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MEDITERRANEAN ACTION PLAN

First Meeting of the Scientific and Technical Committee

Athens, 23-27 May 1988

REPORT OF THE WORKSHOP ON AIRBORNE POLLUTION OF THE MEDITERRANEAN SEA

(Belgrade, 10-13 November 1987)

In co-operation with :

WMO

UNEP

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BACKGROUND

It is now recognized that a substantial fraction of the contamination entering the ocean, and especially semi-enclosed seas, derives from sources located on land via atmospheric inputs. Contaminants of major concern are heavy metals and metalloids, petroleum hydrocarbons, chlorinated hydrocarbons and pathogenic microorganisms. In 1985 the GESAMP* Working Group No. 14 on the Interchange of Pollutants between the Atmosphere and the Oceans reviewed the information available for the Mediterranean Sea and concluded that for some elements, such as Hg, Cd, Pb, Cr, and transuranic elements, the atmospheric transport of contaminants is at least comparable in magnitude to riverine inputs into Mediterranean.

Since 1983 a number of research projects dealing with airborne pollution had been implemented in national institutions of the Mediterranean countries within a research component of the Long-Term Programme for Pollution Monitoring and Research in the Mediterranean Sea (MED POL-Phase II). Furthermore, the Fourth Ordinary Meeting of the Contracting Parties to the Convention for the Protection of the Mediterranean Sea against Pollution and its Related Protocols recommended that a pilot project on studying air pollutant deposition into the region and pollutant concentrations in air should be initiated in 1986 in as many countries as possible. According to the recommendation of the GESAMP Working Group No. 14 cadmium was selected as a pilot contaminant for the project and some WMO Background Air Pollution Monitoring Network (BAPMoN) stations were mentioned as possible sites for sampling.

To discuss preliminary results of the pilot project and relevant research and monitoring activities, and to elaborate detailed programme proposals and recommendations for future research and monitoring, a Workshop

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* GESAMP = IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution

on Airborne Pollution of the Mediterranean Sea was proposed to be held. The following topics were included into the scientific programme of the Workshop:

- atmospheric concentrations and deposition of pollutants in the Mediterranean: research and monitoring,
- modelling of air pollutant transport and deposition,
- development and testing of methods for sampling and analysis,
- assessment of airborne pollution load of the Mediterranean Sea and its coastal regions,
- methodologies for assessing emissions of important pollutants into the atmosphere from various types and groups of sources.

The Workshop took place in Belgrade, Yugoslavia, from 10 to 13 November 1987, at the kind invitation of the Federal Hydrometeorological Institute of Yugoslavia. It was attended by 32 participants from 10 Mediterranean countries. The representatives of WMO, UNEP (MAP) and IAEA were also present. A list of participants is given in Annex I.

1. OPENING OF THE WORKSHOP

Mr. I. Delijanic, Director Assistant of the Federal Hydrometeorological Institute of the Socialist Federal Republic of Yugoslavia and Chairman of the Local Organizing Committee chaired the opening session of the Workshop.

The Workshop was opened by Mr. A. Soudine, Scientific Officer, WMO, who welcomed the participants on behalf of the Secretary-General of WMO, noted the activities of WMO in studying marine environment pollution through the atmosphere and briefly outlined the events leading to the meeting and the importance of the airborne pollution problem in assessing and controlling marine pollution in the Mediterranean region. On behalf of the participants he also expressed thanks to the Federal Hydrometeorological Institute of

Yugoslavia for hosting the Workshop, for providing good facilities for the fruitful work and for the hospitality.

Mr. Lj. Jeftic welcomed all participants on behalf of the Executive Director of UNEP and stressed the importance of the assessment of the airborne pollution of the Mediterranean Sea. Monitoring of the pollution which reaches the Mediterranean Sea through the atmosphere is the fourth and last component of the pollution monitoring programme of the Mediterranean Sea to be developed since the monitoring of sources of pollution, coastal waters and open waters is already established.

