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EVALUATION REPORT OF THE MED POL PROGRAMME

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Preface

The Bureau of the Contracting Parties to the Barcelona Convention, at the Meeting held in Cairo on 9-10 November 1992, decided that an independent evaluation of the MED POL programme should be undertaken.

As a response to that request, the MAP Secretariat recruited five consultants for the preparation of such report. Three consultation meetings were held at the MAP office in Athens during which all the available documentation on MED POL was put at their disposal and discussions were held with the MAP officers involved in MED POL.

The consultants recruited by the MAP Co-ordinating Unit to prepare the present document were: Dr Michael Bernhard (Project leader); Dr Youssef Halim; Dr Arne B. Jernelov; Dr Mario Ruivo; and Dr Graham Topping.

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EXECUTIVE SUMMARY

1. INTRODUCTION

This report presents an evaluation of the monitoring and research work carried out under Phases I and II of the MED POL programme in relation to its objectives. This evaluation examines the work done, its achievements and bottlenecks, and how these might be overcome. It also includes recommendations for future work under Phase III of MED POL.

MED POL has consisted of two parts: Phase I began in 1975 and concluded in 1980. During this period member states acquired experience in marine pollution measurements and research and began to compile data on baseline levels of contaminants in the Mediterranean Sea. Phase II began in 1981 and will end in 1995. The experience gained in Phase I was used to carry out long term pollution monitoring and research work.

Phase I of MED POL had five general objectives :

- to formulate and carry out a co-ordinated pollution monitoring and research program taking into account the goals of the Mediterranean Action Plan and the capabilities of the Mediterranean research centres;

- to assist national research centres in developing their capabilities to participate in the programme;

- to analyze the sources, amounts, levels, pathways, trends and effects of pollutants in the Mediterranean Sea;

- to provide the scientific-technical information needed by the Mediterranean States and the EEC for negotiation and implementation of the Convention for the Protection of the Mediterranean Sea against Pollution and its related protocols; and

- to build up consistent time-series of data on the sources, pathways, levels and effects of pollutants in the Mediterranean Sea.

The specific objectives of MED POL - Phase II are designed to provide, on a continuous basis, the Contracting Parties to the Barcelona Convention with the following:

- information required for the implementation of the Convention and the Protocols;

- indicators and evaluation of the effectiveness of the pollution prevention measures taken under the Convention and the Protocols;

- scientific information that may lead to eventual revisions and amendments of the relevant provisions of the Convention and the Protocols and for the formulation of additional protocols;

- information that could be used to formulate environmentally sound national, bilateral and multilateral management decisions essential for the continuous socio-economic development of the Mediterranean region on a sustainable basis; and

- periodic assessment of the state of pollution of the Mediterranean Sea.

As such, the objectives of both MED POL Phases are not specific enough to provide the Contracting Parties with the information needed for the purpose of their work.

2. INSTITUTIONAL AND FINANCIAL ARRANGEMENTS FOR MED POL

Phase I was co-ordinated by UNEP in cooperation with six other agencies - FAO, UNESCO, WHO, WMO, IAEA and IOC. The overall co-ordination of Phase II is provided by the Coordinating Unit for the Mediterranean Action Plan (MED Unit). It was agreed from the outset that the scientific projects under MED POL would be carried out by national research institutes. Funding was partly provided through the MED Unit out of funds provided by member states. During Phase I more than 200 scientific groups from 84 institutions in 16 Mediterranean countries became involved. The support provided by the MED Unit and the cooperating agencies included: the purchase and maintenance of scientific equipment, the training of staff, the organization of analytical intercomparison exercises, and technical and scientific information covering sampling and analytical methodology.

To assist the Contracting Parties with their work, a Standing Working Group for Scientific and Technical Cooperation was established in 1981 composed of national coordinators for MED POL. The latter were also entrusted with the coordination of the national programmes in their respective countries.

The coordination of the work by MED Unit appears to have been carried out in a professional manner, but the national co-ordinators have failed to assist the MED Unit in the planning and scientific evaluation of the monitoring and research work as outlined in the terms of reference laid down by the Contracting Parties.

3. RESULTS OF MED POL PHASE I AND II

Research in MED POL is conceived as a supporting activity to monitoring and to generate the scientific baseline for a better informed and more efficient management of the environment. Under this policy the responsibility for the programme implementation was given to the Mediterranean scientific community, in preference to calling in expertise from outside the region. This pertinent policy had far-reaching consequences in upgrading the capabilities of the Mediterranean community, although

it had to cope with considerable difficulties, some of which ultimately reflecting on the outcome of the programme.

Given the relative inexperience of participating institutes, and the difficulties inherent to the programme, several problems were encountered in the research work under Phase I of MED POL. They largely relate to the validity and the comparability of the data, and their uneven geographical coverage. Since Phase I was conceived as a preparatory phase for the following long-term programme for research in Phase II it appears however to have been a relatively successful exercise.

Some of the strategic problems encountered during Phase I remained unresolved during Phase II: the insufficient geographical coverage and the validity and comparability of some of the results.

3.1. MONITORING IN MED POL

The monitoring activities during Phase I covered: petroleum hydrocarbons in seawater (MED POL I); metals and chlorinated hydrocarbons in marine organisms (MED POL II and III respectively); and microbiological quality of recreational waters and shellfish (MED POL VII). The baseline studies of pollutants in open sea areas for marine organisms, particulate and open-ocean sediments were pursued under MED POL VIII. A programme of intercalibration of analytical techniques and maintenance service for analytical instruments (MED POL XI) was designed to develop the ability of laboratories to measure levels of contaminants in the various marine matrices and to ensure that the data collected in different countries were comparable. This project remains of essential importance to the success of MED POL.

In general, during the Phase I, the monitoring work carried out under MED POL I provided inadequate coverage of the Mediterranean Sea. In addition, other factors contributed to the lack of success of MED POL II and III. Firstly, the quality of some of the data collected from participating laboratories was relatively poor; this reflected the initial inexperience and low analytical capability of the participants. Secondly, no attempt was made to screen the data base for inaccurate data using the results of the intercomparison exercises. This meant that accurate data became 'contaminated' with wrong and false data thus making any conclusion about the concentrations of contaminants useless or even misleading. Consequently, wrong management decisions based on either too high or too low concentrations may have been made. Lastly, the practice of averaging data over very large areas of the Mediterranean Sea did not allow the identification of hot-spots.

Although 16 countries have signed monitoring agreements during Phase II only 9 of them have included a limited programme of monitoring of pollution sources in their national programmes. As a consequence, only a small number of stations were established to monitor the impact of industrial and urban waste discharge.

In general, the results from Phase II of MED POL do not provide the Contracting Parties with a description of the state of the marine environment in the Mediterranean,

or a provisional estimate of contribution of inputs to the Mediterranean or an indication of temporal trends of contaminants in marine organisms.

By September 1988 monitoring of contaminants in marine organisms during Phase II provided approximately 14,600 data on heavy metals (mainly mercury, cadmium, lead, zinc and copper) reported by 12 Mediterranean States. 87 % of the data were submitted by only 4 countries, Spain, Israel, Malta and Yugoslavia. The remaining data were provided by 7 other countries (Algeria, Cyprus, France, Italy, Lebanon, Morocco and Syria). Because of the limited coverage of data, and the fact that not all countries provided data on the same species for different areas, the spatial comparison of contamination in the Mediterranean Sea is still very poor. Also, none of the data provided by the countries are useful for establishing the trends in concentration of contaminants over time.

During the period 1983-1987, seven Mediterranean States reported data on microorganisms, mainly fecal coliform concentrations (FC) from 300 stations. 82 % of the stations conformed to the interim criteria laid down by WHO/UNEP. This represents a considerable improvement on the 1976-1980 period.

3.2. RESEARCH IN MED POL

During Phase I, most of the experiments on effects of pollutants on marine organisms and their populations were carried out by exposure to pollutants in water and not through food intake. Although valuable information was obtained, most of the concentrations used in the experiments were unrealistically high. Pollution-induced modifications of marine communities and ecosystems were investigated in about 30 sites which were very unevenly distributed over the Mediterranean. Most of the studies were of a descriptive nature. Research on coastal transport of pollutants was understood by most investigators as the measurement of currents in the coastal zone by means of current-meters or even by driftcards. The problems of dispersion and diffusion of pollutants and the exchange between inshore and offshore waters were not properly addressed.

In spite of a more reduced budget, Phase II encompassed thirteen research activities which in 1992 were regrouped into five research areas with no order of priority. In 1992, priority funding was given to eutrophication within 50% of the budget until 1995.

About 200 research proposals from 15 countries were agreed in 1986 and 1987; decreasing to 130 in 1991 and 1992. Funding was very unevenly distributed among the thirteen approved research activities and amongst institutes.

In spite of many limitations, the investigations carried out during Phase I and II and the conclusions and results of the workshops organized through MED POL provide a wealth of data and knowledge of great value for the Mediterranean scientific community. This is documented in the impressive number of volumes of the MAP Technical Report Series (75 publications to date).

4. MONITORING OF LAND-BASED SOURCES AS PART OF MED POL

A pilot project during Phase I (MED POL X) was designed to provide information on the inputs of land-based sources and on current management practices of waste releases into the marine environment. Data collection in many countries proved to be very difficult in the short time allowed (1976 to 1977). Assessments, therefore, were carried out by extrapolations and using general national parameters (i.e. GNP, industrial production, etc.). Although the assessment provided only rough estimates, the project represents an important first approximation of the magnitude of inputs from land-based sources. The project is being updated (MED POL X bis) but the data submission to the MED Unit by the participating countries is still very slow and fragmentary.

5. ASSESSMENTS OF INDIVIDUAL POLLUTANTS

These assessments incorporated both MED POL data and data from the open scientific literature.

The assessments have been of a high quality with regard to the way the existing information has been evaluated and utilized to propose adequate measures. They constitute another major achievement of MED POL.

6. QUALITY CONTROL OF DATA

The achievements under this project can be considered to be one of the more successful components of the MED POL programme. Currently, there is evidence of improved comparability of data for some measurements carried out by the majority of laboratories. A few laboratories have also demonstrated that they have continued to improve their analytical capability over time. However, much more effort needs to be made by the majority of laboratories to improve the quality of their data if all of the objectives of MED POL are to be achieved.

7. TRAINING, ASSISTANCE AND CAPACITY BUILDING

The capacity building programme consisted in equipping national research centres, providing training, consultancy and maintenance services and intercalibration exercises. MED POL help considerably to establish the foundations of a scientific infrastructure in the Mediterranean. An important operational drawback of the programme is that its effectiveness has not been evaluated.

8. INTERNATIONAL COOPERATION

No effort has been made to establish scientific collaboration between participating institutes. Cooperation between institutes from developed and developing countries could have greatly improve the data quality and stimulate the performance of the less experienced institutes.

9. LESSONS LEARNED FROM THE NORTH SEA MONITORING PROGRAMMES

The experience from the North Sea monitoring programmes and similar exercises have shown that the objectives must be clearly defined and the monitoring programmes well designed with respect to detailed sampling strategy, reference methods and data evaluation.

10. EVALUATION OF THE WORK DONE DURING MED POL PHASE I AND II

The most serious bottlenecks are the uneven geographic distribution of the monitoring results and the slow and incomplete transmission of monitoring results by the national coordinators to the MED Unit.

In general, the MED POL programme can be considered to be successful despite the problems encountered during Phases I and II. Many of the problems encountered by participating institutes have been experienced, and to some extent are still being experienced, by other international organizations (e.g. those involved North Sea and Baltic Sea). It should be stressed, however, that the scientists in the institutes in the North Sea and Baltic Sea areas had a distinct advantage over their counterparts in Mediterranean institutes in that at the start of their programmes they were more experienced, better trained and had access to better facilities and instrumentation. The MED POL programme has achieved much in terms of equipping and training scientists in the region, particularly those from the southern and eastern parts. These achievements must be built on by the Contracting Parties by continuing to support these institutes and the scientific work of the MED POL programme.

11. RECOMMENDATIONS

The evaluation has shown that, in addition to inadequate funding, the majority of the problems encountered by MED POL are due to the insufficient scientific expertise given to the MED Unit. Based on this conclusion a single recommendation is made. A Standing Advisory Group of Experts (SAGE) needs to be established to assist the MED Unit in their future work, particularly the designing and implementation of detailed plans for the remaining part of MED POL Phase II (1994-1995) and MED POL Phase III (1996-2005) and the periodical review of data arising from such activities.

1. INTRODUCTION: WHAT IS MED POL ?

Following the UN Stockholm meeting in June 1972, and the formation of the United Nations Environment Programme (UNEP) shortly afterwards, a workshop was organized in 1974 on marine pollution in the Mediterranean Sea. This workshop identified the need for four pilot projects concerned with living resources and fisheries, and a task force subsequently drew up the elements of an Action Plan for these projects. In January 1975, UNEP convened an Intergovernmental Meeting at which 16 of the 18 Mediterranean coastal states participated. This meeting adopted the Mediterranean Action Plan (MAP), which consisted of four main components:

- integrated planning of the development and management of the resources of the Mediterranean Basin;

- co-ordinated programme for research, monitoring and exchange of information and assessment of the state of pollution and of protection measures (MED POL);

- framework convention and related protocols with their technical Annexes for the protection of the Mediterranean environment; and

- institutional and financial arrangements.

A second Intergovernmental meeting, held in Barcelona in 1976 and attended by 16 coastal states and the EC, subsequently adopted the Convention for the Protection of the Mediterranean Sea against Pollution (The Barcelona Convention, which came into force in 1978), and two protocols on dumping and cooperation in case of emergency. In the same year, seven pilot projects were adopted, and these became the basis for the Co-ordinated Programme for Research and Monitoring of Pollution in the Mediterranean Sea (MED POL). Six other pilot projects were later defined, and four of them were implemented to broaden the scope of MED POL.

To date, MED POL has consisted of two parts: Phase I, which began in 1975 and concluded in 1980, in which the member states acquired experience in marine pollution measurements and began to compile data on baseline levels of contaminants in the Mediterranean Sea; and Phase II, which was initially scheduled to run from 1981 and 1990, but subsequently was extended to 1995, in which the experience gained in Phase I was used to carry out long term pollution monitoring and research work.

