Intergovernmental Oceanographic Commission
Training Course Reports

32

IOC-UNEP-FAO
Training Course on Nutrient Analysis and Water Quality Monitoring

Institute of Marine Sciences (University of Dar es Salaam)
Zanzibar, Tanzania
21-26 November 1994

UNESCO

IOC Training Course Reports

No.	Title	Language versions
1.	IOC Indian Ocean Region Training Course in Petroleum Monitoring Perth, 18 February-1 March 1980	English
2.	IOC Regional Training Course for Marine Science, Technicians Cape Ferguson, Queensland, 1-28 June 1980	English
3.	ROPME-IOC-UNEP Training Workshop on Oceanographic Sampling Analysis, Data handling and Care of Equipment, Doha, Qatar, 3-15 December 1983	English
4.	Stage COI d'initiation à la gestion et au traitement de l'information scientifique et technique pour l'océanologie, Brest, France, 28 novembre - 9 décembre 1983	French
5.	Curso mixto COI-OMM de formación sobre el Sistema Global Integrado de Servicios Oceánicos (SGISO), Buenos Aires, Argentina, 15-26 de octubre de 1984	Spanish
6.	UNESCO-IOC-NBO Training Course on Tidal Observations and Data Processing Tianjin, China, 27 August - 22 September 1984	English
7.	Stage COI sur la connaissance et la gestion de la zone côtière et du proche plateau continental Talence, France, 18 septembre - 4 octobre 1984	French
8.	IOC Regional Training Course on Marine Living Resources in the Western Indian Ocean Mombasa, Kenya, 27 August - 22 September 1984	English
9.	IOC-UNESCO Summer School on Oceanographic Data, Collection and Management Erdemli, Icel, Turkey, 21 September - 3 October 1987	English
10.	IOC-UNESCO Regional Training Workshop on Ocean Engineering and its Interface with Ocean Sciences in the Indian Ocean Region, Madras, India, 17 March - 5 April 1986	English
11.	IOC-UNESCO Training Course on the Use of Microcomputers for Oceanographic Data Management Bangkok, Thailand, 165 January - 3 February 1989	English
12.	IOC Advanced Training Course on Continental Shelf Structures Sediments and Mineral Resources Quezon City, Philippines, 2-13 October 1989	English
13.	IOC/IODE Training Course on GF3 Data Formatting System Obninsk, USSR, 14-24 May 1990	English
14.	IOC Training Course on Microcomputers and Management of Marine Data in Oceanographic Data Centres of Spanish-speaking Countries, Bogotá, Colombia, 21-30 October 1991	English Spanish
15.	IOC Advanced Training Course on Nearshore Sedimentation and the Evolution of Coastal Environments, Kuala Lumpur, Malaysia, 17-29 February 1992	English
16.	First IOC Training Course on the Applications of Satellite Remote Sensing to Marine Studies Caracas, Venezuela, 24-28 September 1990	English
17.	IOC-KMFRI-RECOSCIX (WIO) Regional Training Course on Microcomputer-based Marine Library Information Management, Mombasa, Kenya, 10-21 August 1992	English
18.	ROPME-IOC Regional Training Course on Management of Marine Data and Information on Microcomputers for the ROPME Region, Kuwait, 18-28 October 1992	English
19.	IOC-SOA Training Workshop on Environmental Effects on Benthic Communities Xiamen, China, 19-23 October 1992	English
20.	IOC Training Course for the Global Sea Level Observing System (GLOSS) directed to the African and South American Portuguese and Spanish-Speaking Countries São Paulo, Brazil, 1-19 February 1993	English
21.	IOC-SSTC-SOA Training Course on Marine Information Management and ASFA Tianjin, China, 19-30 October 1992	English
22.	First IOC/IOCARIBE-UNEP Training Course on Monitoring and Control of Shoreline Changes in the Caribbean Region, Port-of-Spain, Trinidad and Tobago, 21-30 July 1993	English Spanish
23.	IOC/WESTPAC Training Course on Numerical Modelling of the Coastal Ocean Circulation Matsuyama, Japan, 27 September - 1 October 1993	English
24.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 28 September - 9 October 1992	English
25.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 27 September - 8 October 1993	English
26.	IOC Training Course on Ocean Flux Monitoring in the Indian Ocean. Organized with the support of the Government of Germany, Mombasa, Kenya, 15-27 November 1993	English
27.	IOC-UNEP-SPREP Training Course on Coral Reef Monitoring and Assessment Rarotonga, Cook Islands, 23 February - 13 March 1994	English
28.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 28 September - 9 October 1992	English
29.	IOC-UNEP-WHO-FAO Training Course on Qualitative and Quantitative Determination of Algal Toxins Jena, Germany, 18-28 October 1994	English
30.	IOC Training Course on Oceanographic Data Management for the Black Sea Countries Obninsk, Russian Federation, 1-12 August 1994	English
31.	COI-CEADO Curso Regional de Capacitación en Gestión de Datos e Información Oceanográficos Buenos Aires, Argentina, 17-28 de octubre de 1994	Spanish
32.	IOC-UNEP-FAO Training Course on Nutrient Analysis and Water Quality Monitoring Zanzibar, Tanzania, 21-26 November 1994	English

