Intergovernmental Oceanographic Commission
Workshop Report No. 70

IOC-SAREC-UNEP-FAO-IAEA-WHO Workshop on Regional Aspects of Marine Pollution

Mauritius, 20 October- 9 November 1990

SC-9 1 /WS-49

UNESCO

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SUMMARY REPORT

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1. OPENING

The workshop was opened by the Minister of Environment and Land Use, Mr. S. Kasenally, on 29 October 1990 at 10 a.m. at the Mahatma Gandhi Institute .

In his speech, the Minister highlighted the importance that Mauritius attaches to the conservation of its marine resources, the pressing need for developing a resource base for proper environmental management and sustainable development, and expressed his hopes that the Workshop could assist in these tasks.

The Director of the Meteorological Services, Mr. Y. Valadon, addressed the audience as Representative of the Local Organizers, and described the background for the involvement of the Meteorological Services in the workshop, based on its status as Representative of Mauritius at the Second Session of the IOC Committee for the Cooperative Investigation in the North and Central Western Indian Ocean in Tanzania in 1987.

The Representative of UNEP, Mr. M. Gerges, addressed the audience on behalf of the co-operating United Nations Agencies in the East African Action Plan. In his speech, he described the Regional Seas Programme of UNEP, and focussed on the developments of the Action Plan for East Africa which had led to the convening of the workshop.

The Representative of IOC, Mr. J. Karker, in his statement highlighted the encouragement derived from the involvement of the Swedish Agency for Research Cooperation with Developing Countries (SAREC) in Eastern Africa, and acknowledged their generous support for the workshop which had made its organization possible.

2. INTRODUCTION TO THE WORK PROGRAMME OF THE WORKSHOP

Mr. J. Karker welcomed the participants, reviewed briefly the circumstances which had led to the convening of the Workshop, and introduced the overall Programme for the two weeks to come. He emphasized that the workshop was an innovation in that it was attempted for the first time to combine two workshops with different perspectives into one, and it was hoped that this approach would be able to meet its expectations.

3. ELECTION OF OFFICERS

Mr. W. Kudoja was unanimously elected as Chairman of the Workshop, and Mr. P. Kallee was unanimously elected as Rapporteur.

4. THE UNEP REGIONAL SEAS PROGRAMME

Mr. Gerges introduced the history and evolution of the Regional Seas Programme and the Programmes of the Eastern African Action Plan in particular, and described the development of the approach used in the EAF/ 6 project from the experiences gained from other UNEP Regional Seas Action Plans, notably the

Mediterranean Action Plan and the West And Central African Action Plan. In the latter, initially monitoring had been carried out extensively, but had not produced results to justify the resources which had been necessary. A large amount of data had been generated, but little remedial action could be inferred from them.

5. REFERENCE METHODS AND REFERENCE MATERIALS

Mr. J. Karker then presented the objectives and background of the reference methods for regional and global marine pollution assessment, developed by UNEP in co-operation with IOC, IAEA and with the support of a number of other United Nations agencies.

The presentation was based on a special issue of the reference methods entitled "Reference Methods and Materials" - a Programme of support for regional and global marine pollution assessment, which was later copied for distribution to the participants.

He emphasized the importance of these methods for the EAF /6 project, as they would be a major remedy towards achieving intercomparable data on a regional scale.

The methods described in the series could best be characterized as the Best Available Technique, as determined by reliability, cost, serviceability of required equipment and sufficient accuracy.

The use of certified reference materials and internal reference materials were then described, together with the main areas of application covered by the present selection of reference methods. Information was given on the established procedures for the development, regular updating and improvement of the reference Methods, based on the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration (GEMSI), the IOC-UNEP-IAEA Group of Experts on Standards and Reference Materials (GESREM) and the IOC-UNEP-IMO Group of Experts on Effects of Pollutants (GEEP).

6. THE EAF/6, MODALITIES OF EXECUTION AND DATA MANAGEMENT

The Project Co-ordinator, Mr. T . Orekoya, provided additional information on how to go about the practicalities in the execution of the project, and the system of reporting that would be employed.

