO and with the ocean authorities in the countries concerned.

USE OF OCEAN WEATHER SHIPS FOR MONITORING OF OPEN OCEAN POLLUTION

15. In addition to the BAPMoN stations located on islands or in coastal areas, the ocean weather ships may be considered as platforms for monitoring pollution in the open ocean.

16. At present there are four ocean weather ships operating in the north Atlantic

under a joint agreement between five countries: France, Netherlands, Norway, USSR and UK. These ships carry out three types of services: "primary", "secondary" and "other". The "primary" services include meteorological observations of various kinds; the joint financial agreement between the countries involved cover the performance of "primary" services. In addition "secondary" and "other" services may be performed by the ships "provided that the performance of such services does not involve any addition to the obligatory personnel and equipment carried and does not interfere with the provision of primary services."

17. Secondary services usually involve the relaying of meteorological observations carried out by other ocean weather ships or merchant ships.

18. Other services include inter alia making of oceanographic and other scientific observations. Such observations are encouraged under the agreement, provided no charge is made to the contracting parties. This means that, to the extent oceanographic measurements are taken, this activity is a national undertaking.

19. It would seem possible to approach the single countries involved, in particular the NMS, regarding the possibility of their undertaking special open ocean pollution sampling from the existing weather ships. It is clear that some sampling is already undertaken from the USSR ship C. At least in earlier years, oceanographic measurements were also taken at the Norwegian ship M.

20. The following ships operate in the North Atlantic under the present agreement:

Station M:	Long. 02.00E;	lat. 66.00N
Station L:	Long. 20.00W;	lat. 57.00N
Station R:	Long. 17.00W;	lat. 47.00N
Station C:	Long. 35.30W;	lat. 52.45N.

Ship M is operated jointly by the Netherlands and Norway; Ship L by the UK; Ship R by France and Ship C by the USSR. In case one wished to contact these countries in order to propose that sampling of open ocean water be undertaken by these ships, one should approach the National Meteorological Services.

USE OF IAEA/WMO STATIONS FOR MARINE POLLUTION MONITORING

21. A further possibility in finding staffed stations which could be used for monitoring open ocean pollution would be to approach IAEA regarding the use of suitably located stations belonging to the IAEA/WMO network of stations for studies of tritium in precipitation. This network has been operating as a joint project since 1963 and many of the stations are located on islands in the open ocean. Unfortunately, it is not clear at the moment how this network operates and exactly which stations are in use. It is known, however, that a laboratory at IAEA in Vienna is responsible for the chemical analysis of the precipitation samples. It is expected that Mr. Kohler will receive all relevent information regarding the operation of the network when he visits IAEA and the Austrian Meteorological Service for discussion of BAPMoN in September.

GIPME-RECOMMENDATIONS FOR OPEN OCEAN POLLUTION MONITORING AND USE OF THE BAPMoN STATIONS

22. In the fourth session of the Working Committee of GIPME in New York in January 1982, the question about open ocean pollution monitoring was considered within the framework of an overall Strategy for the Implementation of the Comprehensive Plan for GIPME. Conclusions were as follows:

23. An ultimate aim of GIPME is assessment of the marine pollution processes and situation through construction of mass-balances for potential ocean contaminants. For this purpose three kinds of data are required:

(i) measurements of fluxes of contaminants entering the oceans through river discharge and atmospheric deposition;

(ii) measurements of the "baseline" or "ambient" distribution and concentrations of the same contaminants within the open ocean itself;

(iii) in order to determine the influx to the open ocean of contaminants from the regional seas, it is also necessary to have good baseline measurements in regional sea areas.

24. Measurements of fluxes of contaminants entering the oceans through river discharge and through the atmosphere are not being made at present in the systematic way one would wish to see.

25. Although baseline measurements are plentiful in some regional areas, there are only few data from many areas. This ought to be remedied gradually through the development of the Regional Seas action plans. Some atmospheric depositional measurements are being made through national research efforts but more systematic or standardized measurements must be established.

26. Baseline measurements in the open ocean have been, and are being, made largely through national research efforts. Coverage, however, is sparse in large areas of the globe. As far as certain types of contaminants (i.e. heavy metals) are concerned, baseline data are available to facilitate mass-balance assessments but influx data are lacking. In other areas, particularly organohalogens, baseline and influx studies are lacking.

27. As a general conclusion to the above considerations, it is perhaps reasonable to say that as far as baseline and influx measurements of contaminants are concerned techniques are available for the monitoring of heavy metals and petroleum hydrocarbons but still lacking in the case of organochlorines. It therefore seems reasonable that if baseline measurements could be organized on an operational basis, they would deal in the first place with heavy metals and dissolved hydrocarbons. Stations used for such operations could, of course, also be involved with research on methodology for monitoring organochlorines.

28. It is in connection with organizing operational monitoring of heavy metals and dissolved hydrocarbons in the open ocean that the BAPMoN stations proposed in earlier paragraphs could be useful. As has been stated earlier, BAPMoN baseline stations would be particularly suitable for the purpose of operational monitoring since they are usually equipped with the laboratory means needed for sophisticated analysis of sea water chemistry. No doubt, some of these stations might also be useful in carrying out research on the methodology to be applied to the monitoring of organochlorines.

29. Although it is not clearly spelled out in the Strategy for Implementation of the Comprehensive Plan for GIPME that studies of open ocean baselines of trace metals and development of methodology for organochlorines are to be given highest priority, this may be concluded from the report because of the relatively large sums of money which have been proposed for allocation in the years 1985-86 for these purposes.

30. The GIPME meeting proposed relatively high amounts of money to be allocated for testing of available techniques and for the training in developing countries in such analytical techniques (particularly for dissolved hydrocarbons). It seems possible that some of the BAPMoN stations, once operational for carrying out open ocean pollution monitoring, could also be used in the training scheme foreseen by IOC and scheduled to be carried out in the next two years.

31. It should be added that if BAPMoN stations are used in the future for monitoring open ocean pollution, they will also become involved with measurements of the exchange of pollutants between the air and sea. Since this is a topic of considerable concern for both WMO and IOC, such a function should be seriously considered for studies at baseline stations. In this context, it must be mentioned that another research area to be tackled is that concerned with the processes leading to dispersion of contaminants in the oceans, a problem closely related to the physical aspects of the ocean. These studies are also carried out when analyzing climate systems. Perhaps the BAPMoN stations can also be considered for these purposes.