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TABLE OF CONTENTS

SUMMARY REPORT

1. INTRODUCTION

Over the past three years as many as four workshops have been conducted by IOC in collaboration with Swedish SAREC to build a core of East African nutrient chemists and scientists.

The first in the series covered the theoretical background to the subjects of nutrient chemistry, dynamics and analysis in marine systems.

The second held here in IMS, Zanzibar provided practical training in nutrient analysis, and the third further developed analytical skills by holding an intercalibration exercise for scientists who attended the previous workshop. The fourth and the last workshop in the series organized in April 1994 in Mombasa, Kenya) was designed for the application of the known techniques to a field situation in the monitoring of nutrients in tropical marine waters. The objective was to ensure that different groups working within the East African region in this field use similar laboratory and field techniques.

Thus, a programme of regional co-operation and co-ordination could be fostered through the standardisation of sampling and analytical methods for the effective implementation of regional pollution monitoring and research projects in East Africa.

During last year's consultations on EAF/5, EAF/6 and WACAF-2 Projects, 20-23 September 1994, in Rome, which was jointly sponsored by IOC, FAO, UNEP, FAO and IAEA among others, IOC was assigned the task of developing a monitoring programme to determine nutrients loads in in-shore waters of East Africa. The assignment derived from the conclusions of earlier surveys of land-based sources of pollution in the marine environment which implicated nutrients loading, as the principal cause of water pollution in the coastal and marine environment of the East African region.

The aforementioned series of IOC-SAREC training workshops held in this region on capacity building between 1992 and 1994 conveniently afford a vantage platform for initiating such a monitoring programme.

The present workshop is a joint IOC-UNEP-FAO endeavour and is primarily aimed at a review of the analytical methods and skills already acquired by the nutrient chemists against a backdrop of water quality monitoring.

In the course of the present workshop a monitoring programme will be adopted for the East African Region based on the methodologies already developed. Also guidelines will be provided for selecting and establishing baseline stations for nutrient loads and water quality monitoring within the pilot study sites selected for the purpose of the EAF/5 project on Integrated Coastal Zone Management in the East African region.

2. CONDUCT OF THE TRAINING COURSE

2.1. OPENING

The workshop was opened at the Institute of Marine Sciences (IMS), Zanzibar, Tanzania by 10 a.m. on 21 November 1994 by Dr Chris Horrill, Deputy Director of the Institute. He welcomed the participants and expressed his appreciation to IOC, FAO and UNEP for their joint effort in organizing the Training Course and stressed the importance of standardizing pollution monitoring methods among the countries of the East African Region. He pointed out that the Training Course was most timely for the region because of the rapid growth of the tourism industry and concomitant heavy sewage loading of the inshore waters of the region.

Dr. Dixon Waruinge, the FAO Co-ordinator of the EAF/6 and EAF/5 projects thanked the participants, the local organizers and the lecturers for efficiently preparing for the Training Course at such short notice. He then outlined the EAF/5 and EAF/6 projects and explained how important the projects are for the marine environment of the East African region. He urged all participants to strengthen the co-operation that exists between their different countries in this field.

Dr. Sam Anurigwo, Director of the Imo State Environmental Protection Agency in Owerri, Nigeria, and Principal Lecturer for the Training Course conveyed greetings from Dr. Gunnar Kullenberg, 'Secretary IOC and Dr. Ibe, Head of the Marine Pollution Research and Monitoring Unit of IOC to the participants and expressed appreciation to the Institute of Marine Sciences, Zanzibar for hosting the workshop. He highlighted the efforts of the IOC-UNESCO/FAO/UNEP in promoting the EAF/5 and 6 projects and stressed the importance of nutrient and water quality monitoring in the East African Region. The trend in coastal zone development of the region has a high premium on tourism projects and fisheries development which are remarkable foreign exchange earners for the region and should therefore be promoted.

Dr. Anurigwo reviewed the activities of the previous workshops and discussed the goals of the present one, stressing the need for each participating country to develop and implement a baseline water- quality monitoring programme as input to a database for coastal zone management.