Mr. Joze Roskar, Director of the Federal Hydrometeorological Institute, welcomed the Workshop participants and pointed out the historical importance of the Mediterranean region as the cradle of our civilization and the danger of the pollution of the Mediterranean Sea which is a shallow sea with only one opening in the Gibraltar Strait and its water renews only every hundred years. The problem is even greater taking into consideration the rapidly increasing number of inhabitants in the region and the threat to human health that this problem poses. After the UN Conference on the Environment in 1972 and Barcelona meeting in 1975 when the Action Plan for the Mediterranean protection was accepted, greater attention has been paid to this problem. UNEP and other specialized agencies of UN have prepared a master plan already applied in 83 laboratories in 16 countries which is known as the Long-Term Programme for Pollution Monitoring and Research in the Mediterranean Sea (MED POL). The periods of 1975 to 1980 and 1981 to 1990 have been marked by the First Phase of MED POL and Second Phase of MED POL respectively. He noted that Yugoslavia has played an active role in all the activities in the Region devoted to avoiding environment degradation as well as improvement of air and water quality. In accordance with this principle of preventing the adverse anthropogenic pollution impact on the Mediterranean Sea, the Federal Hydrometeorolotical Institute of Yugoslavia accepted the role of hosting this Workshop organized by WMO and UNEP with the conviction that it would offer the basis for future work in the form of its conclusions and proposals for further monitoring and research activities on the airborne pollution of the Mediterranean Sea.

Mr. Patrick Buat-Ménard, chairman of the Workshop, presented scientific topics to be addressed by the speakers. He stressed that the workshop was being held at a critical time for the future since the specific recommendations related to the pilot project on the transport of atmospheric contaminants to the Mediterranean Sea should be the major output of the meeting. Both coastal and basin-wide pollution should be considered, keeping in mind the need to combine modelling approaches and field experiments. He insisted on the need for the assessment of pollutant fluxes on a regional basis within the Mediterranean Basin and the need for long term time series measurements of high quality to take into account the expected spatial and temporal variabilities. He finally outlined that the pilot project should be realistic or in other words feasible with the available expertise, manpower and potential funding for the participants in the MED POL programme.

Mr. A. Soudine informed the meeting of the fortieth anniversary of the Meteorological Service of Yugoslavia which was established in 1947 and on behalf of the participants congratulated Dr. J. Riskar and his staff on this occasion and wished them all the best and every success.

Mr. M. Slavnic from the Federal Hydrometeorological Institute of Yugoslavia provided more detailed information on the programme of the Workshop and other organizational matters.

2. NOMINATION OF OFFICERS AND ORGANIZATION OF WORK

The meeting agreed that Mr. P. Buat-Ménard, chairman of the Workshop Committee, would chair the meeting and Mr. A. Palumbo and Mr. Z. Janjic as members of the Workshop Committee would assist him in chairing sub-sessions. Mr. A. Soudine acted as Technical Secretary and Mr. U. Dayan was invited to be Rapporteur.

The chairman explained the programme of work, the order and the time allocated for each presentation.

3. PRESENTATION OF PAPERS

A total of 14 papers were presented and discussed at the four sessions of the meeting. A list of the papers presented, and of their authors, is given in Annex II.

At the first session chaired by Mr. P. Buat-Ménard, the papers were discussed which dealt with field measurements of contaminants. The following results were presented: 1. On average amounts of dustloading in the Western and Eastern Mediterranean and Southern Adriatic, on concentrations of some trace metals and their average fluxes in the above regions, 2. On temporal variability and seasonal patterns of concentrations for elements of continental origin (both natural and anthropogenic), on relationship between concentrations and the frequency and amount of rainfall, on relationship between the mean ratio of high and low concentration periods and mass median diameter of the elements and on application of three-dimensional air-mass trajectories for identifying origin areas of the elements, 3. On geochemical study of atmospheric deposition in the North Western Mediterranean and influence of air mass origin on concentration of major ions and some heavy metals in precipitation, 4. On precipitation chemistry and contaminant concentrations in air for some monitoring stations along the Adriatic coast and in Italy.

The second session chaired by Mr. A. Palumbo was devoted to the development and application of laser techniques for the determination of air pollutant properties, and both short range (coastal) and long range (open sea) distribution of air pollutant concentrations all over the Mediterranean area with a fine vertical resolution, to the possibility to use lichens as bioindicators for assessing air pollution by chlorinated hydrocarbons.