Ocean area		Station	m above msl	Lat.	Long.	Country	Baseline Regional	Monitoring	Authority	Remarks
North Atlantic	1	Godhavn	26	69.15N	53.30W	Denmark	Regional	Wet precipitation by gauge only	Dr Hans Buch Danish Meteorological Institute DK-2100 Copenhagen	Approach via Danish ocean authorities
	2	Caharciveen	28	51.56N	10.15W	Ireland	Regional	Wet and dry precipitation in bulk; turbidity	The Director Meteorological Service Glasnevin Hill Dublin 9	Approach directly with NMS
	3	Sable Island	4	43.56N	60.01W	Canada	Baseline	Wet precipitation by gauge, turbidity and CO_2 in flasks	Mr M. Still Atmospheric Environ. Service 4905 Dufferin Street Downsview, Ont.M3H 5T4	Approach oceanographic authorities in parallel with the Atmospheric Environment Service
	4	Tenerife	2370	28.18N	16.30W	Spain	Baseline	Not yet operational; exp. in 1982-83	Director-General Inst. Nacional de Meteorologia Apartado 285 Madrid	Approach via oceanographic authorities in Spain when station is operational. Excellent location
	5	Barbados	113	13.9N	59.37W	Barbados	Regional	Wet precipitation by gauge, turbidity and SPM by H vol sampler	A. Seraphin Technical Officer Caribbean Met.Inst. P.O. Box 130 Bridgetown	Approach with the Caribbean Met. Inst. Excellent location
South Atlantic	6	Trinidad island	5	20.30S	29.19W	Brazil	Regional	Only planned	Director-General Inst. Nacional de Meteorologia Praça 15 de Novembro 2/5 20010 Rio de Janeiro	Approach via the NMS when established and operational
	7	Fernando do Noronha	56	03.51S	32.25W	Brazil	Regional	Only planned	- " -	- " -

Table 1: Proposed BAPMoN Stations for monitoring open ocean pollution

Ocean area		Station	m above msl	Lat.	Long.	Country	Baseline Regional	Monitoring	Authority	Remarks
Indian Ocean	8	Minicoy	2	08.18N	73.00E	India	Regional	Wet precipitation by gauge; turbidity	Dr Krishna Nand Off. of the Deputy Director-General of Meteorology Air Poll. Section Pune 411005	Approach directly with NMS but in parallel with the GOA marine authorities
	9	New Amsterdam	55	37.48S	77.32E	France	Baseline	Wet precipitation by gauge, SPM, turbidity, CO_2 by continuous analyser. Plans for SO_x and halocarbons in air	Dr A. Gandry Dr G. Lambert Centre de Faibles Radioactivitée Domaine de CNRS 91190 Gif sur Yvette or Dr B. Morlet Territoire de TAAF 27 rue Gudinot 75700 Paris	Approach with CNSR is proposed. Location excellent
North Pacific	10	Chici-Jima island	?	27.06N	142.12E	Japan	Baseline	Only planned	Director-General Japan Meteorological Agency Ote-Machi Chiyoda-Ku Tokyo	Approach directly with NMS when station established and operational
	11	Point Barrow	3	71.19N	156.37N	USA	Baseline	Wet precipitation; turbidity, CO_2 by continuous analyser + a number of other variables in air	Director, GMCC ERL/NOAA R329 325 Broadway Boulder, CO 80303	Approach with NOAA, oceanographers in parallel with Director GMCC
	12	Hawaii island	3397 (Hilo at msl)	19.32N	155.35	USA	Baseline	At Mauna Loa wet precipitation by gauge, turbidity, SPM, CO_2 by cont. analyser + a number of other parameters are monitored. Logistics also available at Hilo at sea level	Director, GMCC ERL/NOAA R329 325 Broadway Boulder CO. 80303	Approach with NOAA involving the oceanographers. Excellent location

Table 1 continued

Ocean area		Station	m above msl	Lat.	Long.	Country	Baseline Regional	Monitoring	Authority	Remarks
outh Pacific	13	Cape Matatula	82	14.15S	170.34W	USA (American Samoa)	Baseline	Wet precipitation by gauge, turbidity, CO_2 by cont. analyser + a few other air pollution parameters	Director, GMCC ERL/NOAA R329 325 Broadway Boulder, Co. 80303	Approach with NOAA involving the oceanographers. Excellent location
	14	Rarotonga	22	21.13S	159.46N	New Zealand	Regional	Wet precipitation, turbidity	Director New Zealand Met. Service Box 772 Wellington	Approach with NMS but perhaps also directly at stations. Excellent location
	15	Easter Island	41	27.10S	109.26W	Chile	Regional with extended program	Wet precipitation by gauge, turbidity, CO_2 in flasks	Cmdte F. Roll Director Direccion Meteorologica de Chile Casilla 717 Santiago	Aproach with NMS. Excellent location
	16	Cape Grim (Tasmania)	94	40.41S	144.41E	Australia	Baseline	Wet precipitation by gauge; turbidity, CO_2 by cont. analyser, SPM. Radiation conductivity, aerosols, ozone and halocarbons	Dr R.J. Francey Scientific Director Cape Grim Baseline Station P.O. Box 346 Smithton Tasmania	Direct approach could be taken with Scientific Director but in parallel with oceanographers in CSIRO
	17	Baring Head	79	42.25S	174.52E	New Zealand	Regional	Only CO_2 by cont. analyser at present	Dr M.R. Manning Inst. of Nuclear Sciences Private Bag Lower Hull	Approach directly with Dr Manning

Table 1 continued

Annex I

WMO RESOLUTION 12(EC-XXII) - MEASUREMENT OF BACKGROUND AIR POLLUTION*

THE EXECUTIVE COMMITTEE,

NOTING:

(1) Resolution 31(EC-XVIII),

(2) Resolution 18(CIMO-V)

(3) Recommendation 4(CAS-V)

(4) The abridged final report of CAS-V, general summary, paragraph 6.4,

(5) That a WMO technical conference on the subject of measurement and observation of air pollution is proposed for 1973,

NOTING FURTHER the action taken by the Secretary-General to establish a world-wide network of background air pollution stations,

CONSIDERING:

(1) The increase of air pollution on a global scale and its effects on the human environment,

(2) The need for measuring, in areas relatively free from local sources of air pollution, the pollution concentration levels, referred to as regional air pollution measurements,

(3) The need, in addition, for measuring, at a few locations in the world entirely free from local or regional pollution effects, the concentration of atmospheric constituents of particular significance to long-term weather and climatological changes, referred to as baseline air pollution measurements,

(4) That although many stations have been making air pollution measurements since the International Geophysical Year, the results are not adequate to study the problem on a global scale.