1.1. MED POL PHASE I

The five general objectives of this part of MED POL were:

- to formulate and carry out a co-ordinated pollution monitoring and research programme taking into account the goals of the Mediterranean Action Plan and the capabilities of the Mediterranean research centres;

- to assist national research centres in developing their capabilities to participate in the programme;

- to analyze the sources, amounts, levels, pathways, trends and effects of pollutants in the Mediterranean Sea;

- to provide the scientific-technical information needed by the Mediterranean States and the EEC for negotiation and implementation of the Convention for the Protection of the Mediterranean Sea against Pollution and its related protocols; and

- to build up consistent time-series of data on the sources, pathways, levels and effects of pollutants in the Mediterranean Sea.

MED POL Phase I initially consisted of seven pilot projects on baseline studies and monitoring of oil and petroleum hydrocarbons in sea water, heavy metals and chlorinated hydrocarbons in biota and microbial pollution as well as research on effects of pollutants on organisms, populations, communities and ecosystems. In addition, four related projects were also included to broaden the scope of the programme or to provide the ancillary support. The different MED POL projects are given Latin numbers e.g. MED POL I to MED POL XIII (Table 1).

1.2. MED POL PHASE II

The five objectives of Phase II of MED POL were designed to provide, on a continuous basis, the Contracting Parties to the Barcelona Convention with the following:

- information required for the implementation of the Convention and the Protocols;

- indicators and evaluation of the effectiveness of the pollution prevention measures taken under the Convention and the Protocols;

- scientific information that may lead to eventual revisions and amendments of the relevant provisions of the Convention and the Protocols and for the formulation of additional protocols;

- information that could be used to formulate environmentally sound national, bilateral and multilateral management decisions essential for the continuous socio-economic development of the Mediterranean region on a sustainable basis; and

- periodic assessment of the state of pollution of the Mediterranean Sea.

In addition to supplying technical assistance, including instrument maintenance and data quality assurance programmes, to the laboratories in member states, Phase II of MED POL consisted of the following monitoring components:

- monitoring of sources of pollution providing information on the type and amount of pollutants released directly into the environment;

- monitoring of near shore areas, including estuaries, under the direct influence of pollutants from identifiable primary (outfalls, discharge and coastal dumping points) or secondary (rivers) sources;

- monitoring of offshore areas (reference areas) providing information on the general trends in the level of pollution in the Mediterranean; and

- monitoring of the transport of pollutants to the Mediterranean through the atmosphere, providing additional information on the pollution load reaching the Mediterranean Sea.

This work was to be done through the implementation of National Monitoring Programmes and by the end of 1989 thirteen Mediterranean countries (Albania, Algeria, Cyprus, Egypt, Greece, Israel, Lebanon, Libya, Malta, Morocco, Syria, Tunisia and Yugoslavia) had signed formal agreements to conduct monitoring work and to submit their data to the Coordinating Unit for the Mediterranean Action Plan, Athens (known as MED Unit). France, Monaco, Italy and Spain had agreed to provide data, even without signing a formal agreement, on the basis of an agreed programme. The monitoring and research projects of MED POL Phase II from 1982-1989, are shown in Table II and from 1990 onwards in Table III.

2. INSTITUTIONAL AND FINANCIAL ARRANGEMENTS FOR MED POL

2.1. MED POL PHASE I

This Phase was co-ordinated by UNEP in cooperation with six other agencies - FAO, UNESCO, WHO, WMO, IAEA and IOC. It was agreed from the outset that the scientific projects under MED POL would be carried by the existing national research institutes who would receive partial funding for this work from the Regional Seas Programme Activity Centre out of funds provided by member states whose contribution was based on UN scale of assessment. To obtain funding for this work, it was necessary for institutes to sign an agreement with the relevant agency. Details of the various projects carried out during this Phase can be found in UNEP Regional Sea Reports and Studies No 23 (1983) entitled MED POL Phase I: Programme Description.

During the period from 1975 to 1980 more than 200 scientific groups from 84 institutions in 16 Mediterranean countries were involved in such activities. The support provided by the Regional Seas Programme Activity Centre and agencies included: the purchase and maintenance of scientific equipment, the training of staff, the organization of analytical intercomparison exercises, and technical and scientific information covering sampling and analytical methodology.

2.2. MED POL PHASE II

The overall co-ordination of this Phase is provided by the Coordinating Unit for the Mediterranean Action Plan (MED Unit), co-operating agencies (FAO, UNESCO, WHO, WMO, IAEA, IOC) are responsible for the day-to-day coordination and technical implementation of the work of national institutes participating in monitoring and research.

To assist the Contracting Parties with their work (programme planning, approval of budgets and evaluation of results), a Standing Working Group for Scientific and Technical Cooperation was established in 1981. The participants in this working group included national coordinators, who had been appointed by their countries to carry out the following responsibilities:

- to ensure that national programmes were implemented and to coordinate efforts in their countries;
- to identify institutes who might participate in MED POL work;
- to channel all formal communication between MED Unit and the institutes;
- to provide MED Unit with national data;
- to assess and report as required on the overall amounts of pollutants discharged from national sources; and
- to assess and report on the state of pollution in the areas monitored by national institutes.

This working group met five times between 1981 and 1987.

However, following a decision taken by the Contracting Parties in Sept 1987, this group was replaced by a Scientific and Technical Committee, which met jointly with a new group - the Socio and Economic Committee. To date, there have been four meetings of this combined committee - May 1988, Jan 1989, June 1990 and June 1993.

3. RESULTS OF MED POL PHASE I AND PHASE II

The policy adopted in the component of MED POL gave the responsibility of the programme implementation to the Mediterranean community, in preference to calling in expertise from outside the region. This pertinent policy had far-reaching consequences that it was necessary to upgrade the capabilities of the Mediterranean community, although it had to cope with considerable difficulties, some of which ultimately reflecting on the outcome of the programme.

The objectives of MED POL Phase I were pursued through the conduct of 13 pilot projects covering: baseline studies of contaminants in seawater, sediments and biota; research work on the effects of contaminants on marine life; processes controlling the fate of contaminants in the marine environment; inputs of contaminants from the atmosphere and land-based discharges; and quality assurance.

Participants in project work were provided with general guidance on sampling (e.g. when and how to take a sample), what contaminants should be measured and which analytical methodology should be used. Although regional areas to be investigated were identified by the Regional Seas Programme Activity Centre, Geneva, no master sampling plan was drawn up for the various regions of the Mediterranean Sea for the baseline components of the project work.

The programmes of work under Phase II include similar ones to those carried out under Phase I, but more emphasis was given to the acquisition of data on inputs of contaminants to the sea and survey work in coastal waters.

During Phase II the annual National Monitoring Programmes are elaborated with the help of MED Unit in Athens and are governed by agreements which are formalized in a document which defines the responsibilities of each of the parties involved, including the national co-ordinator for MED POL and spells out in a rather precise manner the work programme: location of sampling stations, parameters, frequency of measurements, methods used, laboratories responsible for the analysis of samples, how the data are to be transmitted and the quality assurance programme. In order to elaborate the agreement covering each programme, guidelines are used to establish the basic criteria of the monitoring programme, both in terms of structure and in terms of content. In particular, lists of parameters were established in 1981 and revised in 1987, which identify two parameter categories, one including those which must be included in all national programmes (category I) and one containing the parameters that are to be included only when it is considered necessary and/or appropriate (category II) (UNEP, 1987). Through this programme, monitoring is currently carried out at hundreds of sampling stations (Fig. 1).

However, it should be noted that no detailed objectives and sampling plans were prepared for these monitoring programmes to assist the participants in their work.

Comments on organizational aspects of MED POL Programme

Overall, the MED POL programme has lacked detailed objectives, particularly for its baseline and monitoring work. Without such objectives, even the best organized work force can waste effort in collecting information and data which have little or no value in relation to the original aims of the programme (see section 9). Indeed it could be argued that without clear and achievable objectives for MED POL, it was unlikely that the participants could provide the appropriate data to achieve the overall aim of the work.

Although the Contracting Parties established scientific working groups to assist them in their planning and evaluation of monitoring work, in practice this does not appear to have happened. An examination of the summary records of their annual meetings indicates that the main topics on their agenda appear to have been the discussion of financial aspects of MED POL, and the slow progress of some countries in establishing agreements with MED Unit, and its cooperating agencies, for monitoring programmes. The task of obtaining, compiling and reviewing the results of the monitoring data appears to have fallen on the MED Unit and its cooperating agencies who were supported by scientists from institutes of the Mediterranean area. The MED Unit staff has done an excellent job of providing logistical support to the national institutes (as described below), and have established a good computerized system for the logging and retrieving monitoring data. However, they are clearly in need of support from the Mediterranean based scientists to ensure that:

- there are clear and specific objectives for the monitoring work;
- the national monitoring work is carried out effectively and in accordance to the any agreed protocols, including data quality requirements;
- the results are reported on time and in the appropriate reporting format; and
- an evaluation of the data is carried out following submission to MED Unit.

The above tasks are essentially those of the designated national coordinators. It is clear, however, that the co-ordinators have not been able to do them. It is therefore necessary to devise an alternative system to provide MED Unit with this essential support.

This could be accomplished if the Contracting Parties established a group of experienced marine scientists to assist MED Unit with its work, particularly with regard to the design, planning and implementation of Phase III of MED POL.

The Contracting Parties should note that at the last Joint Scientific and Technical Committee Meeting reference was made to the need for clearer objectives for MED POL work, particularly with the regard to the provision of data to the Contracting Parties which would allow them to meet their managerial requirements under the Barcelona Convention.

3.1. MONITORING IN MED POL

3.1.1. Monitoring during Phase I

MED POL I (Petroleum hydrocarbons)

In general, the coverage of sampling throughout the Mediterranean Sea was limited, and in some areas the sampling was extremely localized. The scarcity of information on oil slicks and floating tar balls was attributed to the lack of suitable ships and manpower required to carry out the necessary tasks.

MED POL II (Metals)

Under this project, measurements of mercury and cadmium in three species of marine organisms (*Mytilus galloprovincialis, Mullus barbatus and Thunnus thynnus*) were obligatory for all participants. Other metals and other organisms were examined on a voluntary basis.

A total of 2,003 samples of organisms from 25 sampling areas were analyzed for mercury content by the participating laboratories (554 samples of *M. galloprovincialis* by 19 laboratories, 1,227 samples of *M. barbatus* by 23 laboratories and 222 samples of *T. thynnus* by 10 laboratories). In addition, 1,998 mercury data entries on non-obligatory samples were also reported to the Regional Sea Programme Activity Centre. The geographic distribution of these sample locations is shown in Fig. 2, and the amount of data received are shown in Table IV.

The details of all data included: number of individuals in each sample and their mean length; the range, mean and standard deviations of the mercury data. For the purpose of assessing these data, they were grouped according to the 13 MED POL areas into which the Mediterranean had been divided (Fig. 1).

This procedure of averaging data over very large areas, combined with the limited number of sampling stations, provides a very limited interpretation of the data. It is therefore difficult to judge how far the mercury concentrations reported for each area are representative. The large differences between minimum and maximum concentrations can give a rough estimation of possible problems, but averaging over a large area with few sampling stations/fishing zones reduces the usefulness of the data, because locations of high and critical concentrations can not be identified.

Another criticism of this evaluation procedure is that the data were not screened or selected with due regard to the results obtained in the quality control exercise. Thus, wrong data have been included in the evaluation which makes the entire evaluation questionable (see MED POL XI Quality control). This treatment of mercury data was also applied to the limited data on cadmium and the non-obligatory metals such as copper, chromium, lead, zinc, nickel and selenium. Of these only copper and selenium are of interest in a marine context.

Some of the severe shortcomings in data evaluation mentioned above were overcome in the MAP assessment, in which data from the open literature have been evaluated and considered together with the MED POL results (see section 5).

The MAP assessment of mercury (UNEP/FAO/WHO, 1987) showed that the mercury concentrations in the marine biota from the Mediterranean is several times higher than in the same species from the Atlantic and that this is due to the higher natural background levels of mercury in the Mediterranean environment in general. Hence these higher concentrations are of natural geochemical origin and are not due to anthropogenic contamination. Nevertheless, heavy fish consumers, in particular young children and pregnant women, are apparently at risk because their mercury intake with seafood exceeds the Provisional Tolerable Weekly Intake (FAO/WHO PTWI) recommended by FAO and WHO. The MAP assessment also showed that several zones in the Mediterranean are severely contaminated with mercury from industrial sources (chlor-alkali plants and chemical industry sites), but that their influence on the adjacent environment is limited to ca 20 km offshore. The identification of these hotspots and these inferences and risk assessments could not have come from the restricted MED POL data set and the method used for data evaluation.

Similar considerations are valid for the treatment of the MED POL Cd data and the MAP assessment of cadmium (UNEP/FAO/WHO, 1989). The MAP assessment concluded that the main source of cadmium for humans is terrestrial based foodstuffs (liver and kidney) and that sea food does not constitute a hazard even for heavy seafood consumers, except in zones of high anthropogenic discharges. These facts were not, however, identified in the MED POL data evaluation since only means and standard deviations were used in this evaluation.

Finally, since the original MED POL data included information on the exact location of the sampling area/fishing zone, a new evaluation, taking into consideration the exact locations could probably give much better results than those reported in MAP Technical Report Series No. 9 (UNEP, 1986).

MED POL III (Chlorinated hydrocarbons)

Eighteen research institutes collected samples from 122 sampling locations for the analysis of the obligatory chlorinated hydrocarbons (PCBs, DDT, DDE and DDD) in the

mandatory species (*M.galloprovincialis, M. barbatus and Parapenaeus longirostris* or *Carcinus mediterraneus*). Data on PCBs were received from 4 MED POL areas for *M. galloprovincialis*, from 6 MED POL areas for *M. barbatus* and from 6 areas for *P. longirostris* and for *C. mediterraneus*. Data of the obligatory species for DDT, DDE and DDD were received from 5 to 6 areas, for dieldrin from 4 areas, for aldrin from 4 areas, for lindane and for hexachlorocyclohexane from 3 areas.

All institutes participated in the data quality programme but data from those which did not produce satisfactory intercalibration results were not excluded from the data evaluation. The inadequate data evaluation procedure for chlorinated hydrocarbons was also similar to that used in the evaluation of the metal data.

Again it should be noted that the method used to evaluate the MED POL data was unable to provide an assessment of the level and extent of chlorinated hydrocarbon contamination in the various regions of the Mediterranean and that this objective was only achieved through a MAP assessment of the data from the open literature (UNEP/FAO/WHO/IAEA, 1990).

However, it should be noted that on the basis of the results of the intercalibration the large uncertainty in the accuracy and precision of chlorinated hydrocarbon data makes it difficult to compare data on a geographic basis. Utilizing a "pollution index" MED POL area VIII had the highest index followed by areas IX, II, V and IV. For the other areas the data were not sufficient to establish an order of magnitude.