The workshop, he stated, will provide the framework for establishing such programmes. In addition the individual capacity of each country to achieve these goals will be assessed with a view to identifying areas of relevant assistance. He added that the inclusion of a participant from the WACAF/2 project region of IOCEA was a healthy development for inter regional interactions in the protection of the marine environment.

The instructor for the intercalibration exercise, Dr F. Lipshultz from the Bermuda Biological Station also introduced the objectives and targets of the exercise.

After registration, the participants introduced themselves and briefly discussed their backgrounds and roles in water quality monitoring in their home countries. The List of Participants is attached as Annex III.

2.2 TRAINING COURSE PROGRAMME

The following constitutes the course content for the Training Course. The Timetable for the Training Course is attached as Annex I.

Lecture

General considerations of pollutants in inshore waters;
Basic principles in water quality monitoring;
Discuss & distribute survey on water quality monitoring;
Assemble materials for conduct intercalibration exercise;
Review of intercalibration results;
Status of monitoring in the East African Region.

Lecture

Design and implementation of water quality programmes:

(i) parameters to be measured;
(ii) sampling frequency;
(iii) site selection.

Lecture

Data management in water quality monitoring:

(i) data storage;
(ii) data presentation;
(iii) data to policy tool.

Discuss survey questionnaire and identify problems/issues for each country.

Lecture

(i) Criteria for establishing baseline stations;

(ii) Discussion on appropriate sites for each country;

(iii) Site visit to IMS baseline station at Chapani Island;

(iv) Formulate guidelines for selection & establishment of baseline stations.

Lecture

(i) Design of monitoring programme;

(ii) Assessment of capability for programme implementation in home country;

(iii) Final discussions;

(iv) Distribution of intercalibration standards for home laboratory;

(v) Conclusion of workshop.

3. LABORATORY EXERCISES

The participants took part in an intercalibration exercise to promote intercomparability of data resulting from the monitoring programme and to ensure that the regional database had a solid foundation. (Participants from Mauritius and Comores experienced travel delays and hence were not present). Participants were grouped by country resulting in 5 groups of two analysts, with at least one member of each group having attended several previous workshops on nutrient analysis. A common primary standard reagents, an unknown sample, were provided to standardize the conditions and to minimize errors arising from use of unfamiliar equipment. Nitrite was selected for analysis as the analytical procedure is also central to analysis of nitrate and because of a lack of operational cadmium reduction columns. The groups were each requested to:

i) calculate and prepare the necessary dilutions to construct a 5 point standard curve from O to 10 μMNO_{2^-};

ii) analyze the unknown;

iii) use linear regression to calculate the standard curve;

(iv) calculate the concentration of the unknown.

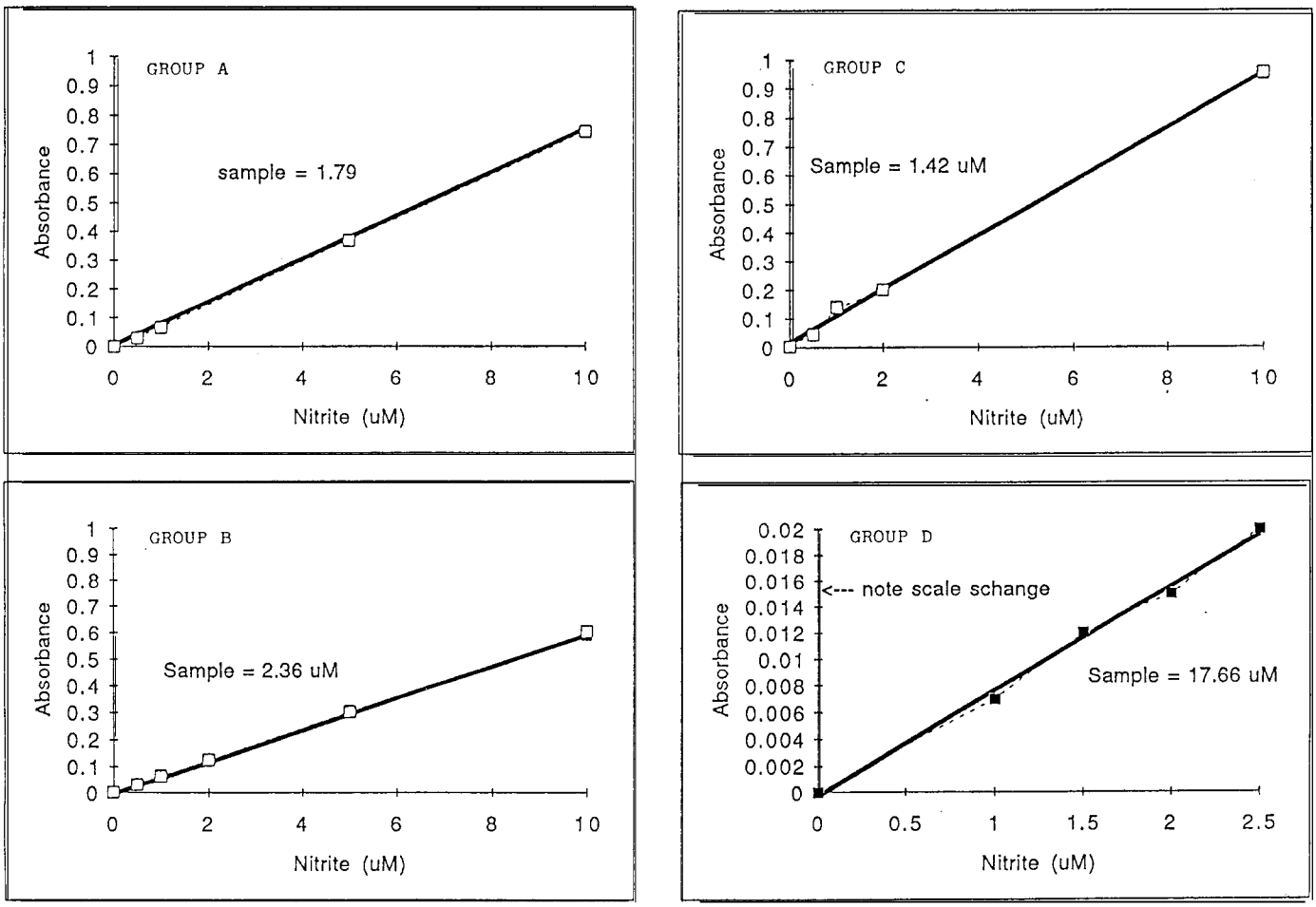
The recent handbook for nutrient analysis in tropical waters (IOC Workshop Manual #28) was passed out to all participants and was used as their guide for the analytical protocol.