RECOMMENDS:

(1) That each Member establish one or more stations to measure regional air pollution in accordance with the programme as outlined in the annex* to this resolution;

(2) That, in addition, Members having sites for baseline air pollution stations establish one or more of them in accordance with the programme as outlined in the annex to this resolution;

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* This resolution supercedes Resolution 11(EC-XXI)

DIRECTS the Secretary-General:

(1) To find permanent representatives of Members willing to accept responsibility for the central collection and publication of the data on air pollution and atmospheric constituent measurements, under WMO sponsorship, and to conclude suitable agreements with them as soon as possible;

(2) To provide advice, as required, to Members which accept such responsibility in initiating anc carrying out the work;

(3) To assist Members lacking adequate laboratories in finding facilities in other countries to analyse their samples;

(4) To inform Members of any additional procedures to be followed in implementing this resolution as soon as any further negotiations have been satisfactorily completed;

INVITES the president of CIMO to study new techniques for making the observations listed in the annex to this resolution and submit periodic reports to the Executive Committee.

Annex to Resolution 12(EC-XXII)

ESTABLISHMENT OF A NETWORK OF STATIONS TO MEASURE

BACKGROUND AIR POLLUTION

I. Objects of the network

It has been recognized that, for the purpose of measuring the changes in atmospheric composition and evaluating the effects of air pollution, stations should be of two types:

(a) Baseline air pollution stations - to document long-term changes in atmospheric composition of particular significance to weather and climate.

(b) Regional air pollution stations - to document long-term changes in atmospheric composition due to changes in regional land-use practices.

II. Density of network

(a) Baseline air pollution stations

It is considered that about ten baseline air pollution stations, well distributed over the surface of the globe, will meet the spatial sampling requirements of this network.

(b) Regional air pollution stations

To ensure adequate sampling coverage it is proposed that each Member establish one or more stations. A minimum density of one station per 500,000 km^2 is recommended. However, where a country has several climatic regions a higher density would be necesary. Stations should be distributed in such a way that observations from each climatic region are available.

III. Siting of stations

(a) Baseline air pollution stations

It is recognized that it will be difficult to find locations which will meet all of the requrements of a baseline air pollution station on a long-term basis. However, the following criteria are proposed and it is recommended that they be carefully considered when such a station is being established.

(1) The station should be located in an area where no significant changes in land-use practices are anticipated for at least 50 years within 100 km in all directions from the station.

(2) It should be located away from major population centres, major highways and air routes, preferably on isolated islands or on mountains above the tree line.

(3) The site should experience infrequent effects from natural phenomena such as volcanic activity, forest fires, dust and sand storms.

(4) The observing staff should be small in order to minimize the contamination of the local environment by their presence and their living requirements.

(5) All requirements for heating, cooking, etc. should be met by electrical power generated away from the site.

(6) Access to the station should be limited to those whose presence is necessary to the operation of the station. Surface transportation should be by electrically powered vehicles.

(b) Regional air pollution stations

Regional air pollution stations should be located in rural surroundings, sufficiently far away from build-up areas so that they will not be influenced by local fluctuations in pollution concentrations. Each should be located near or in conjunction with a principal climatological station.

IV. Observational programme

(a) Baseline air pollution stations may be considered as research enterprises and are encouraged to measure any atmospheric constituent. However, first consideration should be given to those constituents which would most affect long-term changes in the climate. Two groups of priorities are thus proposed:

Priority Group I: Carbon dioxide

Turbidity

Constituents of precipitation and dry fallout

Priority Group II: Carbon monoxide and methane

Sulpher dioxide and hydrogen sulphide

Oxides of nitrogen

Total ozone

Total precipitable water

(b) The regional air pollution station network will include a number of stations established to meet specific environmental requirements. The programmes at these stations should include the measurement of turbidity and constituents of precipitation and dry fallout although the desirability of making additional measurements as noted in IV. (a) should be considered.

V. Sampling and analysis methods

The sampling methods, sampling frequency and analysis procedures should be made according to guidelines determined by WMO and described in the appropriate manual of operations. The chemical analysis of precipitation and dry fallout samples should include sodium, potassium, calcium, magnesium, ammonium ion, nitrate ion, chloride ion, suplhur, pH (alkalinity or acidity) and electrical conducitivity.

VI. Central collection and publication of data

Members should send their data regularly to a central data collection centre in accordance with the procedures established by the Secretary-General.

Annex II

WMO RESOLUTION 21(Cg-VIII) - WMO ACTIVITIES IN THE FIELD OF ENVIRONMENTAL POLLUTION MONITORING*

THE CONGRESS,

NOTING:

(1) Resolution 22(Cg-VII) - WMO activities in the field of environmental pollution,

(2) Resolution 16(EC-XXVIII) - Marine pollution,

(3) Section 3.3.5 of the general summary of the abridged report of Seventh Congress,

(4) Resolution 12(EC-XXII) - Measurement of background air pollution,

(5) Resolution 17(EC-XXVI) - Environmental pollution at the background level,

(6) Resolution 18(EC-XXVI) - Executive Committee Panel of Experts on Environmental Pollution,

(7) Resolution 18(EC-XXX) - WMO activities related to environmental pollution,

(8) Resolution 6(EC-XXX) - Joint IOC/WMO Working Committee for the Integrated Global Ocean Station System,

(9) Resolution X-8 of the IOC Assembly - Programme for monitoring background levels of selected pollutants in open-ocean waters,

(10) The reports of the fifth and sixth sessions of the UNEP Governing Council (Nairobi, 1977 and 1978),

(11) The report of the UNEP/WMO Government Expert Meeting on Climate-related Monitoring (Geneva, 1978),

ENDORSES the action taken by the Executive Committee and the Secretary-General to pursue and stimulate world-wide developments in this field, particularly in relation to the WMO network for monitoring background pollution in air and also in other media and the activities to investigate pollution of oceans and inland waters, including co-operation with other UN and governmental agencies;

CONSIDERING:

(1) The serious economic and social implications to man of the deterioration of his environment and the need to provide to governments information relevant to the abatement of pollution and rational management of the environment,

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* This resolution replaces resolution 22(Cg-VII)

(2) The need for a better understanding of meteorological and hydrological aspects of the complex biochemical cycles involved in the transformation, interchange, long-range transport and global abundance of environmentally harmful constituents throughout the environmental media,

(3) The urgent need for further expansion and strengthening of the WMO background pollution monitoring network, inter alia by filling the gaps in coverage, increasing the number of stations monitoring CO_2 including the monitoring of suspended particulate matter and other variables and developing procedures of integrated monitoring in various media through pilot studies,

(4) The need to continue using meteorological hydrological data to study the problems presented by the general pollution of the atmosphere and the pollution of the sea and inland waters in order to limit its noxious effects or actions,

(5) The increasing concern about pollution of the marine environment by petroleum, as well as by the interchange of pollutants between the atmosphere and aquatic systems,

(6) The need for continuing collaboration of WMO with UNEP and with all UN agencies concerned with the assessment, prevention or reduction of environmental pollution,

INVITES Members:

(1) To pursue vigorously the implementation of Resolution 18(EC-XXX), taking into account the modified priorities set by the Seventh Congress,