MED POL VII (Microbiological coastal water quality)

Thirty laboratories participated in the monitoring of recreational waters (30 stations) and shellfish areas (14 stations). The distribution of the stations over the Mediterranean is very uneven. For example, on the Spanish coast only two stations were sampled and no samples were taken on the entire east coast of Italy. Only a few stations are located in the southern coastal waters of the Mediterranean. However, we are aware that many more data are available than those sent to MED POL. In many of the participating countries e.g. Italy, France etc, microbiological monitoring of recreational waters was obligatory by national law during MED POL Phase I. Therefore, the results obtained under MED POL make up only a very small fraction of the data potentially available for an evaluation of the Mediterranean situation.

During this project, several meetings were organized for the principal investigators in which the methods used and the results obtained were discussed. In addition, the reference methods were intercalibrated on fresh water samples and important parameters influencing the results were studied. Probably the major contribution of this project to monitoring of recreational water was its quality control programme that made the participants aware of the importance of producing accurate data.

MED POL VIII (Biogeochemical studies)

The principal purpose of this project was to establish baseline data on the level of pollutants in sea water, marine organisms, particulate and open-ocean sediments. The International Laboratory of Marine Radioactivity, Monaco was the main contributor in collaboration with 5 other experienced research centres. During the course of 7 research cruises, trace elements and chlorinated hydrocarbons were determined in sea water (Hg, Cd, Cu, Zn), air, suspended matter (Al, Fe, Cu, Zn, Pb, Cd, As), sediments (Mn, Cu, Zn, Pb) and biota (Hg, Cd, Zn, Cu, As, V, Co, Ag, Se, Sb, Rb, Sc, Fe). In seawater, for example, the mean Hg concentrations ranged from 14 to 40 ng/L. By comparison with the presently accepted Hg concentrations of 0.5 to 5 ng/L for open Mediterranean sea water, the concentrations reported in the pilot project are much too high, and are probably due to sample contamination. The mixed plankton sample had relatively low Hg concentrations around 50 μg Hg/g FW. Because nearly all measurements are only single determinations for each station a comparison between areas cannot be made. In retrospect, it would have been more interesting if the exercise had been focused on the determination of the obligatory elements using sample replicates and more samples were analyzed from each area than the single multielement determinations on single samples per station. The effort of sample collection seems much higher than the time devoted to the chemical analysis of the samples. Vertical transport of these substances was determined with sediment traps and an accumulation of V and PCBs and the elimination of As from different marine organisms was studied.

3.1.2. Monitoring during Phase II

During Phase II, 16 countries signed monitoring agreements or agreed to transmit data without signing an agreement. However, the data subsequently transmitted were very limited in terms of geographic coverage of the Mediterranean, and in only a few cases did they comply with the requirements stated in the signed agreement. This poor response may in part be due to the inefficiency of the institutes or to the inadequate specification in the agreement of what was required to be submitted by the institutes. Although, under the signed agreement, the institutes were obliged to participate in the data quality control procedures, the parameters are specified without taking into consideration whether reference methods and intercalibration exercises for the specific parameters were available (e.g. total N and total P). In some cases the parameters were not sufficiently specified to allow institutes to select a suitable method for the determination of some parameters (e.g. radioactivity is specified but not how it should be meaningfully measured). In several cases it is not evident why the specified parameters have to be monitored (e.g. fe and Zn). In other cases very ambitious determinations are requested from laboratories with insufficient infrastructure and little experience of analytical procedures. Such procedures (e.g. determination of Pb in seawater) would tax the capabilities of very experienced and well established institutes.

It is clear that institutes requested to carry out such difficult analysis will be discouraged by this approach to monitoring. Furthermore, only 9 of the monitoring agreements have included the monitoring of pollution sources in their national programmes. As a consequence, only a small number of stations were established for monitoring of the impact of industrial and urban waste discharges. Finally, it appears that no control has been exercised by Contracting Parties on the institutes which failed to meet the obligations arising from signed agreements.

It would appear from an examination of the results of this Phase of MED POL that, at the present stage of the programme, they cannot provide the Contracting Parties with a complete and representative description of the state of contamination of the marine environment in the Mediterranean, and do not allow one to estimate (not even provisionally) the balance of inputs. The Fourth meeting of the Contracting Parties decided that an evaluation procedure of the problems and achievements of the MED POL Monitoring component should be undertaken. After a preliminary evaluation carried out by the MED Unit, a detailed assessment of the available data was made by several experts. The main points arising from one of the evaluations (Joanny, 1990) is presented below, under various headings.

Heavy metals in coastal areas and the open sea

By September 1988, approximately 14,600 data on heavy metals (mainly mercury, cadmium, lead, zinc and copper) had been reported by 12 Mediterranean States. However, it should be noted that 87 % of the data were submitted by only 4 countries, (Spain, Israel, Malta and Yugoslavia) which individually provided thousands of data entries. The number of data from other countries (Algeria, Cyprus, France, Italy, Lebanon, Morocco and Syria) ranged from around ten to several hundred data entries (UNEP, 1989).

In the last few years, heavy metals have been among those contaminants which have been extensively investigated from the point of view of environmental impact. The experience acquired in this field made possible a critical analysis of the reported results and the selection of those which assure the best quality. Validation criteria were based on the sampling and analysis methods reported, but above all on the results obtained from the intercalibration exercises in which laboratories participated.

To date, the only results that can be reliably evaluated are those concerning biota. Table IV presents the contamination levels which are best documented for the Mediterranean on the basis of monitoring two species of bivalves (*Mytilus* and *Mactra*) and red mullet (*M. barbatus*) in the framework of MED POL monitoring. The results in Table IV are based on more than 30 % of the 5300 data on biota which were considered to be acceptable out of 6700 data sent to the MED Unit.

The remaining results relate to either secondary parameters (Fe, Co, Ni, Cr, Mn) or to species which are only present in certain areas. This series of results is the first step in establishing contamination levels in the Mediterranean. However, it should be noted that a comparison of average values does not reveal significant differences among the various areas studied.

Microorganisms in coastal areas

In the period 1983-1987, seven Mediterranean States reported results on microorganisms, mainly fecal coliform concentrations (FC), to the MED Unit. The results of approximately 1000 water samples from 300 stations were evaluated by adjusting a log-normal distribution to the group of results obtained from one station (with a minimum of 6 measurements) and comparison of distribution percentages with the following quality criteria (UNEP/WHO, 1985) :

50 % of results $\leq$ 100 FC 100 mL (FC50)
90 % of results $\leq$ 1,000 FC 100 mL (FC90)

From the assessment of data on the basis of the MAP interim criteria, it follows that the percentage of sampling stations which conform to the standards varies annually between 78 and 96 % (UNEP, 1989a). As a whole, in the period 1983-1986, 82 % of the stations conformed to both FC50 and FC90, i.e. a slightly larger proportion to that of the 1976-1980 period where it was observed to be 80 % (UNEP/WHO, 1986). However, the unequal distribution of stations and the lack of information from several countries (which are known to carry out such monitoring activities), limit the scope of the results obtained to date.

Petroleum hydrocarbons in coastal areas and the open sea

In the 1981-1987 period, approximately 1200 samples were analyzed by six countries for petroleum hydrocarbons in water and sediment. The greatest number data (84 %), concerning measurements in the water, could not be validated with any objective intercalibration data. Similarly, measurements in sediment were only validated through an intercalibration after the relevant monitoring data have been obtained. However, the expert responsible for the evaluation of the results postulated an acceptable degree of confidence for the results on the basis of several objective elements (simplicity of analysis in the water, laboratory performance, similarity of methods used, etc.) (UNEP, 1989b).

These data were therefore examined in depth in order to determine the average level of hydrocarbon contamination. Thus, for general coastal areas the average level in water is considered to be 1.2 g/L, and for sediments the average is 2.8 g/g, whereas the average values for reference areas are 0.02 g/L for the water and 0.1 g/g for sediment. In principle, only 4 % of the stations can be identified as "hot spots", with concentrations for the water exceeding 10 g/L.

Organochlorines in coastal areas

The number of data for organochlorines reported for the 1981-1987 period is of the same order of magnitude as that for petroleum hydrocarbons (more than 1,200). However, the matrices examined were very unevenly distributed in quantity and on a country basis; 64% of results concerned biota and were reported by nine countries, this compares with 20% for water reported by only one country and 16 % for sediment reported by three countries. Thus, although, geographical coverage is very reasonable for biota, 75% of these data were collected by a single country (UNEP, 1989b).

From the evaluation of the organochlorine results, it was concluded by the reviewer that there was no major methodological problem and that on the basis of the majority of results, concentration levels could be established for the areas concerned. However, as in the case of heavy metals, the results concerning the less represented species are of little interest. Thus, Table III which gives the main results refers only to mussel and red mullet data.

A detailed examination of the results seems to indicate that total DDT in sediment is slightly higher in the Adriatic than in the Western Mediterranean; the opposite is true for PCBs. Certain "hot spots" are identified on the basis of concentration levels with an order of magnitude of 7 ng/g for DDTs and higher than 50 ng/g for PCBs. Concerning biota, the above comparison is not possible, but certain parallels have been established between concentrations in the mussels and concentrations in sediment, especially for lindane. As a general rule no temporal trends were identified.

3.1.3. Trend analysis of MED POL monitoring data

In November 1992 a MAP/MED POL study was published entitled "Statistical analyses of the MED POL Monitoring Data on Heavy Metals and Halogenated Hydrocarbons in Biota with special reference to temporal trends (1974-1991)" Table V.

The overall conclusions of this evaluation were:

- *Data quality*: objective investigation of between-year variation in contaminant levels is virtually impossible because of the inconsistent collection, preparation and chemical analysis of data throughout the monitoring programme; and

- *Data quantity*: in general, only very large trends in contaminant levels are likely to be detected because of an insufficient number of pools on each sampling occasion and/or an insufficient number of years sampled.

3.2. RESEARCH IN MED POL

Gaps and weaknesses in the scientific outcome of the research projects were inevitable, given the widely differing levels of competence and experience of the cooperating centres and the difficulties inherent to the programme. They concern in the first place the validity and the comparability of the data, and their geographical coverage.

3.2.1. Research during Phase I

MED POL projects IV to VI were designed as research projects to support the monitoring projects of Phase I.

MED POL IV (Effects of pollutants on marine organisms and their populations)

This project attracted many investigators and generated a large amount of data. However, the pollutants tested, the techniques and the test species were highly variable. Most of the experiments were carried out by exposure to pollutants in water and not through food intake. The responses measured ranged from short-term LC_{50} static experiments to functional or biochemical sublethal responses. Although valuable information was obtained intercomparison and general conclusions were practically impossible. In addition, most of the concentrations applied experimental work were unrealistic.

MED POL V (Pollution induced modifications of marine communities and ecosystems)

About 30 sites were investigated in comparison with reference areas. Half of the studies dealt with the pelagic system (such as eutrophication phenomena) and half with the benthic system (such as damage to sea grasses). Most of the studies were of a descriptive nature. The choice of the study areas by the principal investigators appears to have been governed by the proximity to their institutes or by the fact that they afforded clear-cut perturbation impacts. The results therefore can not lead to generalized conclusions on the state of the Mediterranean ecosystems.

MED POL VI (On coastal transport of pollutants)

This project was interpreted by most investigators as the measurement of currents in the coastal zone by means of current-meters or even by drift-cards. As a result, the problems of dispersion and diffusion of pollutants and the exchange with the offshore were not properly addressed.

The pilot phase of MED POL was conceived as a preparatory phase for the subsequent long-term programme for pollution monitoring and research. Seen in this perspective Phase I appears to have been a successful exercise.

3.2.2. Research during Phase II

In spite of a more reduced budget, Phase II encompassed twelve research activities, A to L (Table II) to which an activity Z was later added to deal with the outbreaks of jelly-fish swarms. The funds approved for Research by the Contracting Parties appear to have been constant around 300,000 dollars since 1987, but the actual financial availability to the research projects has been steadily declining, so that in 1992 it decreased to about 180,000 dollars (Figs. 3 and 4).

Until 1990, it was not possible to assign priorities in the research programmes. In 1990, the projects were combined into five broader areas (Table III) and priority funding was given to eutrophication which accounted for 50% of the budget until 1995, the remaining 50% was allocated to other research areas. The new combined areas do not add to the coherence of the programme as there is an obvious overlap between three of them, areas II to IV.

This research strategy calls for several comments.

About 200 research proposals from 15 countries were agreed in 1986 and 1987; decreasing to 130 in 1991 and 1992 (Figs. 4 and 5), so that, on average, the funding for three years for each ranged between 6 and 8 thousand dollars.

The number of contracted projects was very unevenly distributed among the approved research activities. The bulk of the research efforts went to five of them. Two thirds, i.e. 67%, deal with activities G, D, L, K and A. It is, therefore, the preference of the research investigators, and not the level of priority, which governed the intensity of the research efforts and the total funding allocated to each activity (Fig. 5).

On the other hand, the geographical distribution of the funds allocated to research also reflected the number of agreed applications from the different Mediterranean research centres. The fact that some institutes obtained much more financial support than others was due to them being more active and more productive.

Some of the strategic problems encountered during Phase I remained unresolved during Phase II. Two of these are obvious: the insufficient geographical coverage, the validity and comparability of some of the results. As a consequence we know more about certain aspects in a small number of specific sites, but almost nothing about the vast expanses of the Mediterranean basin. The findings, therefore, cannot be generalized.

The quality and relevance of the research projects was uneven. Several sound contributions to activity A focused on microbiological techniques. Activity D on epidemiological problems and human hazards resulted in a consistent and pertinent report. On the other hand, the experimental toxicological studies (Activity G) followed

diverse procedures, often deviating from the standard methods. The results cannot be extrapolated to the environment, so that their use for management purposes is reduced. Most of the reports on field activities, such as activity H on eutrophication and activity I on ecosystems, did not go beyond descriptive surveys along a pollution gradient, but some modelling exercises have been attempted. Activity K on the biogeochemical cycle of selected pollutants provided some adequate data, although several investigations appear to have confused the concept of biogeochemical cycle with the mere measurement of pollutant concentrations in organisms from different trophic levels or from different ecosystem compartments. Very little has been done under activities B, C, E, and J.