All of the groups were familiar with appropriate laboratory techniques for nutrient analysis such as proper use of adjustable pipettes, use of volumetric flasks and of the spectrophotometer. There was a range of facility however in calculating the required dilutions from the Mm primary standard to the appropriate set of secondary standards. Two groups failed to achieve the appropriate range, one too high and the other too low (see figure Id). The groups all satisfactorily measured the same absorbance for the common unknown and were capable of constructing the standard curve and then calculating the concentration of the unknown.

The level of precision was high for replicates of a single concentration and for the various standards (Figure 1), indicating again that the overall facility with nutrient analysis is good. Only one group (B) accurately determined the 2.2µM concentration of the standard with two groups reporting somewhat lower concentrations. The incorrectly calculated standards in group D obviously lead to calculation of an extremely high concentration. It is important to note that group B is the only group that has instituted a monitoring programme for nutrients: the other groups have not performed this type of analysis since the last workshop.

The results of the exercise were reviewed with the participants and suggestions were made concerning quality control measures for time series analysis. Particular attention was paid to the use of the slope or response factor as a constant value to ensure reliable data. Participants were unaware that the slope had a constant value (e.g. 2.1 for nitrite and 6.5 for ammonium) and that deviations could indicate alteration of the primary standard, reagents or an inaccurate pipette. Further suggestions included collection of two field samples at each sampling station rather than one and then analyzing one set while archiving the second set until after completion of analysis. At least one of the replicate field samples should be analyzed along with the first set to provide confidence that the sampling protocol is representative and to provide a continual check on the inherent variability of the field samples. Another useful practice to ensure high quality is to split a field sample, analyze one replicate immediately and then analyze the second replicate when samples from the subsequent set of monitoring samples is analyzed. Finally, construction and use of data log sheets for field sampling, laboratory analysis and computer spreadsheets for calculation was discussed.

Fig 1. RESULTS OF INTERCALIBRATION EXERCISE



4. DESIGN OF A MONITORING PROGRAMME FOR IN-SHORE WATER QUALITY IN THE EAST AFRICAN REGION

4.1 INTRODUCTION

The six countries in the East African Region that attended the workshop (i.e. Tanzania (including Zanzibar), Kenya, Mozambique, Mauritius, Comores, Seychelles) were discussed individually and extensively to obtain the necessary background understanding of the water quality situation in each country with respect to coastal development and in-shore waters. The monitoring programmes already in place in each country were also reviewed. A survey questionnaire was used for the purpose. The results are summarized in Table 1.

In the context of the need for a uniform monitoring programme in the East African region (vis-a-vis the implementation of the EAF/5 programme) a comprehensive assessment of the information derived from each country of the region has contributed considerably to the final design of a monitoring programme appropriate for in-shore waters in the region.