Several participants took the opportunity to inquire about issues of importance to their particular situation, especially the allocations for equipment within the project as well as problems in relation to meeting local running expenses.

In his response, Mr. T. Orekoya emphasized the need for the cooperating agencies to receive from the participants identification of their needs, so as to allow the available funds to be put to the best use. He also stressed that the funds available were limited, and that basic running expenses were expected to be covered through the normal running of the laboratories.

7. ECOTOXICOLOGY AND ENVIRONMENTAL ASSESSMENT

In the introductory lecture, it was explained what was the objectives of the lectures and the exercises that would be carried out during the first week. Subsequently, the history of the development of environmental toxicology as a tool for decision makers was reviewed, and an introduction made to some of the basic concepts of toxicology. The aim of the introduction was to provide the participants with the mental framework of this type of approach.

After this introduction to ecotoxicology and assessment of effects of pollutants in the marine environment, lectures were given covering the fields of basic principles of estimation of land-based sources of pollution, basic concepts of environmental quality in relation to baseline studies on land based sources, basic principles of sanitary engineering in relation to wastes from domestic, agricultural and industrial activities.

The participants were then introduced to the concept of fugacity as a means for preliminary prediction of the fate of organic chemicals in the environment according to their physico-chemical properties.

8. EXERCISE: COMPUTATIONS BY PARTICIPANTS OF FUGACITY OF SELECTED MOLECULES

This involved practical exercises in calculation of the percentage distribution of some non-dissociated organic substances in different compartments of the ecosystem based on Mackay's fugacity model.

The exercise focussed on the following compounds: Atrazine, Carbofuran, Diuron, Naphthalene, Permethrin and Azinphos-methyl. The physicochemical characteristics used were as follows:

Name	Mol. Wt.	Vap. Press. (mPa)	Water Solub. (mg.l-1)	Log Kow
Atrazine	215.7	0.04	30	2.4
Carbofuran	221	2.7	700	1.6
Diuron	233	0.097	42	2.5
Naphtalene	128	12,000	14	3.29
Permethrin	391	0.045	0.2	6.67
Azinphos -methyl	317.1	0.5	20	2.7
Glyphosate*	169.1	0.0	$12X10^{-3}$	-1.25

* Glyphosate is strongly dissociated in water, and for this reason, cannot be subjected to the Mackay model to determine its natural compartment.

The exercise yielded the following results for the percentage distribution of the compounds in the various compartments of the Mackay model, here a version of the model modified to include vegetal biomass.

Name	Air	Water	Soil	Sed.	S.S	Aq.B	Veg.B
Atrazine	.0094	94.27	2.82	2.63	.0044	.0021	0.275
Carbofuran	.029	98.95	0.47	0.44	.0007	.00005	0.113
Diuron	.017	92.90	3.49	3.26	.0054	.00025	0.315
Naphthalene	99.99	-	-	-	-	-	-
Permethrin	.027	0.091	50.85	47.46	.079	.0085	1.51
Azinphos-m.	.244	89.06	5.31	4.95	.0083	.0035	.413
Atrazine **	.04	66.3	31.2	1.3	.06	.006	1.14

** Postulated Atrazine behaviour in a real-life situation (where the water compartment is represented by the quantity of rain only) when applied at the rate of 1 kg.ha-1.

The implications of the percentages in the different compartments were explained to participants, emphasizing the error which might arise from a too-literal interpretation of the figures. It was thus explained why other factors, such as the persistence of the compounds, the physical environment in which they are found (e. g. a compound which main form of transformation is photodegradability is likely to persist for a long time if it tends to go to groundwater), or time of application (dry or wet season), need to be taken into consideration in determining -the final fate of organic compounds in the environment, and whether or not they are likely to pose hazards to aquatic life in the coastal and marine environment.

The Mackay model was also applied to atrazine in a real part of the world (as opposed to the unit of Mackay's world of 1 km3) where the water compartment was taken out, and the results explained.

