United Nations Environment Programme

UNEP(OCA)/MED WG.59/2
24 February 1993

Original: ENGLISH

MEDITERRANEAN ACTION PLAN

Consultation Meeting on the
Evaluation of the Israeli Monitoring Programme

Haifa, 21-22 December 1992

REPORT OF THE CONSULTATION MEETING ON THE EVALUATION OF THE ISRAELI MONITORING PROGRAMME

UNEP
Athens, 1993

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Introduction

1. A Consultation Meeting on the Evaluation of the Israeli Monitoring Programme was organised in the framework of the review activities for the MED POL programme. The meeting took place at the National Institute of Oceanography of the Israel Oceanographic and Limnological Research Ltd. (IOLR), Haifa, from 21-22 December 1992. The list of participants is attached as Annex I. A list of documents distributed to the participants is attached as Annex II.

Agenda item 1 - Opening of the meeting

2. The meeting was opened by Mr. Yuval Cohen, Director-General of the IOLR, who welcomed the participants on behalf of the host Institute. Welcoming remarks were also addressed by Mr. Ellik Adler on behalf of the Ministry of Environment and by Mr. Ljubomir Jeftić on behalf of the Coordinating Unit for the Mediterranean Action Plan (MEDU).

Agenda item 2 - Background and scope

3. Mr. Jeftić explained that before the end of the second phase of the MED POL programme in 1995, MEDU should prepare and propose to the Scientific and Technical Committee (STC) the new Phase III. Before such a proposal could be made it was necessary to review and evaluate MED POL Phase II and its achievements. In the framework of these activities, it was decided to review in detail two of the on-going national monitoring programmes (N.M.P.) which had been going on uninterruptedly. The N.M.P.s chosen were those of Israel and Croatia. The consultation meeting for Croatia will take place in Zagreb sometime in March 1993.

4. Mr. G.P. Gabrielides added that the review will concentrate on chemical contaminants in the marine environment and that already the data concerning marine organisms have been analysed statistically for temporal trends by a consultant. A Training Workshop on the Design of Monitoring Programmes and Management of Data concerning Chemical Contaminants in Marine Organisms will be organised in Athens from 22-26 June 1993.

Agenda item 3 - Election of officers

5. It was agreed that Mr. Jeftić would act as Chairman and Mr. Gabrielides as Technical Secretary.

Agenda item 4 - Adoption of the agenda

6. The proposed draft agenda which is attached as Annex III, was adopted and the speakers for agenda items 6.1, 6.2 and 6.3 were identified.

Agenda item 5 - New monitoring strategies

7. This agenda item was introduced by G.P. Gabrielides who mentioned some of the discussions taking place at the ICES Working Group for Environmental Assessment and Monitoring Strategies (WGEAMS). According to the Advisory Committee on Marine Pollution (ACMP) of the International Council for the Exploration of the Sea (ICES), "the ultimate purpose of monitoring is the control of exposure of the organism of interest, most likely to be first affected to the activity or contaminant in question, whether this target be Man or some specified element of the marine resource. Basically, monitoring looks at changes in the marine environment, and in practice, falls into one of the following three categories:

- monitoring for compliance purposes
- monitoring patterns and trends, or
- monitoring for research purposes

8. By far the most important step in designing monitoring programmes is the strict definition of the objectives of the programmes concerned. The purpose of marine pollution monitoring has been defined by a US interagency marine pollution committee as ".....to obtain time-series data for detecting significant changes.....to provide timely warning and other advice to management so that appropriate actions may be taken". However, many historical marine pollution programmes have proven useless in a management context.

9. Usually the objectives set are one or more of the following:

a) **the assessment of risks to human health** or the protection of human health. This is known as public health-related monitoring and is normally carried out by national or local health services in a country;

b) **the assessment of the effectiveness or efficiency of measures taken to reduce pollution.** Measures taken to reduce the level of marine pollution are primarily directed at the control and reduction of inputs of contaminants. This objective is therefore directly linked with objective (d) which monitors inputs;

c) **the assessment of damage to marine life** or the protection of marine life. Biological effects monitoring can provide a measurement of the direct effect of adverse water and sediment quality on marine organisms. The basis of such monitoring is measuring the extent to which a specific biological response deviates from a normal value;

d) **the assessment of the inputs of contaminants** into the marine environment from various sources. This is known as load monitoring and is directly linked with objective (b). The main inputs are from land-based discharges. riverine sources, the atmosphere, and direct dumping;

e) **the assessment of the existing level of marine pollution** as a timely warning system. For this objective, water, sediments as well as organisms have to be monitored. As it can be seen, all objectives are inter-dependent and a careful programme design can satisfy them all.