Moreover, the technical capability of each country to run a sustainable monitoring programme was assessed and documented as presented in the survey questionnaire completed by participants. Based on the information presented and the discussions held, recommendations have also been made concerning the technical manpower/equipment requirements of each country to enable the implementation of the monitoring programme hereby designed for the region.

4.2 OBJECTIVES

The trend in coastal zone development in the East African Region has focussed mainly on tourism projects and fisheries development. Industrial activities are also coming on stream.

The emphasis in the monitoring of the quality of in-shore waters in the region will therefore be directed to such issues as the protection of human health, prevention and control of eutrophication/algal blooms and forestalling deterioration in aquiculture potentials.

With these objectives in mind, each country in the region will be required to conduct a preliminary survey on water quality of its coastal beaches and harbours for better understanding of the present nature of the in-shore waters (particularly the spatial and temporal variability within the whole water body) . This will provide the necessary baseline information for the design of a reliable monitoring programme.

Table 1. SUMMARY OF RESULTS FROM SURVEY QUESTIONNAIRE ON EXISTING COUNTRY MONITORING PROGRAMMES IN THE EAST AFRICAN REGION

COUNTRY	PURPOSE OR OBJECTIVE OF BASELINE STATION	PARAMETERS TO BE MEASURED	NUMBER OF BASELINE STATIONS	SAMPLING FREQUENCY (ACTUAL/ POSSIBLE)	TECHNICAL CAPACITY STAFF (TRAINED/ EQUIPMENT ETC.	ADDITIONAL REQUIREMENTS: EQUIPMENT REAGENTS STAFF (TECHNICAL)
MOZAMBIQUE	Tourism and Environmental Protection and Coastal Development	Nutrients Human Pathogens Heavy metals Hydrocarbons Regular Ph, temp, sal.	4 (2 in Maputo 2 in Beira)	Monthly	Equipment available in Ministry of Health can be shared but needs own laboratory equipment	- Training of personnel Chemicals - Logistics (boat)
KENYA	Tourism and Coral Reef Protection	Nutrients Human pathogen D.O.	5	Bi-weekly	Trained personnel and appropriate equipment available	- Chemicals for Nutrient analysis - Microbiological equipment and reagents - Logistics (boat)
SEYCHELLES	Tourism - to establish present pollution level for trend monitoring Protection of coral reefs	Faecal coliforms (Human pathogen) Nutrients routine parameters	3	Faecal - (weekly) Nutrients etc - (monthly)	Basic personnel available Equipment (by January 1995))	- Sampling equipment for nutrients - Logistics (boat)
TANZANIA	Tourism Fisheries Protection Coastal Development	Nutrients TSS Faecal coliforms	7 (5 in Dar es Salaam, 2 in Tanjo)	Monthly	Manpower available Some Equipment	- Boat - Centrifuge - Furnace - Reagents - Logistics (boat)
ZANZIBAR (TANZANIA)	Tourism Coastal Pollution Control	- Nutrients - Faecal coliforms - TSS - DO, BOD	6	Monthly	Manpower available Equipment available except bacteriological	- Bact. equipment - Techniques in bact. t raining - Logistics (boat)
MAURITIUS	Tourism IND & DOM Waters	- Nutrients - BOD - Faecal coliforms	2 now 3 later	Bi-waekly	Basic trained manpower Nutrient analyst Equipment for BOD	- Bact. equipment - Faecal col... analysis - Logistics (boat)
COMORES	Tourism Protection of Coral Reef	- Nutrients - susp. solids - Faecal coliforms etc.	3	Monthly	Basic trained manpower	- Basic Lab equipment to be provided by government - Bacteriological equipment - Reagents - Logistics (boat)

4.3 CHOICE OF VARIABLES (Parameters to be measured)

The choice of variables based on the foregoing issues also considered the technical feasibility of assessment/analysis and relevance to the regional coastal zone development programmes. Tables 4 and 5 indicate simplicity of measurement and priority status, respectively, of the variables identified for monitoring.

The variables chosen are:

- Nutrients
  (a) inorganic nitrogen (Nitrates, Nitrites and Ammonia)
  (b) inorganic phosphorus (soluble reactive phosphorus)
- Dissolved Oxygen
- Human pathogens
- suspended particulate matter (TSS)
- Phytoplankton pigment (chlorophyll)
- Temperature and ph.
- Salinity

These variables are recommended for inclusion in the monitoring programme of each country in the region.

4.4 SAMPLING STATIONS

Sampling stations will be determined by individual countries following assessment of need and preliminary water quality survey. The criteria for location of baseline stations have already been applied to each country. The number and probable locations for baseline stations have been discussed for each country based on the maps and questionnaire data supplied by participants.