(2) To pursue, as a matter of urgency, the establishment, where this has not already been done, of regional and baseline stations within the WMO network for monitoring background pollution, in accordance with Resolution 12(EC-XXII), Resolution 17(EC-XXVI) and Resolution 18(EC-XXX), in order to provide:

(a) Better coverage in certain continental and ocean areas;

(b) Increased input to climate-related monitoring (e.g. CO_2, aerosols);

(c) Better coverage of all major biomes;

(d) As far as possible, inclusion of monitoring of media other than air;

(3) To pursue the development of new and improved techniques for investigating environmentally significant processes and substances, including techniques for integrated multi-media monitoring;

(4) To organize, as necessary, observations in collaborations with other Members of certain pollution factors together with meteorological and hydrological variables related to dispersion, transport and transformation of pollutants on different scales, including their long-range transport and their exchange between the atmosphere and adjacent media, in particular the sea and inland waters;

(5) To arrange for their national Meteorological and Hydrometeorological Services to give advice to and co-operate with the national bodies responsible for providing:

(a) Monitoring of air pollution at the impact level;

(b) Forecasts of urban pollution potential;

(c) Air pollution control;

(6) To take into account the potential of meteorological and hydrological information in studies of marine and inland water pollution:

(7) To encourage participation, when appropriate, in the development and implementation of IOC marine pollution monitoring programmes;

(8) To keep in mind the possibility of obtaining limited support through VCP or through WMO from UNEP or other sources of international funding for some of the activities mentioned in (1) to (6) above;

(9) To provide increased technical support to the WMO network of background pollution stations by operating central facilities, offering training and fellowships and assisting in bilateral agreements in the estabishment of stations and procurement of equipment;

AUTHORIZES the Executive Committee and the Secretary General, in close collaboration with UNEP, UN agencies and other international organizations concerned, to take steps

(1) To ensure that all relevant aspects of environmental pollution and climate-related monitoring are fully considered and introduced in the future strategy and development of the monitoring programme of the WMO network of background pollution stations;

(2) To promote the timely submission by participating Members of data generated in BAPMoN as well as the dissemination, assessment and use of such data;

(3) To promote the universal application of techniques standardized by WMO for the monitoring of environmentally significant variables and to arrange for the further development of such techniques;

(4) To promote the development of techniques for monitoring any new pollutants of environmental significance and to arrange for the monitoring of such pollutants to be introduced at the WMO background pollution stations as appropriate;

(5) To pursue co-operation, particularly through GESAMP, with UNEP, UN agencies and other international organizations regarding scientific aspects of marine pollution, and to continue close co-operation with IOC in marine pollution monitoring programmes;

(6) To promote development and investigation of techniques to measure the interchange of certain substances between air and other media, including processes involved in air-sea fluxes of these substances;

(7) To promote and ensure the application of meteorology and hydrology to air-pollution problems at both background and impact levels, as well as to pollution monitoring in open oceans and inland waters, and to ensure continuing co-operation with other international agencies such as WHO, IAEA and IOC;

(8) To contribute to the UNEP Regional Seas Programme to whatever extent is feasible and appropriate;

(9) To collaborate fully with UNEP in the further development of the Global Environmental Monitoring System.

Annex III

WMO RESOLUTION 17(EC-XXVI) - ENVIRONMENTAL POLLUTION AT THE BACKGROUND LEVEL

THE EXECUTIVE COMMITTEE,

NOTING:

(1) Resolution 17(EC-XXV),

(2) The report of the first session of the Executive Committee Panel of Experts on Atmospheric Aspects of Environmental Pollution,

(3) The report of the UNEP Intergovernmental Meeting on Monitoring, Nairobi, February 1974,

CONSIDERING:

(1) The scientific and economic advantages of integrating as far as possible the various environmental monitoring activities at the same stations,

(2) That the observational telecommunication, data-processing and data-archiving facilities available under WWW can be used with advantage in the system for monitoring environmental pollution at the background level,

(3) The desirability of increasing the important activities of WMO in monitoring environmental pollution at the background level,

(4) The increasing importance of stations for monitoring environmental pollution at the background level,

DECIDES that the WMO policy with regard to monitoring environmental pollution at the background level shall be as laid down in the annex to this resolution;

INVITES Members:

(1) To pursue, as a matter of urgency, the establishment of regional and baseline stations within the WMO network for monitoring background air pollution in accordance with Resolution 12(EC-XXII);

(2) In planning for the establishment of such background monitoring stations, particularly baseline stations:

(a) To attempt to meet, as far as possible, the requirements for other types of environmental monitoring, in particular those related to oceans and inland waters, without adversely affecting the meteorological objectives of these stations;

(b) To keep in mind the desirability of monitoring relevant geophysical parameters in relation to background monitoring of pollutants also in other media such as oil and biota, for the purpose of evaluating their effects;

REQUESTS the Secretary General, taking into account the statement by the Executive Committee that it was appropriate and desirable that WMO play a principal role in planning and organizing the implementation of a global system of baseline and regional stations for monitoring the environment:

(1) To inform UNEP and other international organizations concerned of the policy considerations laid down in the annex to this resolution;

(2) To submit relevant requests for support from the Environment Fund of UNEP for the development of the WMO activities related to background environmental pollution.

Annex IV

WMO RESOLUTION 18(EC-XXX) - WMO ACTIVITIES RELATED TO ENVIRONMENTAL POLLUTION

THE EXECUTIVE COMMITTEE

NOTING:

(1) Resolution 22(Cg-VII) - WMO activities in the field of environmental pollution,

(2) Resolution X-8 of the IOC Assembly,

(3) The progress made in the pursuance of WMO activities in environmental pollution,

(4) That the Executive Committee Panel of Experts on Environmental Pollution at its recent second session discussed all relevant matters as requested by the Executive Committee,

(5) With appreciation the support received from UNEP,

CONSIDERING the need to continue and increase efforts to provide information of significance in the work of WMO and the international community on environmental pollution,

DECIDES:

(1) To approve the recommendations of the second session of the Executive Committee Panel of Experts on Environmental Pollution as given in Part A of the annex to this resolution;

(2) To adopt, as the basis for further work, the objectives of BAPMoN, the siting criteria for baseline stations and the strategy for background air-pollution monitoring as given in Part B of the annex to this resolution;

REQUESTS:

(1) The Secretary-General to arrange for WMO to co-operate with IOC in the preparation of a plan of operation for the first phase of the Programme for Monitoring Background Levels of Selected Pollutants in Open Ocean Waters;

(2) The Executive Committee Panel of Experts on Environmental Pollution:

(a) To consider the merits of developing a marine pollution (petroleum) monitoring programme, especially with respect to visual observations of oil films; and

(b) To continue and refine the studies referred to under "DECIDES (2)" above in respect to CO_2 monitoring and climatic change purposes in consultation with an expert nominated by CAS;

URGES:

(1) Members to take appropriate measures in order to implement this resolution at the national level;

(2) UNEP to continue its substantial support to WMO's activities to environmental

Annex to Resolution 18(EC-XXX)

RECOMMENDATIONS FOR ENVIRONMENTAL POLLUTION ACTIVITIES

Part A

1. ATMOSPHERIC POLLUTION

1.1 Background Air Pollution Monitoring Network (BAPMoN)

1.1.1 The station coverage in BAPMoN is not yet sufficient in certain areas. It should be improved, in particular on the Asian continent, Central and South America, Africa and Australia.