10. There are a number of factors to be considered in the planning of a monitoring programme to meet specific objectives. Some of these are:

a) which contaminants should be measured;

b) in which matrices should they be measured;

c) where should the samples be collected;

d) when should the sampling be done and how frequently.

If biota are going to be analysed, which species and tissue; also what size and how many individuals should be collected. If sediment is the matrix, then sampling technique, grain size and extraction method have to be decided.

11. The selection of contaminants depends on the objectives of the monitoring programme, the likely sources and the analytical capabilities of the participating laboratories. Matrices should be selected accordingly having also in mind where a contaminant would be predominantly associated. For example, one should not look for chlorobiphenyls in water since the octanol:water partition coefficient indicates otherwise.

Agenda item 6 - The Israeli Monitoring Programme (IMP)

Agenda item 6.1 - Development through the years

12. Mr. Yuval Cohen in introducing this agenda item informed the meeting that systematic monitoring of the state of the marine environment (Mediterranean) started in Israel in the mid 1970's. Since then, monitoring programmes were always accompanied by and closely linked to research programmes on the input, fate and impact of potential pollutants.

13. A number of research projects carried out within the framework of MED POL Phase I indicated that future monitoring within Israel's Mediterranean coastal zone should focus on: heavy metals in edible fish, benthic fauna and sediments; beach stranded tar balls; and indicators for sewage-borne pathogenic microorganisms in coastal waters (bathing beaches). Analysis of chlorinated hydrocarbons in fish did not reveal indications for significant pollution. With regard to heavy metals, the results of MED POL Phase I indicated that special emphasis should be given to monitoring of the state of pollution in Haifa Bay.

14. Within the framework of the Israeli National Monitoring Programme (MED POL Phase II), the following activities were undertaken:

a) Monitoring of heavy metals (in particular Hg, Cd, Cu, Zn) in trawl fish, inshore fish, benthic fauna and sediments. From 1981 to 1987 the monitoring in nearshore waters focused on Haifa bay with a few reference stations south of the bay. As of 1988 the monitoring has been extended to include the entire length of the Israeli-Mediterranean coastline (carried out by Israel Oceanographic and Limnological Research).

b) Monitoring of indicators for sewage-borne pathogenic microorganisms (mainly total coliforms and faecal coliforms) in seawater in authorized bathing beaches (carried out by the Public Health Laboratories of the Ministry of Health).

c) Monitoring of beach stranded tar balls (only in 1984) carried out by Israel Oceanographic and Limnological Research).

d) Monitoring of pollutants transported through the atmosphere (air samples) initiated in 1990 (carried out by the Haifa, Hadera and Ashkelon Association of Towns for Environmental Affairs).

In addition, the following complementary activities were undertaken:

a) A survey of the amounts and types of litter (solid waste) on the beaches (from 1989 to 1991) (carried out by Israel Oceanographic and Limnological Research).

b) A survey of floating tar balls in the eastern Mediterranean (undertaken in 1987) by research vessels of Israel, Turkey, Cyprus and Germany within the framework of the POEM Programme.

15. Outside of the scope of the National Monitoring Programme, a number of long-term compliance monitoring programmes, prescribed by the relevant national legislation, were carried out by Israel Oceanographic and Limnological Research. These were:

a) Monitoring of a deep sea dumping site for industrial acidic wastes (40 km offshore).

b) Monitoring of a deep sea dumping site for coal fly ash (70 km offshore).

c) Monitoring of a sewage sludge discharge site (5 km offshore).