It was stressed that the use of Mackay model and Fugacity calculation should not be substituted for actual field measurements, but could be used as a guide to a more rational and precise monitoring Programme. A draft guideline for the preparation of assessment documents was distributed at the workshop.

9. REVIEW OF BACKGROUND DOCUMENTATION FOR THE CASE STUDY ON THE PORT LOUIS HARBOUR

Mr. T . Orekoya reviewed the available background documentation for the case study which had been collated by officers from the Ministry of Environment and Land Use. The participants, working in groups, then utilized the information for computing a preliminary assessment of the pollution load in the harbour and in the adjacent river basin.

10. EXERCISE: PRELIMINARY ASSESSMENT OF POLLUTION LOAD

The procedural steps used for the case study were as follows:

(i) description of the harbour and basin and the activities which may influence the quality of its environment, i. e. a qualitative assessment;

(ii) preliminary assessment of the sources, amounts and effects of pollution problems of the harbour and adjacent river basin, i.e. a quantitative assessment;

(iii) preliminary assessment of the most vulnerable target systems;

(iv) preliminary proposal for preventive, remedial and/or control measures;

(v) proposed workplan for a monitoring/research Programme for a finite period (12 months).

The following factors were focused on in respect of the basin (also applicable to the island as a whole):

a) organic load from urban and industrial discharges,
b) industrial chemicals and their usage, including dyes
c) agricultural chemicals and fertilizers the concept of zones at risk (e.g. coral reefs)
d) the pollution problems posed by sugar processing and refining factories .

In the preliminary assessment, the major sources of potential pollution to the harbour were identified as follows, based on the information available in the case study materials:

> domestic sewage, surface run-off, contributions of the Grand River North West, leachates from solid wastes dumps (garbage heaps), agricultural wastes from land use in the basins of the tributaries of the Grand River North West, industrial wastes from the textile industries which are connected to the sewerage system of Port Louis, -and the dyes used in the textile industries.

Since the greater part of Port Louis (more than 80%) is connected to a sewerage system which has three outlets discharging their untreated wastes beyond the reef, the contribution of domestic sewage to the pollution problems of the harbour was expected to be small. However, the BOD5 load was calculated in order to show how to incorporate such contributions in the overall scheme of calculation of land-based sources of pollution.

The surface run-off from the main Port Louis basin, the solid waste discarded in to the drainage channels, and the leachates from uncollected solid waste heaps within the urban limits of the city, were considered potential sources of pollutants to the harbour, and calculations made for these in the final estimate of the load of pollutants. The estimated BOD5 of the water in the harbour, taking into consideration all sources as determined from the case study background materials varied from 2-3 mg.l-1, which level was not considered greatly polluted for such a body of water. The Grand River North West, which drains into Grand River Bay adjacent to the Port Louis harbour was considered fairly polluted, with a higher BOD5 which varied from 18-25 mg.l-1, contributed mainly by urban and rural sewage in the basin. The wastes generated by ships in the harbour were not included in the calculations due to insufficient data on the total tonnage turnover in the harbour, even though there were no reception facilities for wastes in the harbour. The visual inspection of the harbour water, done after the above figures were arrived at, indicated that the water was unpolluted. It was recognized

however, that a vital component of such studies had not been done; it is necessary to relate findings to the oceanographic and meteorological factors which would influence the water exchange of the harbour with the open sea, and use these factors to do a more refined hazard assessment. Such factors as currents, wind direction, salinity and tidal cycles need to be studied in- order to determine the fate of the pollutants in the immediate environment of the harbour and the lagoons behind the coral reefs.

In making the calculations, it was necessary to consider compounds which are used industrially and which have been reported to have toxic effects to various organisms.

The behaviour in the aquatic medium of Chromium, a constituent of the chromates used in textile dye industry, was discussed. The discussion examined the behaviour of chromium in freshwater, as opposed to brackish and marine water environment, and showed that, at the existing level of use and considering the amount estimated to arrive in the coastal and marine zone, Chromium salts did not pose a hazard to the marine ecosystem. However, where dye industries are not connected to the sewerage system and depend on absorption pits for disposal of their wastes, there would be potential danger due to contamination of groundwater. The behaviour of other inorganic compounds such as ammonia and formaldehyde were also discussed along the same lines as Chromium. The conclusion was that, because of their very high tendency to be transformed in the aquatic medium, the danger posed by the concentration in the industrial wastes of these compounds were relatively small (except in the immediate vicinity of their sources), and unlikely to pose problems for the coastal and marine environment, whose health is the primary concern of the project.