1.1.2 Monitoring of suspended particulate matter (SPM) should be included in the minimum monitoring programme; a 24-hour sample should be taken at least every sixth day; at baseline stations the taking of samples over several days will be appropriate.

1.1.3 Precipitation sampling on a daily or special event basis should supplement monthly sampling.

1.1.4 CO_2 monitoring should be intensified to provide measurements over major land and ocean biomes throughout the world; this monitoring should not be restricted to baseline stations but should include monitoring at some regional stations and perhaps other locations to be incorporated in BAPMoN, as well as determinations of carbon compounds in ocean waters; the technical facilities already developed and available in BAPMoN should be used.

1.1.5 In and around dry and desert areas, monitoring of SPM and dry deposition is particularly useful and should be encouraged.

1.1.6 It is necessary to accumulate information on the representativeness of sampling sites; additional simple stations, sampling suitable substances, should be established, wherever possible, in the vicinity of a station.

1.1.7 Members operating BAPMoN stations thatdo not regularly, if at all, send their data to the WMO data centre should now send data routinely, including data for past or missing periods.

1.1.8 The co-operation with the IAESA/WMO Isotopes in Precipitation Network should be intensified by selecting joint sampling stations which could fill gaps in BAPMoN.

1.1.9 In addition to the already available precipitation chemistry and CO_2 standards, all possible efforts to establish standards and to achieve a high degree of standardization in monitoring should be made; the continuation and broadening of inter-laboratory comparisons is strongly recommended.

1.1.10 The extension of the BAPMoN monitoring programme should be reflected in forthcoming editions of the International Operations Handbook on Air Pollution Measurements.

1.1.11 A write-up should be prepared on the philosophy and principles underlying BAPMoN monitoring activities.

1.1.12 A conference covering items such as data usage, quality control, instruments, calibration techniques and data application to the climate problem should be planned for 1979.

1.2 Co-operation with other specialized organizations

1.2.1 The WMO activities should in particular concentrate on standardization of monitoring, data reporting and evaluation through training and further standardization of procedures and equipment.

1.2.2 In the application of meteorology to air-pollution problems in cities and industrial areas there is still a need for the standardization of transmission parameters. Suitable definitions should be elaborated. Such questions, including development of transmission models based on several years of observation, should be discussed at a seminar or symposium on meteorology and air pollution with CoSAMC and CAS participation.

1.3 WMO synthesizing centres for the ECE Programme on the Long-range Transmission of Air Pollutants in Europe

1.3.1 There is a need for further intensive research on transmission models incuding parameterization of dry deposition, variable mixing height, mesoscale precipitation features, humidity, temperature and radiation dependence of transformation factors; the results of the WMO Symposium on Boundary-layer Physics Applied to Specific Problems of Air Pollution (Norrköping, June 1978) may be of value in this work.

1.3.2 Members operating BAPMoN stations in Europe are urged to adjust the sampling programme of the stations where this has not already been done in order to meet the requirements of the ECE monitoring particulate matter and, if possible, gaseous sulphur compounds would be required.

1.3.3 Meteorological data referring to the 925 mb level should be made available as these will be used in the ECE long-range transmission programme and frequently in work on impact level air pollution.

2. MARINE POLLUTION

2.1 Programme for Monitoring Background Levels of Selected Pollutants in Open Ocean Waters

2.1.1 The possibility should be studied of convening an inter-secretariat meeting and a meeting of representatives of countries that agree to participate in the programme with a view to fostering the implementation of the programme.

2.1.2 Intercalibration of methods should be organized.

2.1.3 The final selection of pollutants for actual monitoring should be made after the preliminary phase of the programme is established.

2.1.4 In addition to monitoring of pollutants specified in the programme, measurements of carbon dioxide should be carried out by as many of the volunteering countries as possible.

2.1.5 When France, the Netherlands and the USSR start measurements of turbidity and CO_2 using their weather ships as platforms the methodologies provided by the WMO International Operations Handbook on Air Pollution Measurements should be followed

as closely as possible; special consideration and special guidance should be given to the sampling procedure of CO_2 and to the operation of instruments on board weather ships.

2.1.7 The Secretary-General is requested to arrange for the preparation of a Weather Ship Marine Environment Pollution Observation Programme; the experience with the methodology used at the Canadian weather station "Papa" should be considered; the programme, when it is developed, should be brought to the attention of the NAOS Board.

2.2 Interchange of pollutants and other substances between the atmosphere and oceans

2.2.1 The draft "Implementation Plan for Determination of Atmospheric Contribution of Petroleum Hydrocarbons to the Oceans" should be used as a basis for action by interested Members; an advisory group working by correspondence should supervise the implementation of the plan.

2.2.2 Special attention should be paid to the problem of interchange of CO_2 between the atmosphere and oceans.

2.2.3 The chairman of the WMO-led GESAMP working group on this subject, with the assistance of the Secretariat, is requested to prepare for the next session of the panel an information document critically reviewing the problems and identifying deficiencies.

2.2.4 The possibility of developing a methodology for the assessment of the the pollution of semi-enclosed seas via the atmosphere should be considered.

2.3 IGOSS Pilot Project on Marine Pollution (Petroleum) Monitoring

2.3.1 The third Workshop on Marine Pollution (Petroleum) Monitoring should concentrate on the following three objectives:

- Review comprehensively the scientific results of the pilot project;

- Review the progress made by the countries that received training and technical support; and

- Advise on the future of marine pollution monitoring activities as envisaged by the operational plan.

A panel representative should be nominated for participation in the workshop in order to fulfil the co-ordination and advisory role of the panel.

2.4 UNEP Regional Seas Programme

2.4.1 Forecast models should be developed to enable the predictions of the spread of pollutants from a source (e.g. oil spills).

2.4.2 WMO should concentrate its efforts on marine meteorological activities related to protection of marine environment and to interchange of pollutants between the atmosphere and seas.

3. INLAND WATER POLLUTION

3.1 In order to study air/inland water interface problems, guidelines for the monitoring of the transfer of a few selected pollutants should be prepared by CHy.