Agenda item 6.2 - Quality control, validation and management of data

16. Mrs Hava Hornung of IOLR described the work undertaken as far as quality control, validation and management of data is concerned in the framework of the IMP. She pointed out that quality assurance consists of two separate but related activities, quality control and quality assessment. Both must be operational and coordinated. The following definitions are offered:

Quality assurance: A system of activities whose purpose is to provide to the producer or user of a product or a service the assurance that it meets defined standards of quality with a stated level of confidence.

Quality control: The overall system of activities whose purpose is to control the quality of a product or service so that it meets the needs of users. The aim is to provide quality that is satisfactory, adequate, dependable, and economic.

Quality assessment: The overall system of activities whose purpose is to provide assurance that the overall quality control job is being done effectively. It involves a continuing evaluation of the products produced and the performance of the production system.

17. Within the framework of the MED POL monitoring and MTF research programmes, sediments and marine organisms are analysed for heavy metals. Intercalibration exercises carried out within this programme are focused mainly on the chemical analysis of the samples. However, it is recognized that sampling is one of the most critical operations in analytical measurement. The sampling strategy, methodology, subsampling, chemical and/or physical treatment, preservation, and storage are logically parts of the analytical plan and must be developed and specified for each situation.

18. Sampling plans and measurement procedures must be adequate to permit evaluation of sample homogeneity and/or population distributions when these are important considerations.

The written procedure should include the following information:

a) Sample preparation and treatment
b) Chemical operations
c) Calibration procedure
d) Measurement procedure
   - Instrumental conditions
   - Instrumental adjustments

19. As biological activity takes place in the sediment sample, it should be kept in cold storage in case further treatment is delayed. Considering many contradictory findings in the literature about loss of mercury by volatilization, it seemed appropriate to assess several methods of drying to see if there would be differences. We therefore designed an experiment for statistical evaluation of drying procedures of sediment for mercury determination. The experiment showed that minimum loss occurs when each sediment sample is thoroughly mixed, frozen and then lyophilized at 0.1 torr pressure for 48 hours. The lyophilized samples are sieved, and only the most dominant fraction of the study area taken for analysis.

20. In the case of fish, they should be prepared for analysis immediately after collection. It was found that freezing a fish prior to sample preparation may reduce metal concentrations in its tissues. Each specimen should be measured, weighed, dissected and frozen in containers prepared for lyophilization. It was also found that no mercury losses occur during lyophilization of marine biological samples. In order to be able to compare results, attempts should be made to achieve complete drying to ensure minimum variations in the fresh weight/dry weight ratio among different specimens of the same species. Our experiments showed that 24 hours are sufficient for the lyophilization of fish samples, and a safe 48 hours freeze drying procedure is recommended.

21. The benthic organisms have to be grouped into species, measured, weighed, washed, frozen and then lyophilized. The same drying experiment as that of fish was performed on two bivalve molluscs. The results are quite different from those of the fish. There is still a loss in weight after 48 hours of freeze drying, but after 72 hours the loss of weight ranged between 0.2-0.6%, and this period of drying is recommended for these species. The experimental results obtained show that evaluation of time is needed for each organism of study. For most efficient results, the mass of the sample before drying should range between 10-50 g, and the sample in the drying dish should be of a thin layer.

Chemical analysis

22. Determination of trace metal concentrations in sediments is an essential part of assessing the fate of heavy metals pollutants and establishing the biogeochemical cycle for each metal of interest. Each step, from the methodological to the analytical phase of the study, has to be carefully considered. It is well known that the metal concentration of sediments depends on the granular composition of the sample; higher concentrations are generally found in the finer-grained sediments. Therefore, it is very important that when comparing sediment samples, the same size fractions should be examined. It is necessary to perform granulometric analysis to define the principal size fraction in the areas of study. The principal granular fraction is then isolated and chosen for analysing metals within such a fraction.

23. Our experience showed that each fish specimen should be analysed individually. The use of composite samples may mislead the analyst in interpretation of the results, especially in fish from polluted areas. As far as benthic fauna is concerned, homogenization of the composite samples proved to be incomplete due to variabilities of tissue texture within the same organism. Therefore, it is recommended to digest the whole organism after lyophilization so that the concentrations that we would determine would be from the entire organism. Of course, this means that the size of every sample is limited by the size of the organism and the acceptable sample size limit of the teflon lined digestion vessels. As a result, we divide such an organism into several samples and take the mean reading of each digestion as the final result, or the 3 or 4 digestion vessels with the organism are combined and diluted to volume in one volumetric flask.