On the basis of information on quantity imported into the country, about ten pesticides were considered to determine what would happen to them in the environment - i.e. their environmental fate. The estimation of the potential environmental distribution of the chemicals was done based on factors such as their biodegradability, big- accumulation and toxicity, as well as the problems of human toxicity and the presence of impurities in the pesticides. On the basis of the workshop exercise the opinion was that the agricultural pesticide use in the basins drained by Grand River North West and its tributaries did not constitute a problem to the coastal and marine environment at the present, but might constitute one to the ground water. The example was given of 2,4,5-trichlorophenoxy acetic acid (2,4,5-T), a herbicide which cannot be produced in sufficiently high purity to get rid of the highly toxic dioxins that are the by-products of the synthesizing process of 2,4,5-T. For this reason, the use of the compound has been banned in a number of countries.

Areas of the coastal environment potentially at risk were considered in relation to the island as a whole. The sea will rapidly dilute even discharges with high BOD5 content. However, during periods of draught and low waters, the diminishing dilution factor may lead to increased concentrations of effluents, with potential impacts on coral reefs. Thus, it was considered that the outfalls within the reef should be monitored closely. It was also recommended that the sewerage outlets beyond the reef be monitored regularly in relation to the potential danger posed to the coral reefs and the marine ecosystem.

With regard to the textile industry, the organic and inorganic load generated by the factories were examined and considered not very significant, partly because of the nature of the substances (quality) and partly because most

of those in the basin under consideration were connected to the sewerage system and contributed only a small fraction of the overall waste. However, there was not enough information on the different dyes used by the industry in Mauritius for an assessment to be made on the potential hazard posed by them. Indication was given to participants at the workshop as to where to get such information on the properties and rates of use of different dyes, and their relative toxicity to different groups of animals.

11. ENVIRONMENTAL PROBLEMS RELATED TO SUGAR CANE PROCESSING

A separate session was held on the problems posed by sugar and the processes of refining it. The lectures described the different stages involved in the refining of sugar, from field harvest to production of sugar, elaborating the wastes that occur at each stage, and the types of solution proposed for each. It was shown that BOD5 of the cane wash water, the waste water resulting from lime treatment and water used for washing of equipment and floors were very high and their disposal could constitute a problem where such wastes are not connected to a sewerage system, but disposed of in absorption pits. The solid trash usually contains a lot of nutrients, including lime, nitrates and phosphates. If such wastes are not disposed of properly, they may cause problems in estuaries and coastal environments.

12. INTRODUCTION TO PHYSICAL OCEANOGRAPHY

The lecture addressed the theoretical and procedural aspects of the physical oceanographical factors to be taken into consideration when confronted with the task of identifying a suitable discharge point in the nearshore or coastal waters for unwanted wastes, including the basic coastal dynamics that are to be considered -when shoreline stability problems are to be examined apart from oceanography in general and turbulence, notably mixing and dispersion.

The lecture emphasized the need for monitoring of basic environmental parameters for considerable time in the form of collection of field data, especially stratification and shear in the advective (horizontal and vertical) field. The guiding factor - the Richardson number - estimation has also been outlined. In addition the philosophy behind working out the wave refraction - an index to examine the stability of the loose/unconsolidated sediment deposits in the form of beach - was presented, together with the essential theoretical considerations .