4.5. SAMPLING FREQUENCY

Sampling frequency for each country should be tailored to available facilities. However, two-weekly to monthly intervals are recommended to ensure sustainability. This tallies with the range of sampling frequencies indicated in the survey questionnaire by all countries.

4.5 FIELD AND LABORATORY EQUIPMENT

The requisite field sampling and laboratory analytical equipment and reagents should be assembled by the relevant monitoring laboratory(ies) in each country.

The top-up requirements of each country in the region for effective water quality monitoring have been articulated (and presented in another part of this report) for the attention of IOC, FAO and UNEP.

4.6 HYDROLOGICAL INFORMATION

Hydrological information relating to the body of inshore water to be monitored should be part of the data relevant to the water quality monitoring programme for better understanding of the comprehensive trend in the region. Countries are therefore advised to incorporate hydrological information/measurements on their inshore waters into the programme. Discharge of rivers into estuaries usually contribute loads of nutrients and pollutants in the inshore waters of the related coastal region. Also current movements (speed and direction are relevant factors that affect coastal hydrology and therefore need to be considered.

4.7 DATA TREATMENT SCHEME

A completely operational data documentation, treatment, storage and retrieval system is a prerequisite for efficient water monitoring programme and should be installed in the programme of each country in the region.

Use of log books, data sheets computer, spread sheets, graphs, tables necessary for data storage and archiving are encouraged. Data handling and presentation was treated as a major topic during the present workshop.

4.8 DATA QUALITY ASSURANCE

As part of the data quality assurance arrangement in each country of the region, intercalibration exercises among workers in a laboratory, among laboratories in each country and among countries should be encouraged.

Periodic cross check on data quality by use of reference materials is also to be practiced. External assistance (for example, from the GIPME Groups of Experts) should be sought in this area of data quality control when necessary.

4.9 DATA FOR POLICY MAKING

The ultimate objective of water quality monitoring is to generate data which, when interpreted, should provide information for the decision making process.

The data from water quality monitoring programmes should not merely serve as a list of variables and their concentrations, but should be assembled and interpreted by experts with relevant recommendations, and forwarded for management action. A mechanism for regional co-ordination of water quality data would enable a comprehensive assessment and understanding of the water quality trends in the inshore waters of the East African region. This is the tool required for efficient management and protection of the inshore waters of the region vis-a-vis the coastal zone development programmes of the region.

4.10 PERIODIC EVALUATION

Periodic evaluation of the monitoring programme is advisable in order to assess the degree of realization of set objectives and to effect necessary adjustments in the monitoring programme especially as coastal zone development activities in the East African Region advance

4.11 ACTION PLAN

A time-related action plan has been recommended for the implementation of the monitoring programme in the region (Table II). It is proposed that within the next 12 month-period each country in the region would have acquired the capacity to effectively and efficiently sustain a water quality monitoring programme to enable the commencement of regional assessment and co-ordination of pollution control initiatives.

5. GUIDELINES FOR ESTABLISHING BASELINE STATIONS

5.1 OBJECTIVES FOR MONITORING

The objective for conducting a water quality monitoring exercise should be taken into consideration when establishing a baseline station for a monitoring programme.

It should be clearly understood whether the objective is

(i) to establish a case of pollution (investigative monitoring)
(ii) a follow-up on known pollution situations to determine trend
(iii) for a specific project consideration

Once the objective has been established, determining the most appropriate location for the establishment of baseline station for monitoring purposes would naturally be an easy sequence.