At the request of the Contracting Parties (Dubrovnik 1983) a project for the investigation of jellyfish outbreaks, at a Mediterranean scale, was adopted, and a number of activities implemented from 1985 to 1987. The activities were carried out in both the frameworks of the monitoring and the research components. Thirty two projects were carried out, generating a large number of multidisciplinary scientific results and informative reviews (UNEP, 1991). The following topics were dealt with: the biology and biochemistry of *Pelagia noctiluca*, the toxicological, epidemiological and therapeutic aspects. The causes and mechanisms of swarm development were attempted, but remained unresolved and no conclusive control measures could be proposed.

Research Programme on Eutrophication and Plankton Blooms

Following the conclusions of a scientific workshop on the implications and control of undesirable plankton blooms (Athens, 4-6 April 1989) and a recommendation of the Inter-Agency Advisory Committee for MED POL, the Contracting Parties agreed that 50% of the entire research budget should be allocated to activities dealing with eutrophication and plankton blooms until 1993. A small consultation meeting was convened from 19 to 20 March 1992 to recommend the most effective approach in order to organize a coordinated research programme on eutrophication and undesirable plankton blooms.

It is recognized that since this is a phenomenon which is both localized and of widespread occurrence in the Mediterranean, the appropriate approach would be to focus on a number of case studies. The following areas are selected as representing lagoons, semi-closed bays and open coast-lines: Alexandria bay, Golfe de Gabes, Etang de Prevost, Gulf of Trieste, Emilia-Romagna coast and Thermaikos Gulf.

The scientific programme is conceived as a multidisciplinary investigation aiming at the development of a 3-dimensional or 2-dimensional model capable of interpreting the eutrophication phenomenon. Eight aspects are identified: the geomorphology of the area, its hydrodynamics, the flux of nutrients and of suspended matter, survey of the catchment area, the coastal zone development activities, oxygen and nutrients in the coastal waters, the algal blooms and the accompanying bacterial populations.

Pilot Project on Biomonitoring in the Mediterranean Sea

Following a recommendation from the FAO/UNEP/IOC workshop on the biological effects of pollutants on marine organisms (Malta, September, 1991), a Pilot biomonitoring exercise is being initiated in the framework of MED POL programme. FAO/UNEP and the Euro-Mediterranean Centre convened a working group of experts in Malta in November 1992 to formulate a pilot exercise to be implemented by selected Mediterranean institutions. The ultimate aim is to introduce biomonitoring in parallel with chemical monitoring in the framework of MED POL. A major objective is to enable a small core of institutions to use a selected number of biomonitoring techniques corresponding to priority contaminants already determined in the chemical monitoring.

In the future, following the achievements of the pilot exercise, a fully operational Mediterranean-wide biomonitoring programme is to be developed. The working group (Malta 10-11 November 1992) listed general stress indices (1) and specific stress indices (2) known to be in use, and recommended those which fulfilled criteria of reliability, routine simplicity, inexpensive equipment. A training workshop on Techniques for monitoring biological effects of pollutants in marine organisms was organized for Mediterranean and Black Sea scientists in Nice, in 14-25 September 1992; (UNEP/FAO/IOC, 1993).

Implications of Climatic changes on Mediterranean coastal areas

Task teams were established by UNEP in 1987 for six Regional Seas including the Mediterranean, to analyze the potential implications of the predicted climate change on marine and coastal environments and to assist governments in the identification and implementation of suitable policies and measures to mitigate their consequences.

The Mediterranean study opted for a site specific approach. Six case studies were prepared in 1987 to 1989 for low-lying sites (deltas of the rivers Ebro, Rhone, Po and Nile, Thermaikos Gulf and Ichkeul/Bizerte lakes) (Jeftic et al., 1992), followed by a second series of five case studies in 1990 to 1992 (Islands of Rhodes, Malta and Cres-Losinj, Kastela Bay and the Syrian coast). The Climatic Research Unit of the University of East Anglia (UEA) produced a basin-wide scenario on climatic change and scenarios for the study areas.

The perturbations of the mean climate changes as predicted by the UEA scenarios would have little effects until 2050. Since the impacts of the demographic pressure and coastal development will most probably far exceed the greenhouse warming impacts, climate changes are not of immediate concern.

Workshops and other scientific meetings

In parallel with the contracted research agreements, MED POL convened a number of workshops and consultant meetings to contribute to specific research topics, to review

the current work and to recommend on future action. Some examples of these meetings are:

- The biogeochemical cycle of mercury in the Mediterranean;
- The toxicity and bioaccumulation of selected substances in organisms;
- Pollution effects on marine ecosystems;
- Undesirable plankton blooms;
- Jelly-fish blooms in the Mediterranean;
- Treatment and discharge of industrial wastewater;
- Air-borne pollution of the Mediterranean;
- Oceanographic processes of pollutant transport;
- The impacts of climatic changes on the Mediterranean;
- The biological effects of pollution on marine organisms;
- Applicability of remote sensing for survey of water quality parameters in the Mediterranean; and
- Accumulation and transformation of chemical contaminants by biotic and abiotic processes in the Mediterranean environment.

It is to be noted that the communications presented to the workshops were rarely submitted to referees before acceptance and publication in the proceedings.

A Directory of Mediterranean Marine Centres and their scientific staff has been compiled and updated to 1992 (UNEP, 1992).

A series of specialized bibliographies are being compiled on specific subjects by the MED Unit, constituting the MEDLIB database, an invaluable tool for the Mediterranean scientific community. Four bibliographies have been completed and published:

- Effects of Climatic change and related topics;
- Marine Pollution by organotin compounds;
- Aquatic Pollution by organophosphorus compounds; and
- Marine litter.

The investigations carried out during Phase I and II and the proceedings of the workshops and meetings and the bibliographies provide a wealth of data and knowledge of undeniable scientific value to the Mediterranean, even if some are less relevant than others. They are documented in the impressive series of MAP Technical Reports (75 volumes by June 1993). That there is a continuous need to readjust the research programme and the research strategy does not belittle the importance of the immense progress accomplished.

4. MONITORING OF LAND - BASED SOURCES AS PART OF MED POL

4.1. PHASE I: PILOT PROJECT MED X

Rationale and Objectives

Pilot Project MED X was designed to provide information on the quantity and nature of inputs from land-based discharges (LBS) and also on the current management and disposal practice in the Mediterranean countries. This was an interagency project, WHO assuming the overall responsibility. The project began in 1976 and was completed in 1977.

Three tasks were assigned to this project:

- to prepare an inventory of LBS including rivers;
- to assess the nature and quantity of the discharged pollutants; and
- to review the waste water disposal and management practices including institutions and legislations.

The project had two ultimate objectives:

- to assist the Governments in the formulation of integrated national plans for pollution management; and
- to provide the technical input to the negotiations of the Protocol on LBS.

Material and Methods

An operational document was prepared by the six cooperating UN Agencies. Technical guidelines and questionnaires were forwarded to focal points in the countries for completion. This procedure was meant to ensure a harmonized approach to the establishment of inventories allowing for a comparative assessment of pollution loads from different source categories: domestic sewage, industrial waste water, mixed

effluents. All activities in the coastal area which could involve the discharge of waste water were to be identified and registered. The pollution load from land runoff and from rivers was to be estimated by indirect assessments and extrapolations. National and international reports and statistics in addition to the inventories were used in a second Phase to quantify the pollution load from the different sources.

Implementation

The project met with considerable difficulties. Country responses were geographically almost restricted to the northern Mediterranean. Sampling frequency, sample pretreatment, analytical methods and reporting formats varied widely. Some pollutants were rarely analyzed (metals, specific organics, organochlorines). Field measurements of domestic sewage and industrial waste waters were very limited. No field measurements on agricultural run-off were available. Among 68 rivers registered, only 30 were adequately monitored.

In view of the limitations and difficulties encountered, assessments of the pollution loads from all LBS categories have been carried out to a great extent by indirect computations and extrapolations. They have been worked out taking into account demographic statistics, the GNP of the countries, industrial production and manpower, and agricultural data.

Results

The time allowed for this ambitious project, one and half years, was too short for any in-depth study of each and all pollution sources in the Mediterranean. For this reason and for the fact that the results were pooled for each of ten UNEP Mediterranean regions, the project does not fulfill the requirements of its first objective, to provide the basis for national management and control plans.

Due to the difficulties and the uncertainties involved in the complex computations and extrapolations carried out, the results can not be better than rough estimates reliable within an error margin of one order of magnitude.

In spite of these limitations however, the project results provide the basis for a comparative assessment of the regional contributions to the pollution load. The heaviest loads are discharged into the North-Western basin. This region has to absorb almost one-third of the total pollution load of the Mediterranean. The Adriatic Sea is also severely affected and receives about one-quarter of the total load. Moderate pollution loads are encountered in the Tyrrhenean and the Aegean Seas, as they receive each about 10% of the total load. The other six Mediterranean sea areas each account for no more than 5% of the total. Mineral oil input is however, an exception to this general rule, as more than half of the total discharges are located in the central and North-Levantine basin.

The outcome of the project (UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA, 1984) represents an important first approximation of the magnitude of the LBS problem, the first of its kind for the Mediterranean Sea. Its results were of primary importance for the successful negotiations which led to the adoption of the LBS protocol, the purpose of its second objective.

4.2. PHASE II: PILOT PROJECT MED X

The protocol on Protection of the Mediterranean Sea against pollution from LBS was adopted in 1980. Following its entry into force in 1983, the Contracting Parties decided that an updated version of Pilot Project MED X was needed and should be set up by a group of experts.

A Working Group of experts was convened in 1985 to identify and list specific actions to be taken in line with the Protocol, to optimize the performance and the coherence of the programme (UNEP, 1985). The working group adopted draft guidelines, a workplan and a timetable for 1986 and 1987, and an indicative workplan for the period 1987 to 1995.

Workplan

The activities planned concern in the first-place:

- programmes and measures for the elimination of the substances in Annex I and for the strict limitation of substances in Annex II (Articles 5 and 6 of the LBS Protocol);
- assessments of the state of pollution of the Mediterranean Sea by substances in Annexes I and II of the Protocol (Article 8);
- the formulation of common guidelines, standards and criteria (Article 7);
- the formulation of guidelines for the issuance of authorizations for the discharge of waste waters (Article 6);
- guidelines for the specifications and computations needed for marine outfalls (Article 7, a);
- compilation of current experience on alternative products and processes susceptible to reduce pollution and on recycling of solid and liquid waste (Article 7, d); and
- assessment of the yield and cost-benefit of alternative products and processes.

Implementation

The MED Unit of MED POL

Assessments of the state of pollution of the Mediterranean Sea by selected substances of Annexes I and II were prepared by the Secretariat with the assistance of consultants on the following: mercury and mercury compounds; petroleum hydrocarbons; organotin compounds; cadmium and cadmium compounds; organohalogens; persistent synthetic materials; microbial pollution of bathing waters and shellfish growing waters; used lubricating oils; organocilicon compounds; organophosphorus compounds; radioactive substances; pathogenic microorganisms; and carcinogenic, teratogenic and mutagenic substances.

The following common measures were adopted by the Contracting Parties in terms of the LBS Protocol (UNEP ,1990):

- Interim Environmental Quality Criteria for Bathing Waters (1985) (Article 7.1 (c));
- Interim Environmental Quality Criteria for Mercury (1985) (Article 7.1 (c));
- Measures to Prevent Mercury Pollution (1987) (item 4 of Annex I);
- Environmental Quality Criteria for Shellfish Waters (1987) (Article 7.1 (c));
- Measures for Control of Pollution by Used Lubricating Oils (1989) (item 6 Annex I);
- Measures for Control of Pollution by Cadmium and Cadmium Compounds (1989) (item 5 of Annex I);
- Measures for Control of Pollution by Organotin Compounds (1989) (item 3 Annex I);
- Measures for Control of Pollution by Organohalogen Compounds (1989) (item 1, Annex I);
- Measures for Control of Pollution by Organophosphorus Compounds (1991) (item 2, Annex I);
- Measures for Control of Pollution by Persistent Synthetic Materials (1991) (item 7, Annex I);
- Measures for Control of Pollution by Radioactive Substances (1991) (item 9, Annex I); and

- Measures for Control of Pollution by Pathogenic Microorganisms (1991) (item 7, Annex II).

Reporting forms on the authorizations for the discharge of liquid wastes into the Mediterranean Sea were drafted in 1986 (UNEP, 1986a) but are not finalized as yet.

Concerning marine outfalls, several technical papers and consultant meetings aiming at the development of common standards and guidelines for the discharge of sewage into the Mediterranean have been carried out. A draft document prepared according to the recommendations of the consultant meetings is now in the process of editing (UNEP, 1985a).

Guidelines for health-related monitoring of coastal recreational and shellfish areas are in the process of finalization by WHO.

A technical document on guidelines for the treatment of effluents prior to discharge has been prepared by consultants and successive drafts were reviewed at a number of expert meetings. The finalized document comprises two parts corresponding respectively to the substances in Annexes I and II.

Guidelines on current alternative products and processes susceptible to reduce pollution and on recycling of solid and liquid wastes are still missing.

Two case studies (Bay of Izmir and the Island of Rhodes) were prepared by the Secretariat with the assistance of consultants on integrated costs and benefits associated with the control of land-based sources of pollution (UNEP, 1993).

LBS data submission by the Contracting Parties

After ratification of the LBS protocol, the Contracting Parties agreed to implement national monitoring programmes, to identify all sources of discharge, to exchange information on national legislation and to report on all granted authorizations for discharge. The process was slow to develop, some countries joining at a much later stage than others.

By 1989, thirteen countries out of eighteen had signed agreements with MED Unit. Nine of them included the LBS in their national programmes, and results were reported by five countries: Cyprus, Malta, Morocco, Yugoslavia for the period 1983-1987 and Algeria for 1987. Out of 10,000 results reported by mid-1989, 50% came from Yugoslavia, 20% from Malta, 5% from each of Cyprus and Morocco. The same countries continued to monitor their LBS and further data were submitted.

Further agreements were signed by 1992 with the following eight countries: Albania, Cyprus, Egypt, Israel, Lebanon, Morocco, Syria and Tunisia.

The situation concerning LBS data submission until June 1993 can be summarized therefore as follows: Algeria - 1987, 1990; Cyprus - from 1983 to 1991; Malta - from 1983 to 1991; Morocco - from 1983 to 1990; Spain - from 1989 to 1991; and Yugoslavia - from 1983 to 1990.

The parameters analyzed are those of category I plus some of category II (UNEP, 1989c).