13 INTRODUCTION TO THE CHEMICAL PROPERTIES OF SEA WATER, THEIR RELATION TO MARINE POLLUTION AND DEMONSTRATION OF A PC BASED MODEL OF WATER CIRCULATION

The introduction covered some of the basic concepts of chemical oceanography, in particular the chemical properties of sea water, and its interrelationship with marine phytoplankton. Special emphasis was given to the processes of oxidation of organic matter in the oceans. Theoretical aspect and reactions during the analysis of some of the contents in seawater were also presented. These included dissolved Oxygen, Phosphate-Phosphorus, Nitrate Nitrogen and Nitrite-Nitrogen. Emphasis was placed on the importance of

conducting inter calibration.

A data series on temperature, current speed and direction obtained in the form of a time series observation was run on a PC to demonstrate the type of information to be extracted towards solving problems of discharge of effluents from land based sources.

14 FIELD WORK: DEMONSTRATION OF EQUIPMENT USED IN PHYSICAL OCEANOGRAPHICAL STUDIES, AND SAMPLING IN THE HARBOUR OF PORT LOUIS, FOLLOWED BY LABORATORY WORK, DETERMINATION OF NUTRIENTS AND OXYGEN IN SEA WATER SAMPLES

In the field work sessions, the use of Nansen bottles, current meters and sediment samplers were demonstrated.

Samples were collected at six stations in the harbour area and in the adjacent Grand River Basin. Three stations were taken as a transect from the thermal power plant across the mouth of the Grand River, one at the Fairway buoy to serve as a reference, and two in the harbour itself . Samples were collected with a Nansen bottles and fixed for dissolved oxygen on board using reagents which had been prepared the day before by some of the participants. The samples were subsequently processed in the laboratory.

15 DATA PRESENTATION AND CONCLUSIONS

The data, attached to this report as Annex V, were presented by Mr. Othman. The values of all nutrients were high, the oxygen content low, in one instance (in the inner part of the harbour) alarmingly low.

Although the number of stations monitored did not allow for derisive statements to be made, the results showed little consistency with the expectations derived from the preliminary assessment previously carried out, the field results suggest that mitigating action would be required without delay.

It was thus agreed that the field work exercise had demonstrated the limitations of the preliminary assessment, and consideration was given to the possible sources of error. It was concluded that the lack of information on the current patterns and flow field of the water body could be a major factor; if the flushing time was very high the harbour and basin would to some extent serve as a sink. Other major factors could be the existence of diffuse sources hitherto unknown, or erroneous assumptions as concerns the BOD content of the urban and agricultural sewage.

The conclusions from the field work exercises during the second week of the workshop could thus be summarized as follows: The preliminary assessment of the pollution load from land based sources, as it had been carried out under Agenda item 13, could not be verified. The number of parameters involved makes it impossible to attribute the discrepancy to any one factor, and it was concluded that further studies should be initiated. The nature and modalities of these studies would be very similar to the tasks to be undertaken by Principal Investigators in other countries in the Region.

In his concluding remarks, Dr. Murty outlined the physical oceanographical factors to be taken into consideration when identifying appropriate sampling stations in a marine pollution monitoring Programme and stressed the importance of carrying out a complete bathymetry of the area in question. He also stressed that the sampling stations could later be adjusted according to the results as well as additional oceanographic studies.

In his final lecture, based on an overview of the marine pollution monitoring activities carried out at the National Institute of Oceanography in Goa, India, Dr. S. Gupta reviewed the work which had been carried out in connection with the preparation of the report of the state of the marine environment in the Indian Ocean. He also provided basic information on the methodologies for fingerprinting of oil, and it was agreed among participants that similar techniques should ideally be introduced in the EAF region.

16. PRESENTATION OF THE ACTIVITIES OF IOC IN THE NORTH AND CENTRAL WESTERN INDIAN OCEAN

This presentation had been placed late on the Agenda in order to separate it in time from the presentation of UNEP activities in the same geographical area under Agenda item 4.

Mr. J. Karker provided an overview of the objectives of the Commission, concerning marine research, observations related services and training, education and mutual assistance, its constituency as well as its mode of operation. He then went on to describe the major areas of interest to IOC and emphasized the regional nature of the Programmes, with problem definition and project assessment through the regional subsidiary bodies of IOC. The regional approach is common for both IOC and UNEP, as well as a number of objectives, on the basis of which an extensive co-operation has been developed, including the co-operation between UNEP and IOC in the execution of the EAF/6 Project.