4. MULTI-MEDIA MONITORING

4.1 In order to start global activities in this field feasibility studies should be undertaken. The forthcoming symposium on MMM should tackle these problems.

Part B

1. OBJECTIVE OF BAPMoN

The function of the WMO Background Air Pollution Monitoring Network is to obtain measurements, in particular in the troposphere, on a global and regional basis, of background concentrations of atmospheric constituents which may affect environmental pollution of climate. From the variability in time and space and the possible long term changes of these data it will be possible to assess the influence of human and natural occurrences on the composition of the atmosphere. Such information is required

(a) To study the effects of atmospheric composition on climate, and the prediction of future climatic changes due to man's future activities;

(b) To aid in the study of the mechanisms of long-range atmospheric transport and deposition of potentially harmful substances;

(c) To aid the study of the biogeochemical cycles of important constituents in order to establish a sound basis for assessing human impact of these cycles and for making predictions of possible impacts on the environment.

Thereby the network will contribute to the gathering of atmospheric data of significance for the rational management of the environment within the framework of GEMS (UNEP).

2. BASELINE STATION SITING CRITERIA

(a) A baseline station should be located away from population centres, highways and air routes, preferably on isolated islands, on mountains above the tree line, or adjacent to a relatively inactive surface such as an ice sheet or ocean;

(b) It should experience only infrequent effects from local natural phenomena such as volcanic activity, forest fires, dust and sandstorms;

(c) It should be located in an area where no changes in land-use practices which may significantly effect the functioning of the station are anticipated for at least several decades, within about 100 km of the station in the direction of prevailing winds. The essential criterion is that "clean air" conditions should prevail for a substantial proportion of the time;

(d) The system of baseline stations should provide a global coverage and (together with regional stations with extended programmes) include all major biomes.

3. BAPMoN STRATEGIES

See attached table. (Scales used agree with those established by CoSAMC).

Table of BAPMoN Strategies

OBJECTIVES	SPACE SCALE PHENOMENON (KM) Hori-zontal	Vert-ical	APPROXIMATE TIME (YEARS) SCALE OF PHENOMENON	VARIABLES TO BE MEASURED	SITE SELECTION CRITERIA	WMO CLASSI-FICATION STATION TYPE	SUGGESTED NUMBER STATION
I. DETERMINE GLOBAL INVENTORIES AND THEIR TRENDS (MAINLY FOR CLIMATE STUDIES)	10^4	10	>1	CO_2 (including isotopic composition), chemical comp. of precip.*, solar radiation* (including turbidity), N_2O, CO, CH_3, total and surface O_3, condensation nuclei.	1. Local and regional influence of population centres, land-use practices, power generation, etc., must be absent, or avoidable with the use of suitable objective data-selection criteria. 2. Local and regional surface exchanges sufficiently weak so that surface measurements represent composition through the depth of the atmosphere. 3. Land-use changes not likely to influence collection of background data (at least after application of selection criteria) for several decades	Baseline	10-1
II. DETERMINE LATITUDINAL TRANSPORT FOR GLOBAL BIOGEOPHYSICAL MODELLING	10^4-10^3	10	0.1-1	Same as for I.		Baseline	2-5
III. DETERMINE AIR SURFACE EXCHANGE WITHIN, AND ATMOSPHERIC TRANSPORT BETWEEN LARGE-SCALE AREAS CHARACTERIZED BY DIFFERENT BIOMES AND DIFFERENT SEA SURFACE CONDITIONS	10^3	10	0.01-0.1	Same as for I, and gaseous sulphur and nitrogen compounds * suspended particulate matter*, chemical composition of particulates*.	Same as for OBJECTIVES I. and II. but minor continuous local influences may be acceptable provided their effect may be removed by some kind of averaging.	Baseline or Regional with extended programme	plus 10 to 20
IV. DETERMINE AIR-SURFACE EXCHANGE AND ATMOSPHERIC TRANSPORT WITHIN REGIONS CHARACTERIZED BY SIGNIFCANT MAN-MADE INFLUENCES AND POSSIBLE CHANGES IN ATMOSPHERIC CONDITIONS	10^2-10^3	1-3	hours days	Gaseous sulphur and nitrogen compounds, suspended particulate matter*, chemical composition of precipitation and of Particulates turbidity*, surface O_3.	Local influence of man-made pollution or natural surface exchanges absent or avoidable with use of suitable objective data selection criteria.	Regional	>100

* priority measurements

SUMMARY REPORT AND RECOMMENDATIONS OF THE FIRST INTERNATIONAL SYMPOSIUM ON INTEGRATED GLOBAL OCEAN MONITORING

TALLIN, 3-8 OCTOBER 1983

The first International Symposium on Integrated Global Ocean Monitoring (IGOM) was held in Tallin, USSR, 3 - 8 October, 1983. The Symposium was sponsored by the USSR State Committee for Sciences and Technology, USSR Academy of Sciences and USSR State Committee for Hydrometeorology and Control of Natural Environment with the support of the United Nations Environment Programme (UNEP), the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

The principal aims of the Symposium were:

(1) To review the scientific problems associated with ecological and physical aspects of ocean monitoring;

(2) To exchange information on the latest achievements in this field; and

(3) To discuss and recommend possible international scientific co-operation in integrated global ocean monitoring.

The Symposium was attended by scientists and experts from 26 countries as well as representatives and observers of the following international organizations: United Nations Environment Programme (UNEP), World Meteorological Organization (WMO), Intergovernmental Oceanographic Commission (IOC) of UNESCO, International Maritime Organization (IMO), Food and Agricultural Organization (FAO) of the United Nations, International Council for the Exploration of the Sea (ICES), Helsinki Commission, South Pacific Commission (SPC) and International Atomic Energy Agency (IAEA).

The first two days of the Symposium were devoted to plenary sessions and the rest of the time to special physical and ecological problems which were discussed in two parallel sessions.

The papers and subsequent discussions centred around the problems of the ocean interaction with other spheres of the environment and on assessment of the role of the oceans in geochemical, geophysical and biological processes.

In numerous presentations at the Symposium the concept of assimilative capacity of the marine environment was recognized taking into account basic hydrodynamic, microbiological and biosedimentary processes. The use of biological indicators in the studies of marine environment contamination (Mussel Watch) was reviewed and it was proposed that it should be expanded into a global programme.

Ongoing and planned programmes of research and monitoring, both national and international, within the framework of various organizations were also presented. The general impression from these presentations was that in coastal zones serious effects of human activities had been detected. These effects should be taken as strong warning signals that the open oceans might also be affected. Views were expressed about the possibility of the integration of regional programmes into a global programme through inter-regional co-operation. In the Symposium it was also

demonstrated that ongoing monitoring programmes, such as MAPMOPP (IOC), the regional pollution studies in the framework of UNEP's Regional Seas Programme, ICES Co-operative Monitoring Studies Programme and the CSK (Co-operative Study of Kuroshio) Programme had given many reliable results and provided much experience.