5.2 RESOURCES

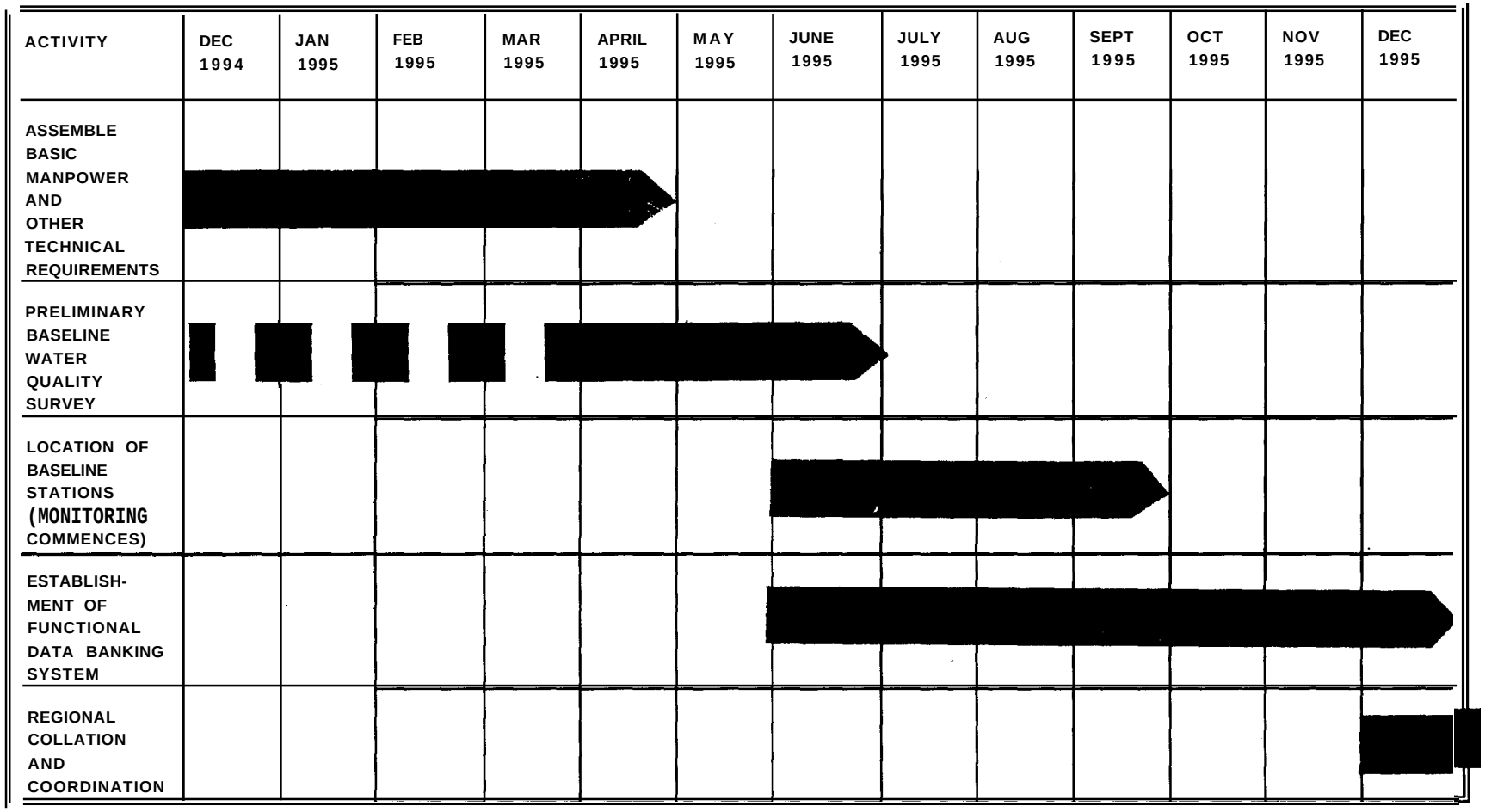
The location of a baseline station for water quality monitoring should ensure availability of:

(i) technical know-how/human resources for executing the monitoring programme

(ii) appropriate equipment/laboratory facilities

The field sampling equipment and laboratory analytical instrumentation are requirements that must be provided for a successful monitoring programme. Their location or sources of availability does govern the establishment and effective location of baseline monitoring stations.

Table 2. TIME-RELATED ACTION PLAN FOR THE IMPLEMENTATION OF A MONITORING PROGRAMME FOR IN-SHORE WATER QUALITY IN THE EAST AFRICA REGION



5.3 GOOD KNOWLEDGE OF COASTAL CONFIGURATION

The geometry of the coastline is a factor usually considered in the establishment of baseline stations for water quality monitoring in-shore waters. Such a factor influences wave action, mixing and concentration of nutrients and should be taken into consideration when deciding where to locate water quality baseline stations for in-shore waters.

5.4 DEVELOPMENT ACTIVITIES

The development projects on the ground in the coastal zone (or intended development programmes) need be considered as factors relevant in determining the establishment of baseline stations. Whenever such proposed projects come on stream their waste sewage effluents are likely to come under the water surveillance of the quality monitoring programme and so should be taken into account during the selection of sites for establishment of baseline stations.

Existing projects/activities should have their patterns of waste discharge taken into consideration.

5.5 SUSTAINABILITY

A baseline station should be run as a sustainable programme for it to yield and serve the intended purpose.

Efforts should be put in determining the most sustainable location for a baseline monitoring station. Indeed even greater efforts should be put into providing the requisite inputs for its sustainability once established, otherwise the desired continuity of data generation could break down.

5.6 GEOGRAPHY OF THE ENTIRE REGION

Familiarization with the geographical features of the entire region under consideration would help the scientist make the right decisions about the location of a baseline sampling station for water quality monitoring. Accessibility of the intended station must be guaranteed.