Mr. W. Kudoja, in his capacity as Representative of Tanzania at the Second Session of the IOC Committee for the Co-operative Investigation in the North and Central Western Indian Ocean (IOCINCWIO), held in Arusha, Tanzania in 1987, then provided information on the topics and decision of the Session, stressing the compatibility between the Regional Pilot Project on Marine Pollution Monitoring adopted during the session and the activities to be carried out in the framework of EAF/6.

Mr. J. Karker finally provided information on the Regional Cooperation in Scientific Information Exchange in the Western Indian Ocean (RECOSCIX-WIO) of IOC, which could provide help to the Investigators in their search for appropriate scientific literature.

17. ENVIRONMENTAL PROTECTION IN MAURITIUS

The present status of environmental management in Mauritius was presented by Prof. Dwivedi, who described the background for the National Policy of Law, i . e . the legal framework designed to reinforce initiatives on environmental protection.

The Advisor to the Minister of Environment and Land Use,

Mr. Veukatasamy, then presented an overview of the limitations of the coastal management policy in Mauritius, describing a number of the environmental issues currently of concern to Mauritius. These included the degradation of mangrove forest due to their being cut down for firewood, the insufficiency of the sewerage system, and the deterioration of the coastline due to a lack of human resources with qualifications in coastal engineering. In particular the last item was of concern bearing in mind the potential sea level rise due to global warming. In his conclusion, he strongly advocated an integrated approach to coastal zone management and the associated need for independent scientific advice of high quality, which should be developed on a national basis.

18 EVALUATION AND RECOMMENDATIONS

There was a general consent that the Workshop had been very beneficial, and that the linking of two different but associated activities was a good approach. A number of discussions during the Workshop concerning the practical aspects of project execution had put focus on some of the requirements in terms of training and equipment needs, and these were reflected in the Recommendations from the workshop which were adopted by the participants. The full texts of the recommendations are attached as Annex II.

The Chairman in his concluding remarks expressed on behalf of the participants their appreciation for the quality of the local arrangements and logistics which had been very conducive to the smooth running of the Workshop.

The Chairman then declared the Workshop closed at 1500 hrs on 9 November 1990.

ANNEX I

AGENDA

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14. FIELD WORK: DEMONSTRATION OF EQUIPMENT USED IN PHYSICAL OCEANOGRAPHICAL STUDIES, AND SAMPLING IN THE HARBOUR OF PORT LOUIS, FOLLOWED BY LABORATORY WORK, DETERMINATION OF NUTRIENTS AND OXYGEN IN SEA WATER SAMPLES

15. DATA PRESENTATION AND CONCLUSIONS

16. PRESENTATION OF THE ACTIVITIES OF IOC IN THE NORTH AND CENTRAL WESTERN INDIAN OCEAN

17. ENVIRONMENTAL PROTECTION IN MAURITIUS

18. EVALUATION AND RECOMMENDATIONS

ANNEX II

RECOMMENDATIONS

The participants in the IOC-SAREC-UNEP-FAO-WHO-IAEA Workshop on Regional Aspects of Marine Pollution, Mauritius, 29 October - 9 November 1990:

1. **Urge** Governments to ensure the provision of the means necessary for the Investigators in the EAF/6 Project to carry out their tasks, and to solicit the positive co-operation of other national agencies in obtaining the data required, as determined by this Workshop;

2. **Recommend** that specialized training on the use of analytical equipment, such as Gas Chromatographs and Atomic Absorption Spectrophotometers be organized as well as on the job training concerning practical aspects of Project execution;

3. **Urge** Governments and United Nations Agencies to endure that appropriate analytical equipment, such as Gas Chromatographs and Atomic Absorption Spectrophotometers, be made available;

4. **Urge** the participants in the EAF/6 Project to adopt a common work plan for all countries with expected targets;

5. **Recommend** that a Regional Intercalibration exercise on analysis of trace metals, pesticides and petroleum hydrocarbons be organized;