Meteorological aspects and modelling of atmospheric transport of pollutants were discussed at the third session chaired by Mr. Z. Janjic. Results were presented on the collection and calculation of meteorological and climatological data required for modelling of air pollutant transport, on application of a three-dimensional (3-D) numerical mesoscale model for evaluating pollutant dispersion by land and sea breezes, and the use of a limited area model with step-like mountains for calculating 3-D and 2-D air-pollutant trajectories and on the development of a three-dimensional model for calculating and predicting pollutant concentration fields using a PBL (planetary boundary layer) formulation based on higher order closure assumptions.

At a short final session chaired by Mr. P. Buat-Ménard, two matters were discussed: the influence of mass-particle size distribution on the dry deposition and the results of ozone monitoring in the Adriatic and Aegean coastal regions. It was shown that large particles composing a small quantitative part of the total aerosol, determine to a large extent the dry deposition of sea-salt and mineral particles. For ozone, results were presented on high level ozone production in urban and industrial areas and its transport to and high concentrations in the air at remote sites.

4. SUMMARY OF THE SCIENTIFIC DISCUSSIONS RAISED DURING THE WORKSHOP

4.1 Field measurements of contaminants in the Mediterranean Sea

1. The Meeting agreed that although the most practical way to analyze the potential influence of air mass origin on concentration of major ions and some heavy metals in precipitation is by using air parcel trajectories calculation, this technique should be applied with care due to the necessity for a precise conjunction of these data with meteorological conditions mainly with the time of storm occurences.

2. Due to great concern for the quality of coastal and open Mediterranean waters and also to human life on coastlines, Workshop participants mentioned the necessity to investigate the transfer of contaminants from the sea to the atmosphere as well.

3. The Meeting stressed difficulties in applying typical loading values of the Mediterranean Basin by airborne contaminants due to high variability of concentrations exerted both in time and in space.

4. The Meeting, furthermore, discussed the evidence of presence of gypsum in Saharan sediments as detected in the Western Mediterranean region but not in the Eastern part and emphasized the lack of sufficient knowledge on the mechanism of the volcanic contribution to pollution loading in the Mediterranean.

5. The use of bioindicators such as lichens for distinction of atmospheric pollution was accepted to be very economically attractive but was questioned by some scientists due to incapability of their application during short pollution episodes.

6. The Meeting discussed the possible efficacy to implement new techniques and approaches for determination of air pollutant properties such as light scattering and others and stressed that such sophisticated techniques should be evaluated along their real potential for future application in the MED POL programme.

7. Complexity involved in flux calculation from the atmosphere to the sea was discussed by some participants in view of previously mentioned uncertainties in the rates of dry deposition. Therefore, it was agreed that results received recently on particle size distribution, which are believed to be of great concern to dry deposition rates, should be used to reevaluate dry deposition fluxes especially for some inorganic contaminants which affect marine fauna and flora in the Mediterranean Basin.

8. The Meeting stressed the necessity to measure wet and dry deposition separately in order to avoid contamination of wet samples mostly by alkaline materials during hazy weather conditions.

9. The Meeting also mentioned the important role of ozone to air quality deterioration and recommended a continuous monitoring of this contaminant which may also serve as a tracer, especially during the summer season.

10. The participants agreed unanimously that cruises provide very important information and, therefore, should be encouraged.

4.2 Meteorological aspects and modelling of atmospheric transport of contaminants

1. The Meeting discussed the appropriate parameters needed for modelling and concluded that differing data sets are needed depending on the scales of the processes considered and on complexity of the model used.

2. Concerning the horizontal scales, the participants have identified two main areas of interest:

- Local scales (in the order of 100 km) for simulation of coastal atmospheric conditions and
- Regional scales (in the order of 1000 km) for simulation of long-range transport (LRT) phenomena in the open sea.

3. Regarding a possible way to overcome the problem of scarcity of meteorological data above the Mediterranean Basin, the Meeting discussed two possible ways to obtain the data: one by using all existing meteorological records and the other by using comprehensive synoptic scale fine-mesh atmospheric models as 4-dimensional interpolation tools.

4. The most practical way to merge LRT model for the open sea with a sequential Eulerian model for coastal zones and estuaries was stressed by one of the participants who suggested that the best available routine observational data should be used to prepare adequate input

data sets for an LRT model to predict the flow configuration on each point grid of a fine mesh. The calculated results after validation could serve as higher resolution input values to sequential dispersion models for simulation of local scale effects such as recirculation of contaminants, weak frontal effects etc.