It was considered by the Symposium participants that fisheries and mariculture might constitute a considerable anthropogenic impact on the oceans.

Methods for assessing the state of the marine ecosystems and measures that might prevent the negative impact of pollutants on marine organisms were extensively discussed.

The following problems were also reviewed: global ocean circulation modelling, large-scale ocean-atmosphere interactions, develoment of world ocean satellite monitoring, the cycle of carbon in the atmosphere and the oceans, El-Niño and southern oscillations, physical aspects of pollution distribution, and modelling the hydrophysical and hydrochemical processes in some seas.

The discussions showed that monitoring of the hydrophysical characteristics of the world oceans was one of the important but very difficult oceanological problems. Since the problem was global in nature, it could be solved only on the basis of global oceanographic information which could permit modelling general non-stationary circulation and distribution of pollutants in the world oceans. As a first step towards the solution of that complicated problem it was necesary to simulate the world ocean climatic circulation with sufficient accuracy. Besides the usual information continuously received in the World Data Center (WDC), an important role in modelling the stationary and non-stationary circulation of the world oceans could be played by the information obtained as a result of ongoing multinational programmes for investigating the atmosphere-ocean interaction to study short-term climatic changes ("Sections" programme), as well as by the planned international Tropical Ocean and Global Atmosphere (TOGA) and World Ocean Circulation Experiment (WOCE) programmes. It was noted that besides fulfilling their formulated tasks these three programmes would also form the basis for testing monitoring schemes.

The Symposium stressed the necessity of further development of global monitoring of hydrophysical and ecological processes making full use of "Sections", TOGA and WOCE Programmes.

The scientific basis of the ecological monitoring was discussed. Special attention was given to bioproductivity. The total biomass of the pelagic biota and its spacial and temporal turnover were estimated.

It was recognized that the most productive coastal zones were already under the negative influence of various pollutants. That influence was observed in a number of biotopes, particularly in neuston.

The important role of marine micro-organisms in the destruction of marine pollutants was stressed. New microbiological and biochemical indicator methods for assessing organic pollution of water masses were noted. The evaluation of potential activity of marine micro-organisms as means of determining the assimilative capacity of different world ocean areas was proposed.

Data on bioaccumulation and biosedimentation of metals, organochlorine and polycyclic aromatic hydrocarbons (PAH) in different ecological situations were presented.

Quantitative estimates of biosedimentation, microbial oxidation of organic compounds including toxicants, as well as estimates of cycle balances for carbon, benz(a)pyrene, petroleum products, mercury and radionuclides were given.

Ecological consequences of the ocean pollution and the role of atmospheric transfer and deposition of chemical toxicants in the ocean were considered.

The efforts of international organizations and active research in many countries helped to provide new information on many global problems considered at the Symposium. In that connection the desirability of establishing an integrated global monitoring system was stressed.

The participants in the Symposium felt that it played an important role in promoting world ocean research and in identifying ways to develop an integrated global ocean monitoring programme.

The participants noted the substantial contribution made by the USSR State Committee for Science and Technology, USSR State Committee for Hydrometeorology and Control of Natural Environment, and the USSR Academy of Sciences to the organization of the Symposium.

Special thanks were conveyed to the Council of Ministers of the Estonian SSR and the Academy of Sciences of the Estonian SSR for providing excellent accommodation for the Symposium and for their warm hospitality.

The participants also expressed their gratitude to the sponsoring international organizations: UNEP, WMO and IOC.

RECOMMENDATIONS

1. It was obvious from numerous presentations at the Symposium that the concept of integrated global ocean monitoring must be developed. There is a need to explore all aspects of such monitoring carefully and to develop a sound scientific basis for establishing an integrated global ocean monitoring programme. International experts should be brought together within the framework of the United Nations system to discuss the development of such a programme.

   Taking note of the past activities of GESAMP, in particular its recent report, Review of the Health of the Oceans, the meeting recommended that GESAMP be requested to develop the aspects of integrated global ocean monitoring (IGOM) related to marine pollution and the protection of the marine environment, as part of UNEP's Global Environmental Monitoring System (GEMS). In developing the concept, GESAMP should be requested to examine the scientific rationale for IGOM, as well as its methodological feasibility, structure (elements) and the support required for its implementation.

   UNEP was invited to take the initiative to bring the matter to GESAMP's attention and to provide support for the preparation of the conceptual framework of IGOM through GESAMP.

   The climatic aspects of IGOM would be developed in the framework of the World Climate Research Programme.

2. Considering the importance of climatic and physical processes in evaluating the state of the oceans and noting that several programmes have been initiated such as the ongoing programme "Sections" (Programme of investigations of the air-sea interaction for exploration of the short-range climatic variations), as well as the planned programmes TOGA, WOCE and exploratory time series, the Symposium strongly recommended that these programmes be supported. Relevant biological projects could also be considered along with these programmes.

3. The Symposium noted that it was feasible to utilize mussels (Mytilus sp.) as indicator organisms for monitoring the level of pollutants in the marine environment. The Symposium recommended that the competent international organizations consider the possibility of expanding the current Mussel Watch activities to determine levels of organohalogen compounds in molluscs, particularly in tropical and sub-tropical areas of the southern hemisphere.

4. Noting that the concept of integrated global ocean monitoring and other elements, including assessment methodologies, biological and ecological indicators, assimilative or receiving capacity, needed further research and development, the Symposium recommended that monitoring should only be developed in a gradual way and in close contact with research and that intercalibration exercises had to be included in order to ensure comparability of data.

5. Eutrophication of the ocean can be monitored microbiologically and biochemically by measuring parameters that have a direct relationship with the turnover rate of biological elements. The technique for measurement can be applied in any country for global monitoring. It is recommended that monitoring for sanitary-microbiological indices be encouraged, with special reference to eutrophication.

6. Noting that the information on contamination levels in the world oceans provided by GIPME needs to be enhanced, the Symposium recommends that programmes be devised for baseline studies of selected contaminants in the open ocean. It is further recommended that after the programmes have been devised by relevant experts, they be supported on an international basis and their results presented at the Second International Symposium on IGOM.

7. The Symposium recognized the success of monitoring activies undertaken by the Regional Seas Programme. The Symposium supports the regional approach to environmental research and monitoring as a vital element in the achievement of integrated global ocean monitoring.

8. Considering the many important results presented at the Symposium, the concepts developed, the exchange of information and the great importance of the subject, it is recommended that the proceedings of the Symposium be published in Russian and English.