Already in 1989, in the framework of Project MED X bis detailed and comprehensive questionnaires were submitted to MED POL coordinators for completion in order to ensure comparability of the baseline information on LBS. They were drafted using the questionnaires of 1976-1977 to facilitate comparison and they concern:

- Liquid domestic discharges (MED X bis 1);
- Industrial discharges containing selected substances listed in Annexes I and II (MED X bis 2); and
- Industrial discharges of petroleum hydrocarbons (MED X bis 3), including oil discharges from refineries, and from reception facilities.

Expert and financial assistance were provided to the countries who requested it.

Questionnaires so far have been received from Croatia, Cyprus, France, Greece (Rhodes), Slovenia, Spain and Syria. Work in Egypt is ongoing and preparations for work to commence in Albania, Morocco and Tunisia were in various stages of advancement by July 1993.

Conclusions

The implementation of the LBS Protocol including monitoring of effluents and sources is in the first place the responsibility of the Contracting Parties.

Ten years after the Protocol came into force, the process of implementation remains very slow and fragmentary, in spite of the efforts of the MED Unit.

Most of the basic studies, guidelines, common measures and criteria have been formulated and agreed upon. Between 1985 and 1991, twelve common measures concerning actions to be taken in terms of specific Articles in the Protocol and its Annexes were adopted at successive biennial ordinary meetings of the Contracting Parties. The majority of the Contracting Parties, however, have not fulfilled their commitments. As a result, Project MED X bis is still very far from its goal, which is to provide an overall assessment of pollutant inputs to the Mediterranean Sea.

The implementation of the LBS Protocol and the monitoring of pollutant sources is the single most important contribution to the control of the pollutants entering the Mediterranean Sea. In spite of its inherent political, financial and technical difficulties, it is therefore, of prime importance that MED POL continues to carry on with the implementation of Project MED X bis, in cooperation with the Contracting Parties.

5. ASSESSMENTS OF INDIVIDUAL POLLUTANTS

Since 1986 a total of 13 assessment documents have been prepared on various types of pollutants in the Mediterranean, in which data generated under MED POL have been integrated with data published in the open scientific literature.

A short summary is given below of the findings and conclusions in these documents.

Assessment of the present state of pollution by cadmium, copper, zinc and lead in the Mediterranean Sea (UNEP, 1986b).

The loads into the Mediterranean from land based sources were estimated to be (tons/year):

	Background	Anthropogenic	Local
Pb	1,000	3,800	4,800
Zn	4,000	25,000	21,000
Cu	?	?	?
Cd	?	?	?

Coastal sediments contained substantially elevated levels of the elements in question, particularly in the north-west Mediterranean and in the Adriatic Sea. However, intake of these elements from sea-food was not considered to be hazardous for the health.

Assessment of the state of microbial pollution of shellfish waters in the Mediterranean Sea and proposed measures (UNEP, 1987a).

Only 3-4% of the monitored stations in the shellfish growing areas were found to be suitable in relation to the direct consumption of shellfish based on the WHO/UNEP interim criteria for the quality of shellfish and shellfish growing waters. For comparison, on the basis of the EEC criteria for shellfish growing waters, about 40% of the same sampling stations would have been found satisfactory in relation to the direct consumption of shellfish.

An assessment of organosilicons as marine pollutants, with particular reference to their status in the Mediterranean Dumping and Land-based Sources Protocols (UNEP, 1987b).

The report concludes that even a substantial increase in the production of siloxane based organo-silicons is unlikely to endanger the marine environment and biota. With regard to man one of the summary conclusions was that the possibility that marine food sold unprocessed cannot contribute significantly to the daily silicon intake.

Assessment of the state of pollution of the Mediterranean Sea by mercury and mercury compounds (UNEP/FAO/WHO, 1987).

The MAP assessment of mercury (UNEP/FAO/WHO, 1987) showed that the mercury concentrations in the marine biota from the Mediterranean is several times higher than in the same species from the Atlantic and that this is due to the higher natural background levels of mercury in the Mediterranean environment in general. Hence these higher concentrations are of natural geochemical origin and are not due to anthropogenic contamination. Nevertheless, heavy fish consumers, in particular young children and pregnant women, are apparently at risk because their mercury intake with seafood exceeds the Provisional Tolerable Weekly Intake (FAO/WHO PTWI) recommended by FAO and WHO. The MAP assessment also showed that several zones in the Mediterranean are severely contaminated with mercury from industrial sources (chlor-alkali plants and chemical industry sites), but that their influence on the adjacent environment is limited to ca 20 km offshore. The identification of these hotspots and these inferences and risk assessments could not have come from the restricted MED POL data set and the method used for data evaluation.

Assessment of the state of pollution of the Mediterranean Sea by petroleum hydrocarbons (UNEP/IOC, 1988).

The amount of petroleum hydrocarbons entering the Mediterranean Sea annually is estimated to 0.6 million tons. Measurements on pelagic tar and tar on beaches suggest a decrease in the tar-quantity during the last years, especially in the eastern Mediterranean.

Studies on uptake in organisms and on effects, are too few to allow any conclusions.

Assessment of used lubricating oils in the Mediterranean Sea and proposed measures for their elimination (UNEP, 1987c).

The report presents figures on the use of lubricating oil in the Mediterranean countries and on the amounts reprocessed. It concludes that available statistics refer to the countries as a whole and not to the Mediterranean region in particular. However it was

estimated that in the four Mediterranean states members of the EEC, the capacity for regeneration of used lubricating oils is made in excess of actual output (In the rest of the countries the situation is the opposite).

The available data on inputs of used lubricating oils, do not allow any realistic estimate to be made of such inputs to the entire Mediterranean Sea. There is also limited available data on levels of oil in organisms, sea-water and sediments.

Assessment of organotin compounds as marine pollutants in the Mediterranean (UNEP/FAO/WHO/IAEA, 1989).

The assessment concludes that concentrations of tributyl tin exceeds threshold effect levels for many marine organisms in "hot-spot" areas, e.g. near harbours and marinas. In many locations, the most sensitive organisms can not survive.

Assessment of the state of pollution of the Mediterranean Sea by organohalogen compounds (UNEP/FAO/WHO/IAEA, 1990).

The risks associated with current levels and loads of organohalogen compounds were as follows:

- DDT- Maximum concentrations found in marine species are comfortably below those reported to cause effects on reproduction or other sub lethal effects. With regard to marine birds and reproduction disturbances associated with egg shell thinning, the assessment document concludes that there is nothing in concentration levels that suggests that populations of marine birds in the Mediterranean are at risk, and no indication that their numbers are in decline;

- HCH- There is no reason to suppose that present levels of HCH present any risk for marine birds or mammals in the Mediterranean;

- PCB's- The risk to marine fish and shellfish from concentrations found in the marine environment is assessed as minimal. With regard to marine mammals it is said that the highest concentrations found in the Mediterranean have been associated with effects in other parts of the world;

- HCB's- There is little cause for concern in relation to the potential impact of HCB on the marine organisms in the sea;

- Drins- On the basis of limited available data it was found to be unlikely that present levels of drins in the Mediterranean would adversely affect marine organisms. It was found equally unlikely that marine seabirds or mammals were at risk; and

- Heptachlor- The small data base available indicates levels well below those of concern in the Mediterranean.

With regard to human health hazards and cancer risks, computations in the assessment show that DDT and PCB from one fish-meal a week in high contamination categories, elevates life time cancer risks above 10-5. It is further stated that although the figures are alarming, the uncertainties must be kept in mind. However, the assessment methodology used, in spite of its weakness, is the best one available.

Assessment of the state of pollution of the Mediterranean Sea by radioactive substances (UNEP/IAEA, 1992).

The main conclusions of the report were:

The input of Cs^{137} from the atmosphere, river and through the straits into the Mediterranean Sea was increased by the Chernobyl fallout by 25-40%; with the highest deposition in the northern Mediterranean region. The radiation risk to man from seafood consumption and the effects on living marine organisms are considered to be negligible.

Assessment of the state of pollution of the Mediterranean Sea by persistent synthetic materials which may float, sink or remain in suspension (UNEP/IOC/FAO, 1991).

Studies indicate that plastic litter dominate on shores and beaches as well as among the floating litter. Many effects of litter on navigation and on biota are reported, but no estimate of the magnitude of the problem can be made from existing data.

Assessment of the state of pollution in the Mediterranean Sea by pathogenic microorganisms (UNEP, 1991a).

- ill-health arising from consumption of contaminated shell-fish is a common and wide-spread problem in the Mediterranean;

- the trend in recent years has been towards improved water quality in shell-fish growing waters;

- although presently impossible to assess quantitatively, the health effects from swimming in polluted waters it is a problem that should be taken seriously in the Mediterranean region; and

- although biotoxins in shellfish is a relatively recent problem in the Mediterranean, the extent of the problem and current trends are unknown.

Assessment of the state of pollution of the Mediterranean Sea by organophosphorus compounds (UNEP/FAO/WHO/IAEA, 1991).

- there is no health hazard due to organophosphorus compounds from the consumption of sea-food; and

- it is possible however that the potential impacts on the marine ecosystem have been substantially underestimated and therefore that the principle of precautionary approach should be followed;

Assessment of the state of pollution of the Mediterranean Sea by carcinogenic, teratogenic and mutagenic substances (UNEP, 1993a).

Marine organisms living in highly polluted areas stand a much larger risk of being negatively effected, than those in clean water, but complexity of cause and dose/effect relationship makes it impossible to quantify such effects.

The conclusions regarding the effects on man are written in a "guarded" way:

> "...provided that the intake from sea food is within the guidelines set by the authoritative bodies and that this intake does not significantly add to the burden from terrestrial food, there is little likelihood of adverse effects such as cancer developing in communities dependent on marine products for their subsistence."

6. QUALITY CONTROL OF DATA

MED POL XI (Quality control and instrument maintenance)

From the outset, it was realized that data quality control i.e. the ability to carry out reliable analytical measurements with appropriate levels of accuracy and precision, was essential if MED POL was to be successful. In fact MED POL XI was specially designed for this purpose and every participant in the various MED POL projects was required to participate in the intercalibration exercises organized by the International Laboratory for Marine Radioactivity (ILMR) of IAEA in Monaco.

The exercises organized by ILMR consisted of the distribution of specially prepared samples (homogeneous samples of sediment or biological tissue with known amounts of the contaminants under investigation) which were then analyzed by participants using either their own methods or the reference analytical methods prepared by UNEP experts. On the basis of the results of the analysis of these samples, the ILMR was

able to judge the current analytical capability of each laboratory and its ability to produce comparable data in any cooperative monitoring programme. Ten intercalibration exercises, two using sediment samples and eight using marine biological tissue, for both trace elements and organic contaminants, were organized by the ILMR over the period 1974-1993. The results of these exercises, together with comments on the interpretation of the data in terms of changes of analytical performance with time, are presented in a recent report by ILMR (MESL, 1993).

The results from these intercalibration exercises provide evidence of improvement of analytical performance with time, particularly for the core group of laboratories (fourteen for trace elements and six for trace organics) which participated in all exercises. However, this encouraging sign is offset by the fact that the vast majority of participants (70 laboratories from 13 countries) still need to improve their analytical performance to improve the comparability of their data with the core group of laboratories.

Although, the intercalibration programme as a whole can be considered to be one of the most successful of the MED POL projects, there are a number of problems associated with the data quality projects. Firstly, not all participants in the various MED POL projects submitted their results to ILMR as requested. Secondly, reliable methods did not exist for all measurement procedures at the beginning of the MED POL Phase I. Thirdly, and most important, the intercalibration results for individual laboratories were not made available to MED Unit during the evaluation of the monitoring data. Consequently, the Unit could not screen the data and eliminate faulty results from the data set to be evaluated. It was, therefore, not possible to determine whether high and low values were due to inaccurate analytical techniques or to contamination. In fact, the inclusion of faulty data in the statistical treatment introduced bias into the results and made evaluations of background concentrations and hot spot values very questionable. Fortunately, many participants in the MED POL projects published their field data and their intercalibration results in the open literature which allowed an accurate evaluation of their results to be made by MAP.

Additional and important components of the data quality work carried out by ILMR were the instrument service missions and the visits by experts to discuss analytical quality assurance problems. This aspect of quality assurance work is quite unique in international cooperative monitoring work and the organizers of MED POL are to be congratulated for the finance and staff time put into this part of the programme. The service missions played an essential part in maintaining equipment at a good working level, especially in developing countries that would have had immense difficulties in finding local efficient repair and maintenance services.

Between 1982 and 1993, twelve intercalibration exercises on microbiological methods were organized by WHO for institutions participation in the network component of MED POL. These were held in a number of Mediterranean laboratories. A general improvement was recorded, but a considerable variation between industrial results was invariably encountered.

7. TRAINING, ASSISTANCE AND CAPACITY BUILDING

At the beginning of MED POL, no model of an international scientific programme at the Mediterranean scale was available. Both the tools and coordinating mechanisms had to be built as the programme was unfolding. At that stage many of the Mediterranean states lacked the capabilities needed and their research centres were unable to contribute efficiently to the research and monitoring programme. The pilot phase of MED POL considerably helped to lay the foundations of a scientific infrastructure in the Mediterranean. The capacity building programme consisted in equipping national research centres, providing training, consultancy and maintenance services and intercalibration exercises. At the end of Phase I, a Mediterranean-wide network of scientific institutions cooperating with MED POL was in place, the largest cooperative scientific programme ever undertaken in this basin. The training, assistance and capacity building efforts continued during Phase II.

From 1982 to 1989, more than 200 junior scientists from 16 countries were given short-term training through participation to training workshops, intercalibration exercises or by on-the-job training in other Mediterranean institutions. During the same period, 530 fellowships were granted to Mediterranean scientists to attend workshops either convened by MED POL or by other organizations. The opportunity to attend such international scientific fora and to submit communications was open to Mediterranean scientists and had a strongly stimulating effect on research and monitoring.

The training programme has, however, an important drawback, in that there is no mechanism to evaluate its achievements. The programme often lacks both preliminary planning with clearly defined objectives, and follow up of the outcome. The report requested from either the trainee or the receiving institute was often not submitted to the MED Unit. An evaluation questionnaire for participants to training workshops has only recently been introduced.

The training programme would have been more effective if the programme were better institutionalized and a UNEP - MAP officer be given the responsibility of planning ahead, following up and evaluating the outcome of training exercises.

8. INTERNATIONAL CO-OPERATION

Interactions between Mediterranean countries in the framework of MED POL appear to have only taken place at the level of Intergovernmental meetings regarding financial, administrative, legal and other strategic issues. In the meantime no effort has been made to establish bilateral or multilateral scientific cooperation between countries or research institutes.