5. The Meeting suggested that a sequential Eulerian model should be used for simulation of selected worst cases of contaminant dispersion and transport over the Mediterranean Basin versus a climatological model that might be used on a seasonal scale.

6. The common opinion was to adopt as a beginning the most widely used approach in similar studies elsewhere in which simple single-layer Lagrangean models are applied.

7. Regarding the question raised about the most appropriate isobaric level for construction of the trajectories, a point was made by one of the participants explaining the rationale behind choosing the 850 hPa level. This level is believed to represent the intermediate level between surface winds and the geostrophic (frictionless) wind drift layer.

5. PROPOSAL FOR A MONITORING PROGRAMME ON AIRBORNE POLLUTION OF THE MEDITERRANEAN SEA

The Meeting recognized the importance of atmospheric transport of contaminants from diverse land-based sources to the Mediterranean region. Previous measurements have shown evidence that such a contamination may be of concern for the quality of coastal and open Mediterranean waters, marine life and human life on coastlines. The common opinion was expressed that over the last years research and monitoring activities on airborne pollution had essentially increased and were steadily developing. The Meeting agreed that a monitoring and modelling programme on pollutant transport to the Mediterranean Sea through the atmosphere should start as soon as possible.

The major goals of this programme should be the following:

- To evaluate the importance of the atmospheric transport and deposition of land-based contaminants to coastal and open Mediterranean waters;
- To assess the airborne contamination level of trace substances which can affect the quality of human life on coastlines;
- To identify sources and source regions for these atmospheric contaminants;
- To develop predictive models of the airborne contamination of the Mediterranean environment to provide the basis for future action.

The Meeting agreed that for an assessment of airborne pollution two horizontal scales have to be considered:

- local scale for impact studies close to "hot spots", i.e. large seaside cities and industrial sources,
- large scale for an evaluation of the level of contamination of open Mediterranean waters. This would require the implementation of selected permanent reference stations distant enough from local pollution sources. Such stations should be exposed most of the time to maritime air and could be located at remote coastal sites, on Mediterranean islands, and also on existing offshore platforms. Complementary information could be obtained during cruises on board research vessels.

Because of the expected temporal variability of atmospheric concentrations and fluxes of contaminants, any monitoring programme should be run continuously for several years. Furthermore, since the ultimate goal is to predict atmospheric contaminant inputs, a simultaneous effort should be undertaken to model the atmospheric transport and deposition of these contaminants at the different spatial scales considered. The models would be progressively calibrated using the data gathered from the field measurements.

5.1. MONITORING PROGRAMME

The Meeting discussed the chemical parameters to be measured as well as physical parameters necessary for the interpretation of the data. The list of these parameters is given in Annex III and consists of:

a) inorganic, organic and radioactive contaminants of concern for marine waters, marine life and human life along coastlines,
b) tracers of natural and anthropogenic sources,
c) meteorological parameters.

The following recommendations deal with standardized sampling and analytical procedures which should be adopted for the acquisition of high quality data for the monitoring programme.

5.1.1 Sampling procedures

- Sampling frequency

On the basis of the experience of previous monitoring programmes either on land or over other regional seas, the Meeting recommended that the sampling duration both for air and rain concentration determinations should not generally exceed one week. When feasible, higher sampling frequency, on a daily basis or even shorter, would be desirable for selected contaminants. This would allow the use of field data for model calibration exercises.

- Aerosols

In order to minimize sample and analytical contamination problems, the use of high volume aerosol filter samplers (as for the BAPMoN network) is recommended. The meeting recognized, however, that specific collection substrates have to be used to sample inorganic and organic contaminants. Based on presently available expertise and analytical difficulties, it is recommended that in the first phase of the monitoring programme, priority

should be given to the sampling of inorganic contaminants, including radionuclides. The following chemical parameters should be analysed:

- heavy metals: Cd, Pb first priority
  Cu, Zn second priority
- other inorganic elements indicators of natural and anthropogenic contributions: Na, Al, SO_4^{2-}
- radionuclides: ^{137}Cs, transuranic elements. Because of the very low levels of these contaminants, the analysis may require the use of composite filter samples integrating up to a month of sampling.
- organic species: PCBs, DDTs, HCHs (hexachlorocyclohexanes), PAHs and other particulate hydrocarbons.