6. **Encourage** and support the exchange of experiences and data between participants;

7. **Realizing** that an oceanographic vessel is necessary for the conduct of the oceanographic studies, urge Governments and United Nations Agencies to explore all possibilities for its acquisition and its availability to all countries in the East African Region;

8. **Recommend** that all existing and future industrial plants and hotels be fitted with appropriate waste treatment, and that all future major construction works be preceded by rigorous Environmental Impact Assessment;

9. **Realizing** that a multidisciplinary approach is necessary, recommend that each Government designates one institution as responsible for all aspects of environmental pollution;

10. **Encourage** visits of Experts from other regions to advise and exchange experiences on environmental issues;

11. **Suggest** the establishment of National Institutes of Oceanography charged with all issues relating to marine resources.

ANNEX III

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ANNEX IV

LIST OF WORKING DOCUMENTS

This list reflects the documentation on which the lectures were based and which was distributed to the participants, unless otherwise indicated. **The list is for reference purposes only, no stocks of these documents are maintained.**

Case study: Rapid assessment of air, water and solid waste pollution sources in Abidjan, Ivory Coast. WHO/EFP/83.50, pp 26-50. WHO Geneva 1983.

Management and control of the Environment, WHO/PEP/89.1, WHO, Geneva 1989.

Control of Environmental Hazards: Assessment and Management of Environmental Health Hazards, WHPO/PEP/89.6. WHO, Geneva 1989.

Ouano, E. A. R .
Training Manual on Assessment of the quantity and type of land-based pollutant discharges into the marine and coastal environment. COBSEA Project EAS-21. 1989.

Calamari, D .
Perspectives in the assessment of harmful chemicals in the environment. 1989. Lecture notes.

Calamari D., Vighi M.
Quantitative Structure Activity Relationships in Ecotoxicology; Value and limitations. ReviewsinEnvironmentalToxicology4, 1-106. 1990 Elsevier.

Iwugo, K.
Basic concepts of environmental quality control in relation to baseline studies on land based sources of pollution. 1990. Lecture notes.

Calamari D., Di Guardo A.
Anzali Lagoon. Preliminary hazard assessment for fisheries in relation to pesticides use in the adjacent agricultural areas . Report (not distributed) .

Mackay D., Peterson S.
Calculating Fugacity.
Env. Sci. Tech. 15 no 9 1981, pp 1006-1014

Fugacity calculation; instructions for use of Mackay's model, level I and II. Handout.

Marine Pollution Monitoring, Research, Assessment and Control in the framework of the UNEP Regional Seas Programme: A comprehensive Approach with special reference to the Eastern Africa. UNEP OCA/PAC 1990.

UNEP/IAEA/IOC: Reference Methods and Materials - a Programme of support for regional and global marine pollution assessments. UNEP 1990.

Analytical Methods for Nutrients and Heavy Metals. Handout.

Oceanography. Lecture notes prepared by Mr. C. S. Murty. Handout.
Prevention and control of marine pollution - an overview. Paper prepared by Mr. H. Henriksen, IMO Regional Adviser on Marine Pollution. (Not distributed).

ANNEX V

RESULTS FROM FIELD EXERCISES

STATION	Nitrite (all in µmol/l)	Nitrate	Phosphate	Oxygen (ml/dm)
1. Off power plant	0.12	5.68	-	4.76
2. Mid channel	0.24	7.36	-	4.41/ 4.45
3. Pointe Sables	0.48	9.16	2.90	4.59/ 4.59
4. Off Fairway	0.20/ 0.12	7.24/ 7.76	1.04/ 1.76	4.28/ 3.08
5.Off Dockyard	0.44	9.68	3.10	4.31

NOTES:

Stations 1, 2 and 3 constitute a transect across the mouth of the Grand River, station 4 was chosen to serve as a reference as the buoy is at quite some distance from any known source, and station 5 is from the harbour area itself.

In some cases two figures are given. These correspond to different sampling depths, at surface and at approx. 3 meters, respectively. Where only one figure is given, it relates to surface conditions.

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