Cooperative regional research projects coordinated by UNEP and including developed and developing countries would have greatly improved the data quality, the transfer of knowledge, put an end to the scientific isolation of scientists from developing countries and finally ensure a better coverage of the Mediterranean.

9. LESSONS LEARNED FROM THE NORTH SEA MONITORING PROGRAMMES

What lessons have been learned by ICES and the North Sea Regulatory Commissions about the design and conduct of international monitoring programmes over the past twenty years.

It is clear that there has been a tendency to adopt and implement international monitoring programmes with very broad and ill-defined objectives, and that these were frequently difficult to evaluate in terms of the original and specific management aims. With the exception of the most recent work in the North Sea, most of the international programmes were conducted along similar lines and had not been designed to cater for specific sub-regional issues and characteristics. In most cases very little effort had been devoted to the design of monitoring by comparison with the efforts and costs of implementation.

Other reasons for the lack of a successful outcome of monitoring work included the lack of adherence to agreed protocols for sampling, quality assurance work and data handling procedures. Such protocols are specifically designed to ensure that data collected by different laboratories and countries are comparable. If these protocols are ignored, the aims of the monitoring programme are undermined and valuable resources are wasted. It is also clear that only during the data assessment stages were such deficiencies revealed. Had they been detected, and corrected, at an earlier stage in the monitoring programme it would have allowed the organizers to meet their objectives and enhanced the cost-effectiveness of the programme.

On the basis of this collective experience to date, the following advice, has been offered by ICES and other North Sea scientific groups (Joint Monitoring Group, North Sea Task Force) in an attempt to improve the conduct of future international monitoring programmes:

- the aims of the monitoring programme and the general procedures to be followed at the data assessment stage must be agreed and clearly documented by the organizing body before any exercise begins;

- following agreement on the above point, a scientific coordinating group should be established to plan and coordinate the monitoring work. This group, consisting of relevant specialists (hydrographers, chemists, biologists, statisticians), and representatives of the official body under which the work is to be done, should meet well in advance of the commencement of the exercise to complete the following tasks:

  a) select the contaminants and matrices to be examined during the monitoring work;

b) select the geographical coverage of sampling work, select the sampling locations and identify the countries and laboratories who will be doing the relevant measurements at these locations;

c) agree, and if necessary prepare, clear and detailed protocols for sampling strategy, and collection and storage procedures;

d) specify the analytical detection limits, the precision and accuracy of measurements required for each contaminant and matrix;

e) agree and prepare the quality assurance (QA) approach to be used for (a) the conduct of appropriate intercomparison activities, both prior to and during the period of the monitoring programme, (b) the provision of appropriate reference materials, (c) the procedure for the assessment of the ability of laboratories to produce reliable and comparable data prior to their participation in the exercise, and (d) the QA criteria to be applied in the assessment of the data;

f) discuss and agree appropriate deadlines for the submission of data by participating laboratories and review the intended commitments of participating countries to ensure that they meet the demands of the study and these deadlines;

g) agree on the approach to be adopted, and action to be taken, in the event that data are submitted which (a) arrive after the stated deadline, (b) were not collected according to the agreed protocols, and (c) do not comply with other requirements of the study (e.g., not accompanied by supporting data on in-house QA measurements); and

h) agree, and if necessary prepare, the format to be used for the reporting of the data to the data centre.

- once the monitoring work has commenced its progress should be reviewed by the coordinating group to ensure that it is being done in accordance with the agreed protocols;

- data assessment groups, comprising specialists in the various scientific disciplines together with a number of representatives of the participating laboratories, should be established before the completion of the monitoring programme;

- members of the data assessment groups must receive all relevant information (validated monitoring data, required data products and statistical summaries, QA information, national comments, etc.) well in advance of any proposed assessment meeting. Adequate time must be allowed for the compilation and validation of monitoring data by the data centre, prior to the data assessment meeting;

- the data assessment procedure should comprise the following:

  a) a meeting of the data assessment group (or a subgroup) to evaluate a sub-set of the monitoring data to establish the best (statistical) methods and primary data products required for the assessment, and to develop instructions for experts conducting pre-assessments;

  b) the application of these methods to all data and the preparation of necessary data products by the data centre;

  c) the pre-assessment of data by individual members of the assessment group at their respective institutes; and

  d) the conduct of the final assessment of the data by the full group.

- at all stages of the work it is important to ensure the availability of sufficient financial and staff resources to conduct the monitoring and data assessment work in an appropriate manner.

10. EVALUATION OF THE WORK DONE DURING MED POL PHASES I AND II

At the beginning of MED POL Phase I many national research centres lacked both experience and instrumentation to monitor the contaminants requested by the scientific programmes. Even in the national centres with the relevant experience and equipment, the basic principles of monitoring and quality control of the data were not well established. Therefore, during MED POL Phase I it was necessary not only to adopt uniform reference methods and introduce quality control measures, but also to provide training to many participants and instruments to many laboratories, in order to allow them to participate in the programmes. It is against this background that the achievements that have been made during Phases I and II of MED POL are assessed.

Achievements of MED POL

Probably the most important achievement during Phase I of MED POL was the introduction of quality control and common reference methods for the analysis of contaminants in the various matrices and the quantification of microorganisms. The use of common analytical methods provided a good approach to the collection of meaningful data on contaminants and pollutants and allowed the comparison of the data on a Mediterranean-wide scale. The introduction of intercomparison exercises also made participants aware of the need for better data quality, and this has led to a

significant improvement in data quality over time for some laboratories, particularly for the measurement of metals in sediments and marine organisms and in general has improved the capability of some countries to carry out other types of measurements, e.g. organochlorines in marine organisms.

Likewise, the water quality control survey introduced uniform methods for the determination of microorganisms indicators for pollution from sewage and help to provide that the determination of total coliforms is not a useful parameter in microbiological water quality. This method can therefore be excluded from future monitoring surveys.

The MED POL programme had a very positive effect in stimulating most countries to establish national monitoring programmes. This has led to improved international cooperation, unfortunately mainly at government level, and stimulated the discussion of national pollution problems and the need to implement control measures. Many of the data obtained in these national programmes have been published in the scientific literature with exact position of the sampling stations or areas and, most important, with the data obtained during intercalibration exercises (quality control).

The MED POL project on pollution inputs from land-based sources can be registered as the first attempt to assess the magnitude of this problem in the Mediterranean. Data collection proved to be very difficult in the short time allowed (1976-1977) so that the assessments had to be worked out by extrapolation in most cases. The project was updated in 1985 but the supply of information from the Mediterranean countries remains slow and fragmentary.

The assessment documents prepared for individual elements of the black and gray list during MED POL Phase II constitute another major achievement of MED POL. In these documents the data generated under the MED POL monitoring projects are used together with all available data from the scientific literature to evaluate the state of contamination and its impact in the Mediterranean area. These assessments are much superior to the previous evaluation achieved using the MED POL practice of averaging contaminant concentrations over the thirteen MED POL areas to respect confidentiality of data (Fig. 1). In fact, the assessment documents prepared during MED POL Phase II demonstrated the enormous utility of the literature data for a better evaluation of the impact of contaminants and pollutants.

The large number of species and the different methods used in studies on pollution effects on organisms and their populations made comparison between results extremely difficult. Unfortunately the majority of tests were short-term exposure to water only and with high pollutant concentrations, thus severely limiting the usefulness of the results. However, it can be considered as positive that the methodology of bioassay was introduced in Mediterranean through these experiments. Similarly the study of effects on marine ecosystems and communities showed that these ecosystems could be studied systematically and that in many areas of the Mediterranean highly degraded ecosystems exist.

Bottlenecks of MED POL

The original broad aims of MED POL were and are very sound. However, the objectives established to meet these aims were not defined in sufficient detail to allow participants to provide data to meet these aims.

This problem is not unique to the Mediterranean region, as experience has shown over the past 20 years that other regions (North Sea) and international organizations (see "Section 9") have gone through the same problems.

Some laboratories are still unable to carry out some measurements, e.g. organochlorine in marine organisms to the required level of accuracy and precision, which means that currently there is a lack of comparability of data among these laboratories for these measurements.

It is also clear that in many cases the sampling and analytical procedures have not been adhered to and this has affected the usefulness of the monitoring data.

The institutional bodies which are responsible for the management of MED POL did not supply the MED Unit with enough scientific expertise either directly or through additional expert consultations to optimize the management of MED POL projects.

The national coordinators have not fulfilled the commitments laid down by the Contracting parties. Specifically this has meant that they have not provided MED Unit with the scientific support that it was required from them.

Although some progress has been made on monitoring of land-based inputs, much more effort is required on this topic.

The most serious bottleneck of the entire MED POL project is that data were collected and stored in the data bank without considering the results of the quality control carried out by IAEA's laboratory for Marine Radioactivity in Monaco (MED POL XI). This means that accurate data are 'contaminated' with wrong and false data making any conclusion about the concentrations of contaminants and pollutants useless, or even worse, misleading. Consequently wrong management decision based both on too high and too low contaminants and pollutants concentrations, may have been made.

Another shortcoming is that no effort was made to establish collaboration between the participating institutions from different Mediterranean countries. In fact, the expectations of many cooperating scientists from developed countries, who participated without funds from MED POL during Phase I were disappointed when it

became obvious that MED POL would not stimulate international collaboration and many discontinued their participation to MED POL. Joint ventures between participants from developed and developing countries would have greatly improved the transfer of scientific knowledge, diminished the scientific isolation of scientists in developing countries and as a consequence would have increased considerably the amount of data obtained from developing countries.

This last point is of special importance because despite the considerable efforts in supplying funds, training, instrumentation and instrument maintenance very few data were obtained from the southern coast of the Mediterranean. In part this is due to the missing or unreliable infrastructure (e.g. power cuts and discontinuous water supply, etc.) in the developing countries that hindered greatly the effective use of sophisticated instrumentation and the execution of the planned working schedule. Both requirements are essential for producing accurate and precise data. These difficulties should not be underestimated but there is still need for means and ways to encourage and motivate scientists from the above mentioned countries.

Suggestions for overcoming the problems encountered in both Phases of MED POL:

- having learned from the experiences gained under Phases I and II of MED POL it is timely to consider the establishment of more specific aims and achievable objectives which will meet their requirements under the Barcelona Convention to provide an effective system of environmental data collection which will allow them inter alia to:

  a) periodically assess the environmental quality status of the Mediterranean Sea in relation to chemical contamination and its effects on marine life;

  b) quantify and compare inputs of wastes to rivers and inshore areas; and

  c) on the basis of any measures taken to reduce inputs of wastes, to be able to monitor the effects of these changes on the environmental status of the Mediterranean Sea.

Monitoring

As concluded above, MED POL has greatly contributed to the improvement of the analytical capabilities of the developing member countries and thereby helped build a foundation for future national and international environmental monitoring. There are, however, still considerable improvements to be made in many cases, both with regard to quality and to productivity in the laboratories engaged.

A strategic shortcoming in most of the monitoring programmes in MED POL as well as on national and other international levels is that the purpose of the monitoring is not well defined. Ideally a monitoring programme should specify its goal - e.g. to detect the long-term trend in DDT levels in eggs of fish-eating birds in a region or to safeguard human health from mercury in fish. The goal should further be specified as to the level of change to be detected over what period of time or as to precision with which it should be established that a present level is not exceeded. When this is done statistical models should be used to determine the geographical and time distribution of samples and the analytical precision required.

There are generally three types of questions that monitoring programmes are designed to answer:

- temporal trend;
- compliance with standards; and
- geographic abnormalities (unknown hot-spots).

More effort must be made by Contracting Parties in encouraging institutes to provide the necessary monitoring data to the MED Unit.

Research

The major bottleneck for research is clearly in the allocation of funding. All experience show that high quality results are only obtained when the parameters being examined are of interest or importance to the country in question. The selection of projects and allocation of funds should be done on scientific units only by complements bodies e.g. with peer-review systems.

Fair geographical distribution of the funding could be obtained through research-consortia where institutes/laboratories collaborate in joint projects - an ad hoc version of the twinning arrangements that WAITRO (World Association of Industrial and Technical Research Organization) have promoted for collaboration between institutes in industrialized and developing countries.

National co-ordinators for MED POL

The Group of national co-ordinators was established to facilitate contact between MED POL and the various national agencies/institutions, to assist in the transfer of information between national institutes and MED Unit and to preliminary review the scientific data before its despatch to MED Unit.

Some of the coordinators did not fulfill the tasks assigned to them by the Contracting Parties. In particular they did not supply the data, in a timely way, necessary to fulfill the agreed objectives of MED POL including data on land-based sources. Some of the coordinators were unable to stimulate the monitoring programme of their own countries. Also coordinators did little to establish international scientific collaboration between participating countries. Most important, they did not provide MED Unit with adequate scientific expertise to assist MED Unit in the organization and management of MED POL.

If the Contracting Parties decide to retain the system of national co-ordinators for MED POL, then they will need additional scientific support if they wish for a greater success for MED POL Phase III than that achieved under Phases I and II.

It is therefore suggested that the Contracting Parties consider the use of special expert groups to assist them with the tasks of:

- designing and planning project work for MED POL Phase III; and
- reviewing the scientific information produced under MED POL Phase III.

The recommendations given at the end of this report provide further details in this subject.

Conclusions

In general, the MED POL programme can be considered to be a success, despite the problems encountered during Phases I and II. Many of the problems encountered by participating institutes have been, and to some extent still are being, experienced by other international organizations (e.g. those involving North Sea and Baltic Sea). It should be stressed, however, that the scientists in the institutes in the North Sea and Baltic Sea areas had a distinct advantage over their counterparts in Mediterranean institutes in that at the start of their programmes they were more experienced, better trained and had access to better facilities and instrumentation. The MED POL programme has achieved much in terms of equipping and training scientists in the region, particularly those from the southern and eastern parts. These achievements must be built on by the Contracting Parties continuing to support these institutes and the scientific work of the MED POL programme.

To ensure that this support is converted into more achievements during Phase III of MED POL it is essential that MED Unit receives the proper scientific advice and support in its work. This is the reason for the main recommendation that the Contracting Parties establish a standing advisory group of independent scientists to support MED Unit in its activities.