When feasible, other possible parameters to be studied would be:

- elemental carbon, fluorides;
- heavy metals such as Hg, Sn, As, Se.

Furthermore, useful information on the particle size distributions of the atmospheric contaminants could be obtained through the use of high-volume cascade impactor samplers. This would allow to improve model calculations of dry deposition fluxes.

- Gas phase

Due to its importance in air quality and atmospheric chemistry, the Meeting recommends the implementation of continuous ozone monitoring during the summer season and, if necessary (e.g. at some impact or "hot spot" sites), throughout the year. This is particularly relevant for impact stations where expected high ozone levels may generate photochemical smog and influence the transformation of some organic compounds such as hydrocarbons.

- Atmospheric deposition

Owing to sampling difficulties, direct measurements of dry deposition for atmospheric contaminants cannot be considered as feasible at the present

stage in a continuous monitoring programme. The Meeting recommended to estimate dry deposition fluxes using aerosol concentration data and relevant deposition models to the sea surface.

Wet deposition (rain) should ideally be collected on an event basis. Owing to recent developments in instrumentation, it is recommended that a fully automatic device be employed, similar to that used in the BAPMoN network. The Meeting recognized, however, that rain collections on an event basis may not be feasible at all stations. It is therefore recommended that precipitation be collected on a weekly basis. When considering the various chemical parameters (see section on aerosols) to be measured, the Meeting recognized that for contaminants such as heavy metals and organic species the sampling protocols have to be different from the standard procedures used for major ions.

It is therefore recommended that 3 rain collectors be implemented at each station:

- one for pH, acidity, alkalinity, conductivity and major ions: the standard BAPMoN procedure is recommended;
- one for heavy metals and radionuclides: rain-collecting bottles should be preacidified;
- one for organic species: the collection surface should be made of stainless steel. The rain sample processing should meet the procedures adopted in MED/POL for organic species in seawater.

The Meeting recommends that first priority should be given to the implementation of two rain collectors, one for major ions and one for heavy metals and radionuclides.

- Meteorological parameters during the sampling periods

The Meeting recommended that the sampling sites should be located as

close as possible, or within a major meteorological station such as a surface synoptic station or a main meteorological station.

The sampling records should be accompanied by the records on the chronology of precipitation events that occurred during the sampling period. These records should include the beginning and ending times of the precipitation event as well as the information on intensity on preferably hourly basis.

In addition to this, the sampling records should be accompanied at least by the data on the wind speed and direction, air and sea temperature and humidity and other weather phenomena.

If these data are not available or representative from the nearby major meteorological station, they should be measured at the sampling site during the sampling periods.

5.1.2 Analytical procedures

The meeting recommends the use of the best available techniques either in individual laboratories or in central laboratories nominated by participating countries for conducting analyses within the programme. Such techniques can be found in WMO or UNEP reference handbooks which should be provided to the participating laboratories.

The Meeting recommended that intercomparisons and intercalibrations of analytical methods be carried out. These exercices could be coordinated by various host countries or international organizations.

5.1.3 Data reporting and exchange of information

The Meeting recommended that monitoring data from background stations should be reported on weekly-averaged basis for precipitation chemistry and on daily basis for pollutant concentrations in air (particles). The

corresponding formats, based on the existing WMO BAPMoN formats, are given as Annexes IV and V. The annual national data reports should be sent to the Co-ordinating Unit for the Mediterranean Action Plan (MED Unit) not later than 1 March of the following year. Copies of all national reports would be sent then to WMO co-ordinating these activities within MED POL. At the beginning of the monitoring programme implementation the WMO BAPMoN Data Centre (National Climatic Centre, Asheville, N.C., USA) could be used for preliminary treatment and storage of the data. Otherwise a regional data centre should be nominated for this purpose.

National reports from impact stations containing generalised results should also be sent to the MED Unit annually by 1 March of the following year.

It was recognized that review reports on national activities relevant to the study of airborne pollution of the Mediterranean Sea (including information on national projects and programme, laboratories and their potentialities and needs, scientists involved in studies, cruises, meetings, etc.) could be very useful for further planning and co-ordination of the programme. This information should be collected as soon as possible by the MED Unit and WMO through the National Co-ordinators for MED POL and then up-dated annually.

The Meeting recommended that countries who joined the programme should nominate one or several monitoring stations for the programme and report information on the stations to the MED Unit using the format given in Annex VI.