9. Regarding the many important results on the ecological situation in the world oceans and the obvious value of the exchange of scientific information related to the development of integrated global ocean monitoring, the Symposium recommended that the Second International Symposium on Integrated Global Ocean Monitoring be held in 3-4 years.

10. The participants in the Symposium request the Chairman of the Organizing Committee to convey the present conclusions to the heads of the sponsoring international organizations and ask them to inform relevant bodies or expert groups of these organizations about the outcome of the Sumposium.

TERMS OF REFERENCE OF THE GESAMP WORKING GROUP ON INTEGRATED GLOBAL OCEAN MONITORING

(ESTABLISHED AT FOURTEENTH SESSION OF GESAMP, VIENNA, 26-30 MARCH 1984)

(i) To examine the scientific basis, rationale, feasibility and technical requirement for monitoring biological and chemical conditions and the ecological consequences of pollution, i.e. the scientific justification for an integrated global ocean (by which is meant all sea areas) monitoring study (IGOM) related to marine pollution and the ecological consequences thereof, taking into account what is already being done in these fields. In examining the scientific justification for IGOM the Working Group should consider:

(a) the type of observations and measurements that could be included in IGOM, i.e. the parameters which could be included and the areas in which they may be required;

(b) the methodological feasibility of IGOM, i.e. the availability of adequate sampling and analytical techniques which can be expected to provide reliable data on a world wide basis and to advise on the extent to which these can actually be applied and what, if any, further facilities may be required;

(c) the type of observations/measurements which might be practicable to include in a monitoring programme;

(d) the type of observations and sampling strategy which would be required i.e. the frequency of sampling in both space and time and the distribution/location of sampling stations; and

(e) the support needed to initiate and implement the IGOM such as intercalibration, quality control of data, co-ordination, data processing and institutional arrangements and what further facilities, if any, may be necessary; and

(ii) to prepare an interim report for the 15th session of GESAMP on the progress achieved in considering the subjects defined by these terms of reference.

PUBLICATIONS IN THE UNEP REGIONAL SEAS REPORTS AND STUDIES SERIES

No. 1 UNEP: Achievements and planned development of UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. (1982)

No. 2 UNIDO/UNEP: Survey of marine pullutants from industrial sources in the West and Central African region. (1982)

No. 3 UNESCO/UNEP: River inputs to the West and Central African marine environment. (1982)

No. 4 IMCO/UNEP: The status of oil pollution and oil pollution control in the West and Central African region. (1982)

No. 5 IAEA/UNEP: Survey of tar, oil, chlorinated hydrocarbons and trace metal pollution in coastal waters of the Sultanate of Oman. (1982)

No. 6 UN/UNESCO/UNEP: Marine and coastal area development in the East African region. (1982)

No. 7 UNIDO/UNEP: Industrial sources of marine and coastal pollution in the East African region. (1982)

No. 8 FAO/UNEP: Marine pollution in the East African region. (1982)

No. 9 WHO/UNEP: Public health problems in the coastal zone of the East African region. (1982)

No. 10 IMO/UNEP: Oil pollution control in the East African region. (1982)

No. 11 IUCN/UNEP: Conservation of coastal and marine ecosystems and living resources of the East African region. (1982)

No. 12 UNEP: Environmental problems of the East African region. (1982)

No. 13 M. PATHMARAJAH: Pollution and the marine environment in the Indian Ocean. (1982)

No. 14 UNEP/CEPAL: Development and environment in the Wider Caribbean region: A Synthesis. (1982)

No. 15 UNEP: Guidelines and principles for the preparation and implementation of comprehensive action plans for the protection and development of marine and coastal areas of regional seas. (1982)

No. 16 GESAMP: The health of the oceans. (1982)

No. 17 UNEP: Regional Seas Programme: Legislative authority. (in preparation)

No. 18 UNEP: Regional Seas Programme: Workplan. (1982)

No. 19 Rev. 1. UNEP: Regional Seas Programme: Compendium of projects. (1984)

No. 20 CPPS/UNEP: Action Plan for the protection of the marine environment and coastal areas of the South-East Pacific. (1983)

No. 21 CPPS/UNEP: Sources, levels and effects of marine pollution in the South-East Pacific. (1983) (In Spanish only)

No. 22 Rev. 1. UNEP: Regional Seas Programme in Latin America and Wider Caribbean. (1984)

No. 23 FAO/UNESCO/IOC/WHO/WMO/IAEA/UNEP: Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MED POL) - Phase I: Programme Description. (1983)

No. 24 UNEP: Action Plan for the protection and development of the marine and coastal areas of the East Asian region. (1983)

No. 25 UNEP: Marine pollution. (1983)

No. 26 UNEP: Action Plan for the Caribbean environment programme. (1983)

No. 27 UNEP: Action Plan for the protection and development of the marine environment and coastal areas of the West and Central African region. (1983)

No. 28 UNEP: Long-term programme for pollution monitoring and research in the Mediterranean (MED POL) - Phase II. (1983)

No. 29 SPC/SPEC/ESCAP: Action Plan for managing the natural resources and environment of the South Pacific region. (1983)

No. 30 UNDIESA/UNEP: Ocean energy potential of the West and Central African region. (1983)

No. 31 A. L. DAHL and I. L. BAUMGART: The state of the environment in the South Pacific. (1983)

No. 32 UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA: Pollutants from land-based sources in the Mediterranean. (1984)

No. 33 UNDIESA/UNEP: Onshore impact of offshore oil and natural gas development in the West and Central African region. (1984)

No. 34 UNEP: Action Plan for the protection of the Mediterranean. (1984)

No. 35 UNEP: Action Plan for the protection of the marine environment and the coastal areas of Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. (1983)

No. 36 UNEP/CEPAL: The state of marine pollution in the Wider Caribbean region. (1984)

No. 37 UNDIESA/UNEP: Environmental management problems in resource utilization and survey of resources in the West and Central African region. (1984)

No. 38 FAO/UNEP: Legal aspects of protecting and managing the marine and coastal environment of the East African region. (1983)

No. 39 IUCN/UNEP: Marine and coastal conservation in the East African region. (1984)

No. 40 SPC/SPEC/ESCAP/UNEP: Radioactivity in the South Pacific. (1984)

No. 41 UNEP: Socio-economic activities that may have an impact on the marine and coastal environment of the East African region. (1984)

No. 42 GESAMP: Principles for developing coastal water quality criteria. (1984)

No. 43 CPPS/UNEP: Contingency plan to combat oil pollution in the South-East Pacific in cases of emergency. (1984)

No. 44 IMO/ROPME/UNEP: Combating oil pollution in the Kuwait Action Plan region. (1984)

No. 45 GESAMP: Thermal discharges in the marine environment. (1984)

No. 46 UNEP: The West and Central African marine environment. (1984)

No. 47 UNEP: Prospects for global ocean pollution monitoring. (1984)