11. RECOMMENDATIONS

The evaluation has shown that, in addition to inadequate funding, the majority of the problems encountered by MED POL are due to the insufficient scientific expertise given to the MED Unit. Based on this conclusion a single recommendation is made. A Standing Advisory Group of Experts (SAGE) needs to be established to assist the MED Unit in their future work, particularly the designing and implementation of detailed plans for the remaining part of MED POL Phase II (1994-1995) and MED POL Phase III (1996-2005) and the periodical review of data arising from such activities.

a) to evaluate the detailed plans for the programme of work to be carried out during 1994-1995 under MED POL Phase II, and to assess the data produced from this work (see Annex IV, Section C, subsection 7 (1), A Report of the Joint Meeting of the Scientific and Technical Committee and the Socio-Economic Committee (UNEP, 1993b);

b) to design the research and monitoring programmes, and other activities, that are needed to meet the general objectives specified for MED POL Phase III (1996-2005) (see Annex IV, Section C, Subsection 7 (2), A Report of the Joint Meeting of the Scientific and Technical Committee and the Socio-Economic Committee (UNEP, 1993b); and

c) to evaluate the scientific data produced during MED POL Phase III and if appropriate to suggest proposals for adjustments to this programme for future work.

On the assumption that the Contracting Parties adopt this recommendation, we provide below additional information relating to the work of SAGE.

DETAILS OF THE STANDING ADVISORY GROUP OF EXPERTS (SAGE)

Composition

A group of 15 to 20 independent scientists drawn from countries within and outside the Mediterranean region, who should be identified by MED Unit.

SAGE should include four scientists from non-Mediterranean countries who have experience in the design and organizational aspects of similar international or national programmes concerned with environmental research and monitoring programmes. It is suggested that two members could be drawn from North Sea and Baltic Sea countries who have experience of the North Sea and Baltic Sea Monitoring Programmes and two from North America who have experience in the USA/NOAA Trends and Assessment Programmes and the Canadian Marine Monitoring Programme.

Three of the experts (one of which should be the chairman of the group) should serve as an steering and organizing committee. This committee should arrange for the necessary documentation to be prepared for the meetings and be responsible for preparing the reports of the meetings. The organizing committee must be able to call upon MED Unit to assist them in the compilation and distribution of any background documents dealing with the most important topics of MED POL Phase III. These background papers should be distributed one month before each meeting.

On certain occasions SAGE might find it appropriate to request assistance from relevant specialists (chemists, biologists, statisticians hydrographers).

The Chairman of SAGE should be responsible for any liaison work with MED Unit on matters concerning the work of SAGE.

Modus operandi

SAGE should meet for 5 days in 1994 and 1996 to carry out its tasks under its first responsibility (see (a) above), and in 1995 for 5 days to carry out its tasks under its second responsibility (see (b) above).

Following the Implementation of MED POL Phase III, the Group should meet annually, beginning in 1997 and ending in 2005 to carry out its tasks under its third responsibility (see (c) above).

In relation to its second responsibility, SAGE should bear the following points in relation to planning of research and monitoring work for Phase III.

Research work

On the basis of the research work completed to date in the Mediterranean Sea, SAGE should identify what additional research work is needed to meet management needs and suggest possible projects to meet these needs. SAGE should provide MED Unit with sufficient details of the required field and experimental work, and the relevant priority of each project, to allow MED Unit and the UN agencies to assign priority and finance for this work.

Monitoring work

In planning the programmes for the various components of the monitoring work (land-based sources of pollution, atmospheric inputs, marine matrices, biological and biological effects parameters) SAGE should take account of the lessons learned by other international bodies such as the North Sea Task Force and Baltic Coordinating Monitoring Programmes in such work.

These bodies have drawn up a protocol for dealing with future chemical monitoring work (see section 8 of this report for details of this protocol). This Protocol has been used as a basis for drafting the following guidance to SAGE for both chemical and biological parameters:

- the objectives of each monitoring programme and the general procedures to be followed at the data assessment stage must be agreed and clearly documented by MED Unit before any exercise begins. In this case, the SAGE will use the objectives laid out in Annex VII of the Report of the Joint Meeting of the Scientific and Technical Committee and the Socio-Economic Committee (UNEP, 1993b) as a basis for the overall aims of Phase III of MED POL;

- on the basis of the objectives referred to in the point above, SAGE with assistance from relevant specialists (hydrographers, chemists, biologists, statisticians, etc.), and representatives of MED Unit and UN agencies, will complete the following tasks:

  a) following a critical review of the existing MED POL guidelines on contaminants and matrices, select the contaminants and matrices to be examined during the Phase III of MED POL monitoring work;

  b) following a critical review of existing guidelines from MED POL Phase II, choose the geographical coverage of sampling work, select the sampling locations and identify the countries and laboratories who will be doing the relevant measurements at these locations during MED POL Phase III;

  c) review the existing MED POL guidelines for sampling strategy, collection and storage procedures and if necessary prepare additional guidelines to meet the requirements for Phase III of MED POL;

  d) review the existing MED POL guidelines on analytical detection limits, the precision and accuracy of measurements required for each contaminant and matrix and if necessary specify more precise requirements for measurements under Phase III of MED POL;

  e) agree and prepare the quality assurance (QA) approach to be used for (a) the conduct of appropriate intercomparison activities, both prior to and during the period of the monitoring programme, (b) the provision of appropriate reference materials, (c) the procedure for the assessment of the ability of laboratories to produce reliable and comparable data prior to their participation in the exercise, and (d) the QA criteria to be applied in the assessment of the data;

f) in consultation with MED Unit and UN agencies, discuss and agree appropriate deadlines for the submission of data by participating laboratories and review the intended commitments of participating countries to ensure that they meet the demands of the study and these deadlines;

g) in consultation with MED Unit and the agencies, agree on the approach to be adopted, and action to be taken, in the event that data are submitted which (a) arrive after the stated deadline, (b) were not collected according to the agreed guidelines, and (c) do not comply with other requirements of the study (e.g., not accompanied by supporting data on in-house QA measurements); and

h) following a review of the existing MED POL formats that are used for the reporting of data to the MED Unit, prepare any updates that are required for MED POL Phase III.

Although the above specifically applies to chemical monitoring programmes, the guidelines laid down here can be used as a basis for establishing guidelines for dealing with microbiological and biological effects monitoring work.

In relation to its third responsibility (point (c) page 47), SAGE will be required to meet annually to review the scientific aspects of work performed, to assess the progress of this work and to make proposals for future activities. The review of the scientific data arising from MED POL Phase III should consider the following points:

- once the monitoring work has commenced its progress should be reviewed by SAGE to ensure that it is being done in accordance with the agreed procedures laid down at the 1995 meeting of SAGE, and adopted by the Contracting Parties in 1995;

- from the membership of SAGE it will be necessary to establish a number of data assessment groups, supported by specialists in the various scientific areas of MED POL activities (e.g. marine monitoring, land-based sources of pollution and atmospheric inputs) and a number of representatives of the participating laboratories. These assessment groups should meet once a year to carry out their work;

- members of the data assessment groups must receive all relevant information (validated monitoring data, required data products and statistical summaries, QA information, national comments, etc.) well in advance of any proposed assessment meeting. Adequate time must be allowed for the compilation and validation of monitoring data by the data centre, prior to the data assessment meeting;

- the data assessment procedure should comprise the following:

  a) an intercessional evaluation of a subset of the monitoring data to establish the best (statistical) methods and primary data products required for the assessment, and to develop instructions for the MED Unit assessment meeting;

  b) the application of these methods to all data and the preparation of necessary data products by MED Unit;

  c) the pre-assessment of data by individual members of the assessment group at their respective institutes; and

  d) the conduct of the final assessment of the data by the assessment meeting; and

- at all stages of the work it is important that MED Unit ensures the availability of sufficient financial and staff resources at MED Unit to conduct the monitoring and data assessment work in an appropriate manner.

Table I

List of MED POL Phase I Projects (1976-1980)

The pilot projects approved at the 1975 Barcelona Meeting as parts of MED POL Phase I were:

MED POL I : Baseline Studies and Monitoring of Oil and Petroleum Hydrocarbons in Marine Waters

MED POL II : Baseline Studies and Monitoring of Metals, particularly Mercury and Cadmium, in Marine Organisms

MED POL III : Baseline Studies and Monitoring of DDT, PCBs and Other Chlorinated Hydrocarbons in Marine Organisms

MED POL IV : Research on the Effects of Pollutants on Marine Organisms and their Populations

MED POL V : Research on the Effects of Pollutants on Marine Communities and Ecosystems

MED POL VI : Problems of Coastal Transport of Pollutants

MED POL VII : Coastal Water Quality Control

Subsequent to the 1975 Barcelona Meeting, six other projects were added or considered as collaterals to MED POL to broaden the scope of the programme and to provide the necessary support to it. They were:

MED POL VIII : Biogeochemical Studies of Selected Pollutants in the Open Waters of the Mediterranean

MED POL IX : Role of Sedimentation in the Pollution of the Mediterranean Sea

MED POL X : Pollutants from Land-Based Sources in the Mediterranean

MED POL XI : Intercalibration of Analytical Techniques and Common Maintenance Services

MED POL XII : Input of Pollutants into the Mediterranean Sea through the Atmosphere

MED POL XIII : Modelling of Marine Systems

Table II

Research and study topics included in MED POL Phase II (1982 - 1989)

(A) Development of sampling and analytical techniques for monitoring the sources and levels of pollutants. Testing and harmonization of these methods at the Mediterranean scale and their formulation as reference methods. Substances listed in Dumping and Land-Based Sources Protocol as priorities.

(B) Development of reporting formats required according to the Dumping, Emergency and Land-Based Sources Protocols.

(C) Formulation of the scientific rational for the environmental quality criteria to be used in the development of emission standards, standards of use or guidelines for substances listed in Annexes I and II of the Land-Based Sources Protocol in accordance with Articles 5, 6 and 7 of that Protocol.

(D) Epidemiological studies related to the confirmation (or eventual revision) of the proposed environmental quality criteria (standards of use) for bathing waters, shellfish-growing waters and edible marine organisms.

(E) Development of proposals for guidelines and criteria governing the application of the Land-Based Sources Protocol, as requested in Article 7 of that Protocol.

(F) Research on oceanographic processes, with particular emphasis on surface circulation and vertical transport. Needed for the understanding of the distribution of pollutants through the Mediterranean and for the development of contingency plans for cases of emergency.

(G) Research on the toxicity, persistence, bioaccumulation, carcinogenicity and mutagenicity of selected substances listed in Annexes of the Land-Based Sources Protocol and the Dumping Protocol.

(H) Research on eutrophication and concomitant plankton blooms. Needed to assess the feasibility of alleviating the consequences and damage from such recurring blooms.

(I) Study of ecosystem modifications in areas influenced by pollutants, and in areas where ecosystem modifications are caused by large-scale coastal or inland engineering activity.

(J) Effects of thermal discharges on marine and coastal ecosystems, including the study of associated effects.

(K) Biogeochemical cycle of specific pollutants, particularly those relevant to human health (mercury, lead, survival of pathogens in the Mediterranean Sea, etc.).

(L) Study of pollutant-transfer processes (i) at river/sea and air/sea interface, (ii) by sedimentation and (iii) through the straits linking the Mediterranean with other seas.

Table III

Research Areas in MED POL Phase II (from 1990 onwards)

I. CHARACTERIZATION AND MEASUREMENT

This area will include research projects on the characterization (identification of chemical or microbiological components) and measurement (development and testing of methodologies) of specified contaminants.

II. TRANSPORT AND DISPERSION

This area will include projects which aim to improve out understanding of the physical, chemical and biological mechanisms that transport potential pollutants from their sources to their ultimate repositories. Typical topics will be atmospheric transport and deposition, water movements and mixing, transport of contaminants by sedimentation and their incorporation in biogeochemical cycles. Priority will be given to the provision of quantitative information ultimately useful for modelling the system and contributing to regional assessments.

III. EFFECTS

This area will include projects relevant to the effects of selected contaminants listed in Annexes I and II of the LBS and Dumping protocols to marine organisms, communities and ecosystems or man and human populations. Priority will be to effects and techniques providing information useful for establishing environmental quality criteria.

IV. FATES/ENVIRONMENTAL TRANSFORMATION

This area will include projects studying the fate of contaminants (including microorganisms) in the marine environment such as persistence or survival, degradation, transformation, bioaccumulation, etc., but excluding transport and dispersion which is dealt in area II.

V. PREVENTION AND CONTROL

This area will include projects dealing with the determination of the factors affecting the efficiency of waste treatment and disposal methods under specific local conditions as well as the development of environmental quality criteria and common measures for pollution abatement.

Table IV

Statistical analysis of the MED POL monitoring data on heavy metals and halogenated hydrocarbons in biota with special reference to temporal trends (1974-1991) (UNEP/FAO, 1992)

Year	Heavy Metals			Halogenated Hydrocarbons		
	Station count	Sample count	Data count	Station count	Sample count	Data count
1974	3	47	47	-	-	-
1975	26	92	188	15	24	143
1976	80	728	1792	44	152	910
1977	155	1601	4863	85	527	2295
1978	136	1235	3768	61	340	1471
1979	187	1307	3160	80	298	1757
1980	36	151	403	18	37	178
1981	-	-	-	-	-	-
1982	28	46	184	24	39	145
1983	106	276	742	27	33	221
1984	92	477	1293	77	266	1002
1985	190	581	1916	200	337	1793
1986	59	487	2141	22	61	304
1987	70	771	3561	39	87	622
1988	91	700	2909	71	226	1294
1989	81	564	2522	62	218	904
1990	68	489	2196	50	326	1362
1991	41	449	2275	26	210	443
Total		10001	33960		3181	14844

Table V

Selected summary results of MED POL monitoring concerning heavy metals (UNEP, 1989)

Species and area	Average concentration and standard deviation of metals in $\mu g\ g^{-1}$ of wet weight				
	Hg	Cd	Pb	Cu	Zn
Bivalve *					
Adriatic:					
- Piran area	0.03 ± 0.01	0.22 ± 0.05	-	-	-
- Rovinj area	0.02 ± 0.01	0.12 ± 0.07	-	-	-
- Pula area	0.05 ± 0.04	0.19 ± 0.05	0.40 ± 0.20	0.90 ± 0.40	-
- Rijeka area	0.02 ± 0.01	0.14 ± 0.05	0.30 ± 0.10	-	-
- Kornati and Sibenik	0.05 ± 0.04	0.18 ± 0.09	0.30 ± 0.10	1.10 ± 0.60	23 ± 6
- Split area	0.08 ± 0.07	0.17 ± 0.04	-	-	-
- Dubrovnik area	0.03 ± 0.01	0.18 ± 0.05	0.40 ± 0.20	1.50 ± 0.80	19 ± 7
Mediterranean:					
- NW	0.07 ± 0.07	0.13 ± 0.08	0.70 ± 0.40	-	-
- SW	0.09 ± 0.09	0.20 ± 0.10	0.90 ± 0.60	1.60 ± 0.50	29 ± 6
- Eastern	0.05 ± 0.03	0.13 ± 0.04	0.30 ± 0.10	0.70 ± 0.10	17 ± 4
Red Mullet					
Eastern Mediterranean	0.10 ± 0.05	0.04 ± 0.02	-	0.70 ± 0.20	4.80 ± 0.50
Ionian Sea	0.19 ± 0.08	0.02 ± 0.01	-	0.40 ± 0.10	3 ± 1
NW Mediterranean	0.20 ± 0.10	0.01 ± 0.01	-	-	-

* *Mytilus galloprovincialis* except for the Eastern Mediterranean where *Mactra corallina corallina* is used.