5.1.4 Assistance and training

The Meeting recommended that mutual bilateral and multilateral assistance in programme implementation should be encouraged through consultant services, joint cruises, on-job training, etc.

Furthermore, the Meeting was of the opinion that sampling equipment and analytical instruments available in national institutions willing to participate in the monitoring programme could be insufficient for the implementation of the programme to the needed extent. In this connexion it was emphasized that assistance should be provided to the participating institutions to get necessary sampling equipment using funds available for the monitoring component of MED POL.

It was also recommended that the WMO training courses on background air pollution measurements held every year in English or in French should be used for training as fully as possible. WMO was invited to provide information on the courses regularly and well in advance.

5.1.5 Emission inventories

The Meeting expressed the view that gathering and compilation of emission data for selected pollutants are the important prerequisite of reliable model calculations. The collection of emission data should be initiated as soon as possible using common methodologies which should be prepared by a consultant in line with the LBS Protocol.

5.2. PROPOSAL FOR A MODELLING PROGRAMME

5.2.1 General

Concerning the horizontal scales, two main areas of interest were identified. These are:

- Local scales (in the order of 100 km); and
- Regional scales (in the order of 1000 km and more).

Both of these areas require international cooperation, coordination and data exchange.

On both scales, two separate problems should be addressed. These are:

- Emission, horizontal and vertical diffusion, transformation, dry and wet deposition rates, and
- Meteorological driving parameters.

5.2.2 Pollution emission, transport, diffusion, transformation and deposition

The common approach to similar studies elsewhere is the use of simple single-layer Lagrangean models. The Meeting noted with satisfaction, however, that primarily due to improved computational resources, and better understanding of the processes involved, more sophisticated and potentially more powerful Eulerian models including those based on higher order closure hypotheses and more appropriate treatment of orography are becoming available in the scientific community and in the weather services in the region. The Meeting recommended that further research using both approaches be encouraged.

The Meeting recognized that in order to apply and verify such models, the observed data on pollution, concentration and deposition should be available on various spatial and temporal scales. The Meeting also agreed that high quality information on concentration fields is necessary. This information can be obtained by direct measurements and as output from forecasting models fed with data on pollution sources. In this connection, it is essential that an inventory of the pollution sources be made, preferably by an independent contractor or by national authorities using common methodologies.

5.2.3 Meteorological driving parameters

Meteorological parameters are needed on various spatial and temporal scales depending on the scales of the processes considered, and on the complexity of the model for simulating the transport, diffusion, transformation and deposition of the pollutants.

The Workshop stressed the need for appropriate treatment of specificities of PBL over the sea. Possible sources of observational data are the ALPEX and the Med Alpex data sets and the WMO sponsored compilation of meteorological data above the Mediterranean region by Dayan and Miller (in press). In this connection, it is important to improve our knowledge of the processes at the sea-air interface by means of theoretical as well as more detailed observational studies. Two possible ways to obtain the relevant meteorological data have emerged. One is to use the existing meteorological records in order to identify predominant weather patterns in the region, or in the local areas, and to estimate the pollution transport and deposition on the basis of the data obtained in this way. The other possibility is to use comprehensive synoptic scale fine-mesh atmospheric models as 4-dimensional interpolation tools. Both approaches have advantages and disadvantages and require further research.

The main advantage of the models based on climatological data is their simplicity and relatively low computational cost so that they can be used to obtain qualitative answers relatively quickly

On the other hand, having in mind the lack and/or scarcity of observed meteorological data particularly over the sea, the approach based on model synthetized data may provide better insight into the relevant processes. The data produced by the model can be used to study the pollution propagation in the atmosphere on various scales either by coupling a model for transport, diffusion, transformation and deposition directly to the model used for 4-dimensional interpolation, or to drive finer mesh models on local scales. This approach is particularly interesting because it can form a basis for developing a forecasting capability.

Having all this in mind, the Meeting recommended:

- that information on available data and models be collected;
- that all available means be used to specify the meteorological data needed without further delay;

- that, in the longer run, research should be supported aimed at 4-dimensional model interpolation with the possibility of coupling the sophisticated pollution transport, diffusion, transformation and deposition models with the ultimate goal of developing a forecasting capability for the Mediterranean region.