24. All analytical procedures have to be checked by analysing samples of reference standardized research materials. These samples should be prepared and analysed for trace metal concentrations in a similar manner to those of sediments, benthic fauna and fish, simultaneously with each batch of samples. A very important factor in choosing a method is the minimal possible handling of a sample and the minimum use of reagents for the analysis.

Conclusion:

25. From the preceding paragraphs, it is obvious that for a joint monitoring programme on the assessment and sources of pollution, methods should be standardized and tested in the participating laboratories. The effort should be channelled towards a coordinated programme for comparable data in a manner which makes it possible to solve mutual problems. It is of primary concern that the results must be expressed in a form which is meaningful to other workers. To utilize and coordinate the implementation of both ideas and solutions to endemic problems will take time and effort, but should prove possible.

26. Ms Nurit Kress followed by presenting the work carried out within the IMP relevant to heavy metals in biological material. She mentioned that at the beginning of MED POL Phase II, a gastropod, Arcularia gibbosula was shown to accumulate mercury at mercury-polluted stations in Haifa Bay, and was therefore chosen to serve as an indicator species. However, additional species of molluscs were also analyzed. From 1989, the Arcularia gibbosula disappeared from the control area as well as from Haifa Bay. This disappearance does not seem to be connected with pollution effects, but to natural occurring cycles. Concurrently, the relative frequency of the bivalve Mactra corallina increased in the studied area, showing that one must be aware of probable natural changes occurring in the environment and of the importance of choosing not only one species to serve as a monitoring species but various, representing different phyla.

27. Heavy metal content in shore and trawl fish were determined during MED POL Phase II. The monitoring of shore fish was introduced in the Israeli monitoring programme not as a UNEP requirement, but as a national need: a pollution hot spot for mercury was identified in Haifa Bay and detected only in shore fishes. Between 1979-1990, 280 specimens of Diplodus sargus (among other shore fish) and 121 specimens of Mullus barbatus (among other trawl fish) were analyzed.Significant differences in mercury levels between Diplodus sargus caught in Haifa Bay and those caught in other areas along the Israeli shore were detected. After pollution abatement measures were introduced, a decrease in mercury concentration was recorded in the specimens collected in Haifa Bay. The present levels of mercury are lower than the maximum permissible concentration for human consumption (1 $\mu g\ g^{-1}$ fresh wt), but are still elevated compared to those found in specimens from other areas along the Israeli coast.

In addition to the areal dependence it was found that mercury concentration in Diplodus sargus is size dependent, the larger the fish, the higher the mercury concentration found. Therefore, the comparison of mercury levels was performed on specimens of the same size or on normalized concentrations. Mercury and zinc levels in the trawl fish Mullus barbatus, a recommended MED POL monitoring species, were independent of location. The same was true for other trawl fishes analyzed. There was a marked dependence between mercury concentration in the muscle tissue and size of Mullus barbatus. Zinc (one of the essential metals) concentration in the muscle tissue was independent of size, and the frequency distribution showed that the mean concentration was between 4-5 $\mu g\ g^{-1}$ fresh wt.

28. General conclusions

a) Shore fish are more indicative of land based pollution because of the proximity of the pollution sources to the fish habitat.

b) Heavy metal levels (or other contaminants) may depend on the size of the organism and must be taken into account when comparing the levels in different specimens. The relationship may be positive (the larger the specimen the higher the concentration) or inverse (the larger the specimen the lower the concentration).

c) Determination of contaminant levels in the muscle tissue (or edible part) is sufficient when monitoring concerns only public health. In order to understand the mechanism of incorporation and accumulation of pollutants it is necessary to analyze different parts of the organism.