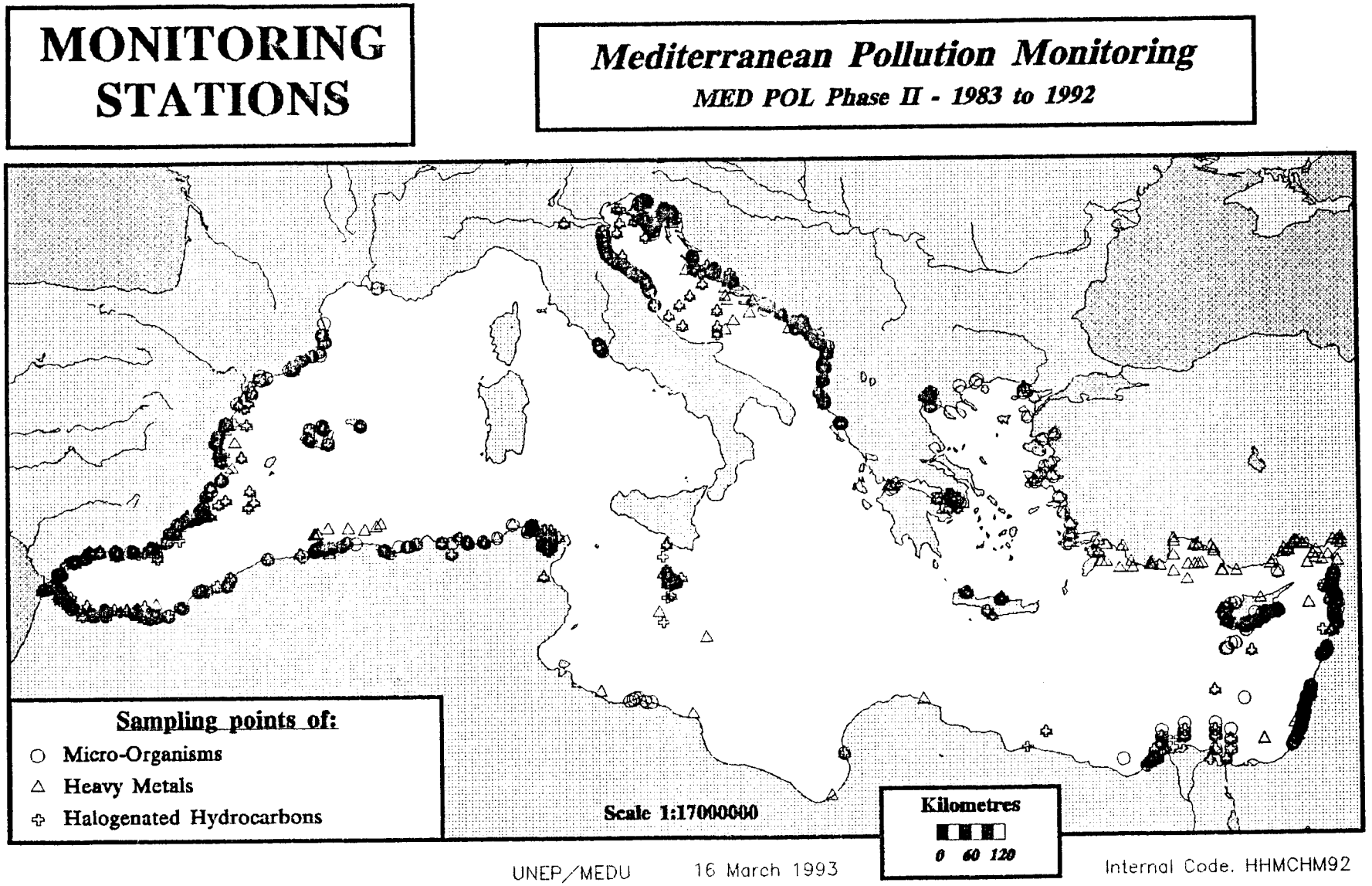
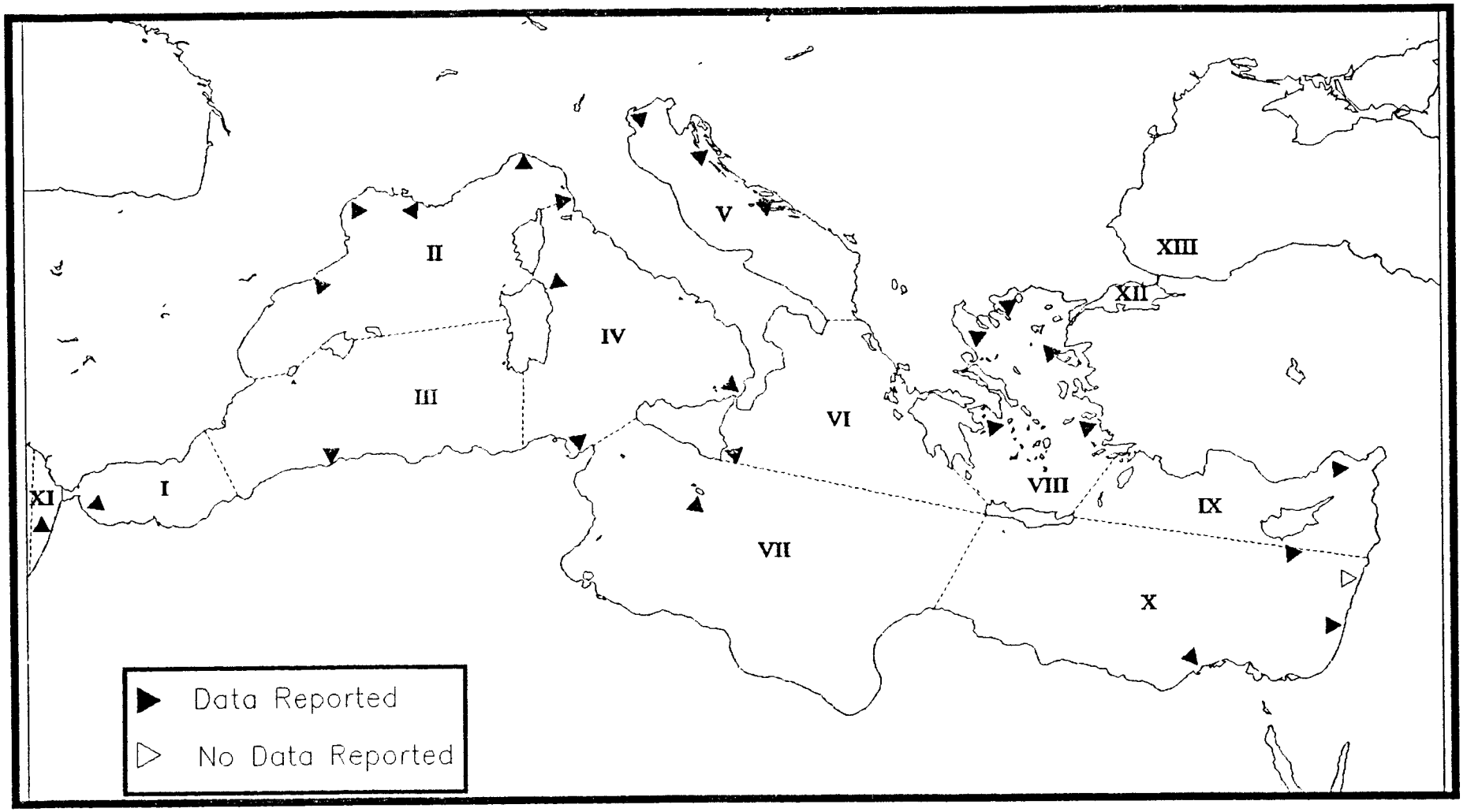


Figure 1. Sampling stations of the MED POL monitoring Programme - Phase II



I. Alboran
II. North – Western
III. South – Western
IV. Tyrrhenian
V. Adriatic
VI. Ionian
VII. Central
VIII. Aegean
IX. N. Levantine
X. S. Levantine
XI. Atlantic
XII. Sea of Marmara
XIII. Black Sea

Figure 2. Sampling areas for MED POL Phase I

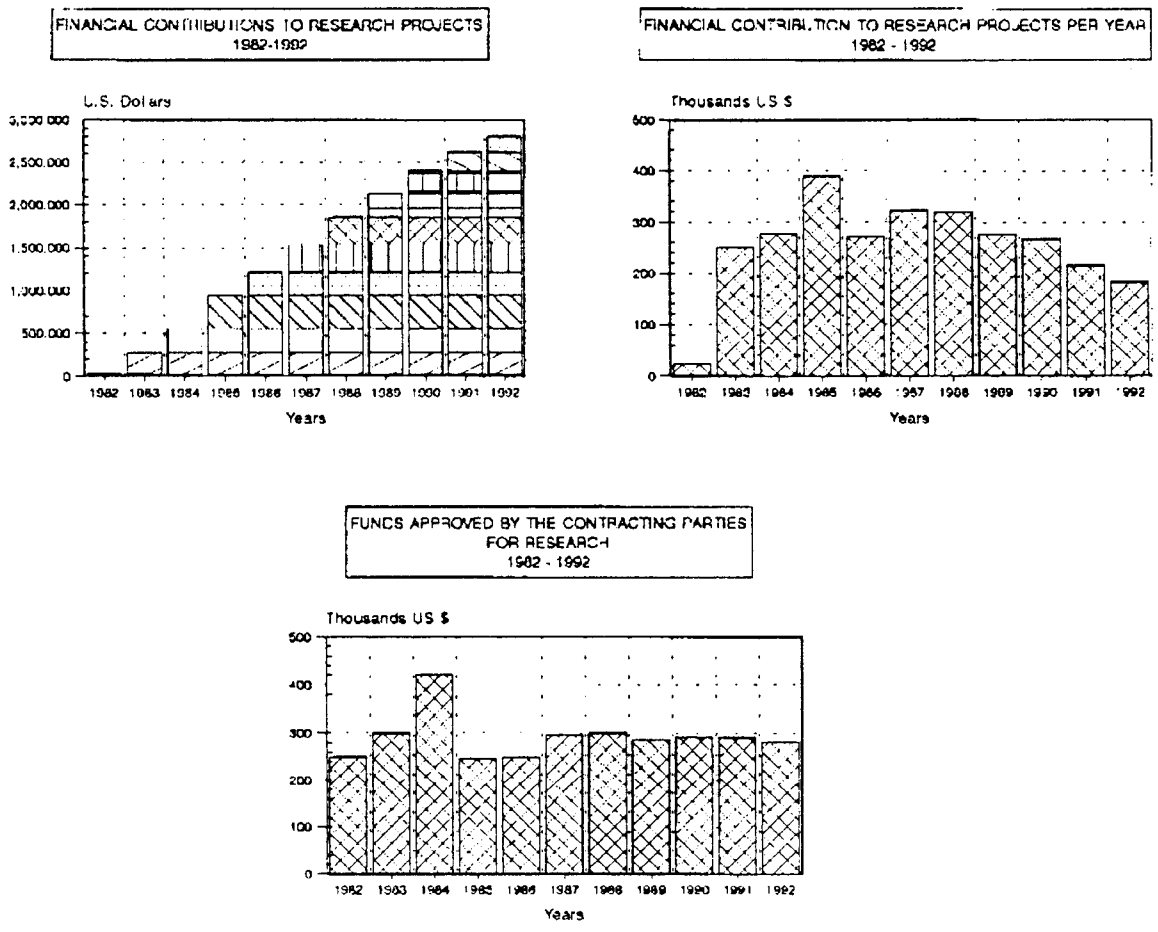


Figure 3. Summary of financial status of the MED POL research component in the period 1982-1992

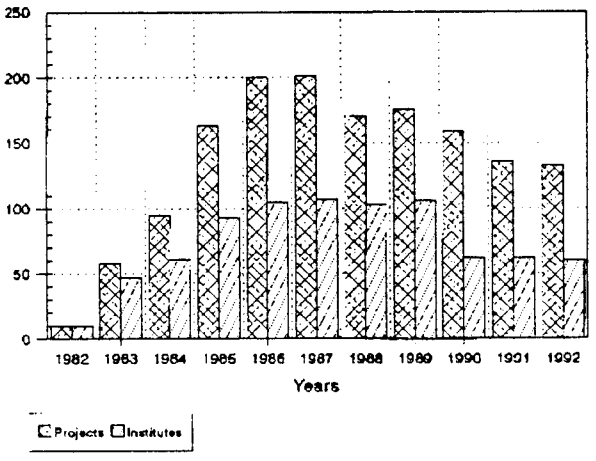


Figure 4. MED POL research: Number of projects and participating institutions

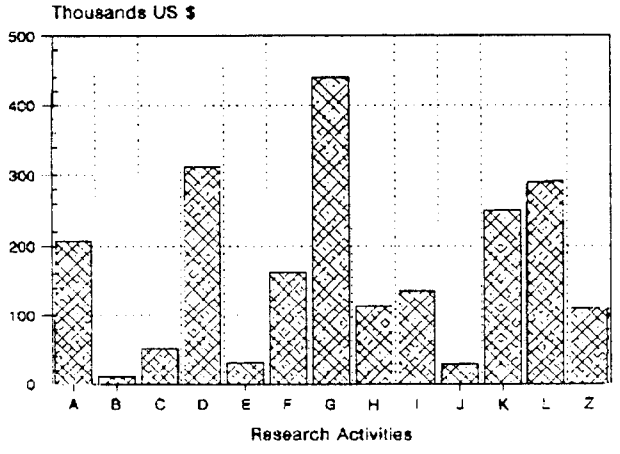


Figure 5. MED POL financial contribution to individual research activities

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