- that a meteorological institute in the region should be nominated to co-ordinate modelling activities, to collect relevant data and to make (in future) model calculations of air pollutant transport and deposition for the whole region.

5.3 Co-ordination and programme implementation monitoring

For better co-ordination and monitoring of implementation of the proposed programme the Workshop recommended that an Ad Hoc Expert Group on Airborne Pollution of the Mediterranean Sea be established and National Co-ordinators for MED POL were invited to inform the MED Unit and WMO about the names of the designated experts. It was assumed that the Ad Hoc Expert Group would work by correspondence, at least until the next workshop. Mr. P. Buat-Ménard, Chairman of the Workshop Committee, was proposed as the Chairman of the Group.

It was also recommended that the Second Workshop on Airborne Pollution of the Mediterranean Sea should be held at the end of 1989 to consider first results of the monitoring and modelling programme on transport of pollutants to the Mediterranean region through the atmosphere and implementation of the recommended research activities, and to clarify monitoring programme requirements.

6. ADOPTION OF THE REPORT AND CLOSURE OF THE WORKSHOP

A draft report of the Workshop was unanimously adopted and the WMO representative was requested to finalize it, taking into account comments made by the participants as soon as possible after the meeting.

All the participants thanked the Federal Hydrometeorological Institute of Yugoslavia for hosting the Workshop and providing excellent facilities for fruitful work, as well as for the warm hospitality extended.

The Workshop was closed at 12.30 on the 13th of November 1987.

ANNEX I

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ANNEX II

List of papers presented

1. F. Dulac, P. Buat-Ménard, U. Ezat, S. Melkl, G. Bergametti. Influence of mass-particle size distributions on the dry deposition rates of atmospheric trace elements over the western Mediterranean Sea.

2. S. Guerzoni, R. Lenaz, G. Quarantotto. Trace metals characterization of airborne particles from different Mediterranean areas.

3. V. Djuricic. Some characteristics of air and precipitation chemistry of selected stations along the Adriatic coast.

4. L. Cruciani. Review of chemical data by the Italian Meteorological Service.

5. J. Morelli. Time variability of the atmospheric input in the north-western Mediterranean basin.

6. G. Bergametti, E. Remoudaki, A. Dutot, P. Buat-Ménard. Factors influencing the seasonal variability of the elemental composition of atmospheric aerosol particles over the north-western Mediterranean.

7. T. Cvitas, L. Klasinc. Tropospheric ozone production and transport in the Mediterranean.

8. U. Dayan, J.M. Miller. Meteorological and climatological data for the assessment of atmospheric transport of pollutants in the Mediterranean basin.

9. Z. Janjic, F. Mesinger, S. Nickovic, B. Rajkovic. Synoptic-scale transport of passive substances and its model simulation over European region.

10. M. Ivanovic. Mathematical model of unsteady diffusion of pollutants over complex terrain.

11. E. Wakshal, I. Mahrer. Assessment of atmospheric pollution sources of the eastern Mediterranean Sea and its coastal area of Israel.

12. A. Nejjar. Application of light scattering techniques to the determination of air pollutants properties.

13. J.P. Villeneuve. Use of lichens as bioindicator for atmospheric pollution by chlorinated hydrocarbons.

14. G. Cali, A. Palumbo. Remote sensing of airborne pollution over the Mediterranean Sea.

ANNEX III

List of recommended parameters

Precipitation	Routine programme	Extended programme
pH	+	+
Conductivity	+	+
Acidity	+	+
Alkalinity	+	+
SO_4^{2-}-S	+	+
NH_4^+	+	+
NO_3^--N	+	+
Na	+	+
K	+	+
Mg	+	+
Ca	+	+
Cl	+	+
Cd	+	+
Pb	+	+
Cu	+	+
Zn	+	+
Radionuclides	-	+
Organic compounds	-	+
Precipitation amount	+	+
Particles		
SO_4^{2-}-S	-	+
Na	-	+
Al	-	+
Cd	+	+
Pb	+	+
Cu	-	+
Zn	-	+
Radionuclides	-	+

List of recommended parameters

(continued)

	Routine programme	Extended programme
Organic compounds	-	+
Total SPM	+	+
Air volume	+	+
Gas		
O_3 *)	+	+
Meteorological parameters		
Wind speed	+	+
Wind direction	+	+
Air temperature	+	+
Sea surface temperature **)	+	+
Dew point	+	+
Relative humidity	+	+
Barometric pressure	+	+