Sediments

29. Mr. Barak Herut of IOLR gave a presentation on trace metals in shallow sediments from the Mediterranean coastal region of Israel. He stressed that the Mediterranean coastline of Israel is an important resource for tourism and recreation and also in certain areas for fishing and aquaculture. Yet it is also subject to possible contamination from domestic and industrial wastes both directly and via the several rivers and streams which drain into the sea. Trace metal content of the sediments in the lower reaches of the rivers and streams and in the adjacent coastal marine areas was determined. The purpose was to determine which areas were contaminated by trace metals and which would therefore merit subsequent more detailed study. In addition to determining the trace metals, Hg, Cd, Cu, Pb and Zn which are potentially toxic contaminants, Fe and Al (partially) were measured as conservative trace elements. By considering the ratio of the trace metals to these conservative elements it is possible to differentiate the fraction of the trace metal due to anthropogenic input from the trace metals contained in the unpolluted fine grained fraction of the sediment. Using this procedure it is possible to identify environmental contamination and frequently also the sources of that contamination even where the overall level of contamination is low.

30. The main conclusions are:

a) No major contamination of Hg, Pb, Cu, Zn and Cd, was found at most of the stations along the coast. Contamination was found in the Kishon and Yarkon estuaries (Hg, Cu, Zn and Cd) derived from localized pollution associated with specific point sources;

b) At most of the rivers stations the levels of iron-normalized trace metals were above those at coastal stations and background sediments. Polluted effluents (that are the only permanent flows) from industries adjacent to the rivers are the main source for the contaminated sediments;

c) The Kishon and Yarkon rivers (that cross the two major populated areas in Israel (Haifa and Tel-Aviv)) contain the most polluted sediments. These pollutants reach the estuaries and are diluted rapidly to background levels seaward;

d) A general northward increase in normalized concentrations of trace metals was found along the coast (mainly for Pb, Cu, and Zn). This gradient could represent (i) mixing process between 'clean' Nile sands from the south and anthropogenic metals introduced by rivers and streams or via atmospheric transport and (ii) a natural trend due to changes in the mineralogical composition of the sediments along the coast.

Agenda item 6.3 - Utilization of data with particular reference to management decisions

31. Mr. Ellik Adler in introducing this agenda item said that raw data is hardly ever used by decision-making authorities. Data must be analysed, interpreted and presented in a manner so that administration can take decisions and actions without going into in-depth study of the raw data itself. Such analysis and presentation should be the role of the monitoring institution and/or scientific body before being reported to the authorities.

32. Most of the monitoring data, especially those of heavy metals, have been analysed and presented in the correct format either directly by IOLR reports, or by scientific papers published in scientific journals. The microbial pollution data and the atmospheric pollution data have not been treated in the same way, and data has only now been published. It is expected that once the data is transferred and stored in data-base formats, manipulation and analysis will be easier to perform, and thus data presentation will significantly improve.

33. Monitoring data was used in the following ways:

Scientific Purposes

- Establishment of natural background levels of contamination.
- Haifa Bay environmental capacity study.

Human Health

- Assessment of risks to health. (This information was added by Y. Cohen). The discovery of high concentrations of Hg in fish in Haifa Bay generated a ban on marketing these fish (Diplodus sargus) in 1980-81.

Environmentally Sound Management

- Decisions as to location, length, diffusion factors and design of marine outfalls of effluent discharge pipelines.

- Content, provisions and measures of permits for land-based discharges and dumping of industrial wastes.

- Decisions on the locations of sites for dumping contaminated dredged material.

Administrative Measures

- Microbial pollution data was used to detect failures in sewage treatment plants, and later for closure of polluted bathing beaches.

Effectiveness of Measures

- Microbial pollution monitoring data was used to evaluate effectiveness of criteria for bathing water quality. After studies and analyses, the national criteria was officially changed by the Ministry of Health (from 1000 F. coliforms in 100 ml of seawater to 400, with 200 as geometrical mean for the bathing season).

- Tar balls monitoring was used to assess effectiveness of oil pollution prevention and abatement measures.

34. Airborne pollution monitoring is now in its first stages. It is used for air quality control around power stations. The data will later be incorporated in models to determine the degree of atmospheric input into the Mediterranean Sea.

35. Mr. Cohen gave some examples of how the monitoring data have been useful. He mentioned, inter alia, the observation of a mercury hot-spot in front of a chloralkali plant which led to the discovery that there was a leakage in the treatment facilities of the plant.