*) at impact stations

**) when applicable

Weekly Precipitation Data Form

MAIL TO:

2 1 Agency

Station name

Site Address

Country Area Site
2 3 4 5 6 7 8 9 10

Agency Project Time
0 11 0 12 13 14

Sample start day → Year 15 16 Month 17 18 Day 19 20

Have siting criteria changed? Yes ☐ No ☐

Parameter Name	Method	Units		Parameter Code	Method	Units	DP		Value
Precip (NG)	Volumetric	mm	(23-32)	655301	71	29	0	(33-36)	
Precip (SG)	Volumetric	mm	(37-46)	655301	81	29	0	(47-50)	
pH	Glass Electrode	pH	(51-60)	655302	81	61		(61-64)	
Conductivity	Cond. Cell	µS/cm	(65-74)	655303	81	69		(75-78)	

Parameter Name	Method	Units		Parameter Code	Method	Units	DP		Value
Na		mg/l	(23-32)	655311		62		(33-36)	
K		mg/l	(37-46)	655312		62		(47-50)	
Mg		mg/l	(51-60)	655313		62		(61-64)	
Ca		mg/l	(65-74)	655314		62		(75-78)	

Parameter Name	Method	Units		Parameter Code	Method	Units	DP		Value
Cl		mg/l	(23-32)	655316		62		(33-36)	
NH_4-(N)		mg/l	(37-46)	655318		62		(47-50)	
NO_3-(N)		mg/l	(51-60)	655321		62		(61-64)	
SO_4-(S)		mg/l	(65-74)	655322		62		(75-78)	

Parameter Name	Method	Units		Parameter Code	Method	Units	DP		Value
Acidity	Alkaline Tit.	µeq/l	(23-32)	655330	81	67		(33-36)	
Alkalinity	Alkaline Tit.	µeq/l	(37-46)	655331	81	67		(47-50)	
			(51-60)					(61-64)	
			(65-74)					(75-78)	

Parameter Name	Method	Units		Parameter Code	Method	Units	DP		Value
Cd		µg/l	(23-32)	655332		63		(33-36)	
Pb		µg/l	(37-46)	655337		63		(47-50)	
Cu		µg/l	(51-60)	655333		63		(61-64)	
Zn		µg/l	(65-74)	655338		63		(75-78)	

*(NG) Denotes National Gauge
(SG) Denotes Sampling Gauge

DAILY DATA FORM

MAIL TO:

24-hour or greater sampling interval

2 (1)

Agency

Station name

Site Address

Area Site (2 3 4 5 6 7 8 9 10)

Agency (11) Project (12 13) Time (14) Year (15 16) Month (17 18)

Q | 0

Time Interval

	PARAMETER SPM	PARAMETER Cd	PARAMETER Pb	PARAMETER
NAME PARAMETER CODE	1 1 1 0 1 (23 24 25 26 27)	(37 38 39 40 41)	(51 52 53 54 55)	(65 66 67 68 69)
Method	7 5 (28 29)	(42 43)	(56 57)	(70 71)
Units	0 1 (30 31)	(44 45)	(58 59)	(72 73)
DP	(32)	(46)	(60)	(74)

Day (19 20)	St (21)	Hr (22)	SPM (33 34 35 36)	Cd (47 48 49 50)	Pb (61 62 63 64)	(75 76 77 78)
01						
02						
03						
04						
05						
06						
07						
08						
09						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
DP =			4 3 2 1 0	4 3 2 1 0	4 3 2 1 0	4 3 2 1 0

Enter Local Standard Time, 24 hour clock

ANNEX VI

BACKGROUND INFORMATION ABOUT EACH STATION

Name of the station: _____

Responsible national institute: _____

Full address: _____

_____

Country: _____ Tel. No.: _____

Latitude: _____ Longitude: _____

Elevation: _____

Distance from the nearest meteorological station: _____

Surrounding area (agricultural land, forest, important sources, etc., if possible. If the monitoring station is within a monitoring network, this should be indicated): _____

_____

_____

_____

_____

_____

Monitored parameters: a) at present _____

_____

b) being planned _____

_____

_____

Available equipment: a) for sampling _____

_____

b) for analysis _____

_____