Agenda item 6.4 - Achievement of IMP and MED POL objectives

36. The specific objectives set out by Israel in its heavy metals monitoring programme were:

a) Determination of natural background levels of heavy metals in the territorial waters area and their variability in space and time;

b) Identification of trends or changes in the distribution of the heavy metals in space and time and understanding the reasons for these changes;

c) Identification of sources of pollution of heavy metals, assessment of the ecological damages expected as a result of this pollution and of potential risks to public health.

37. After an extensive discussion it was agreed that all above objectives were achieved to a very large extent.

Agenda item 6.5 - Conclusions on the IMP

38. The Israel National Monitoring Programme (IMP) requires two more activities:

- A full, one-time study of all river mouth sediments; "screening" for organo-phosphorous and organo-halogenated contamination in order to verify the assumption that the organo-contamination is not a problem. This will be carried out during 1993.

- A serious, long-term monitoring of marine litter in the open sea and on beaches in order to quantify the phenomenon and to try to find ways to prevent or reduce the nuisance.

Agenda item 7 - Recommendations for IMP and MED POL

39. a) The Data Quality Assurance Programme should be more active and interactive eg. in the selection of standards;

b) MED POL monitoring should be divided into two levels; regional and national. Monitoring at the national level should concentrate on specific objectives selected according to local needs and conditions while monitoring at the regional level should concentrate on status and trends.

c) The MED POL programme should include a strong research component oriented mainly towards the design of improved monitoring strategy and interpretation of the monitoring resutls.

d) The MED Unit should exercise more control on the content of National Monitoring Programmes and should provide assistance only to agreed activities.

e) Monitoring, Research, Data Quality Assurance, Training, Assessment of loads and Development of common measures were put forward as possible components of the MED POL programme.

Agenda item 8 - Closure of the meeting

40. During the closing session the participants expressed the opinion that the meeting was a success and that it had given the opportunity for a very useful exchange of views on the Israeli Monitoring programme, the MED POL and on monitoring aspects in general. The Chairman expressed, on behalf of the MED Unit, his gratitude for the warm hospitality and informed the participants that a similar meeting will take place in another country next March.

ANNEX I

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ANNEX II

AGENDA

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4. Adoption of the agenda
5. New monitoring strategies
6. The Israeli monitoring programme (IMP)
   - 6.1 Development through the years
   - 6.2 Quality control, validation and management of data
   - 6.3 Utilization of data with particular reference to management decisions
   - 6.4 Achievement of IMP and MED POL objectives
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7. Recommendations for IMP and MED POL
8. Closure of the meeting

ANNEX III

LIST OF DOCUMENTS

1. Agenda of the meeting, UNEP(OCA)/MED WG.59/1

2. Contaminant monitoring programmes using marine organisms: Quality Assurance and Good Laboratory Practice. UNEP Reference Methods for Marine Pollution Studies no. 57.

3. Draft guidelines for monitoring chemical contaminants in the sea using marine organisms. UNEP Reference Methods for Marine Pollution Studies no. 6 (Draft).

4. Monitoring strategies of marine pollution by Michel Joanny. Paper presented at the Xth ICSEM/UNEP/IOC Workshop on Marine Pollution, Perpignan (18-19 October 1990).

5. Draft Paper on Monitoring Strategies and Objectives by G.P. Gabrielides.

6. Excerpts from GESAMP (1991). Global Strategies for Marine Environmental Protection. GESAMP Reports and Studies no. 45, pp.20-24.

7. Excerpts from the report of the ICES Advisory Committee on Marine Pollution, 1988. ICES Cooperative Research Report no. 160, pp.18-23.

8. Excerpts from the report of the ICES Advisory Committee on Marine Pollution, 1989. ICES Cooperative Research Report no. 167, pp.22-36.

9. Excerpts from the report of the ICES Advisory Committee on Marine Pollution, 1990. ICES Cooperative Research Report no. 172, Annex 3, pp.115-120.

10. Draft guidelines to be followed for sample collection, preparation and analysis of fish and shellfish in the context of the Joint Monitoring Programme. 8th Meeting of the Joint Monitoring Group (Paris, 24-27 January 1983). JMG 8/8/1 Add. 1-E.

11. Bibliography on statistical aspects of trend monitoring.