5.7 PRELIMINARY SURVEY

It is always useful and advisable to first conduct a preliminary nutrient and water quality survey exercise before deciding on where to establish a baseline station. This is necessitated by the fact that such survey provides the initial water quality information which will guide the design of the water quality monitoring programme and indeed the proper location for the establishment of a baseline water quality monitoring station.

6. CONCLUSION

A review of the objectives and targets of the Training Course was undertaken by participants and lecturers at the end of the Course to determine to what extent these had been accomplished and to provide the basis for recommendations for future national/regional actions in the field of environmental monitoring and pollution control.

It was unanimously agreed that the Training Course had been a success and certain recommendations for follow-up actions *were* made (see Annex II). If implemented, these recommendations would lead to the acquisition of a scientific data base upon which future management actions aimed at the protection of the coastal and marine environment of the East African region and the sustainable utilization of its resources could be based.

7. CLOSURE OF THE TRAINING COURSE

Dr M. Ngoile, Director of IMS, Zanzibar who had been unavoidably absent at the opening of the Training Course, congratulated the participants, lecturers and sponsors of the Training Course for a productive outcome and pledged his continued readiness to make available the facilities of his Institute for similar Training Courses in the future.

He closed the Training Course by 3.30pm on Saturday, 26 November 1994.

ANNEX I

TRAINING COURSE TIMETABLE

Monday, 21 November

1. Opening Session

   Welcome remarks by Dr C. Harris, Acting Director, IMS, Zanzibar

   Address by Dr D. Waruinge, Co-ordinator EAF/5 & 6 projects UNEP, FAO

   Address by Dr. S. Anurigwo, IOC/UNESCO Consultant

2. Registration Formalities

3. Introductory Session

   Introductions (by participants)

   Background and Objectives of the Training Course

   Programme of the Training Course

   Brief country presentation by participants

4. Lectures

   General considerations of pollutants in inshore waters

   Discussion

   Distribute survey on water quality monitoring

Tuesday, 22 November

Lectures

Basic principles in water quality monitoring

Assemble materials & conduct intercalibration exercise

Review of intercalibration results

Status of water quality monitoring in the East African Region (surveys)

Wednesday, 23 November

Lectures

Design and implementation of water quality monitoring programmes:

- parameters to be measured
- sampling frequency
- location

Data management in water quality monitoring:

- data storage
- data presentation
- data to policy tool

Discussion & identification of problems/issues for each country based on survey questionnaire responses.

Thursday, 24 November

Lecture

- Criteria for establishing baseline stations
- Discussion of appropriate sites for each country (country reports)
- Site visit to IMS baseline station at Chapani Island, Zanzibar.

Friday, 25 November

Lectures

- Formulate guidelines for selection & establishment of baseline stations
- Design of monitoring programme for inshore water quality in the East African Region
- Director IMS, Dr M. Ngoile, addresses the participants of the workshop
- Assessment of capability for programme implementation in home country

Saturday, 26 November

- Final discussions and conclusions: Recommendations
- Distribution of intercalibration standards for home laboratory
- Closing remarks by Director IMS, Zanzibar
- Departures

ANNEX II

RECOMMENDATIONS FROM THE TRAINING COURSE

In the light of the issues raised and the information generated during the workshop on the potentials of a successful and sustainable water quality monitoring programme in the East African Region, the following recommendations have become necessary.

1. WATER QUALITY MONITORING

(i) Parameters to be measured

A very high premium is placed on tourism as a major foreign exchange earner in the region. This therefore summons great attention to the protection of human health as a salient factor in the water quality monitoring programme of the region. The coastal waters of the region receive heavy organic matter loading from domestic sewage and other sources.

In the light of the above the following parameters have been discussed with participants and are hereby recommended for the regional nutrient and water quality monitoring programme. The recommendations have been made also with due consideration to: (i) analytes of relevance and (ii) ease of analysis; to enable uniform capability and compliance in the region:

a) Nutrients (Nitrates, Nitrites, Ammonia, Phosphates)

b) Dissolved oxygen (and BOD)

c) Human pathogens

d) Total suspended solids

e) Phytoplankton pigment (chlorophyll)

f) Temperature, Ph

9) Salinity

(ii) Analytical Methods

a) The methods for nutrients analysis outlined in the IOC "Manuals and Guide" No.28 of 1993 on Nutrient Analysis in Tropical Waters are recommended for use in the East African Region. However for the determination of Ammonia the indophenol method is recommended in preference to the oxidation methods

b) For human pathogens, the use of faecal coliform as indicators in routine monitoring (and isolation of staphylococcal and streptococcal or other species in specific cases) need be applied in bacteriological monitoring of the inshore waters of the region as conventional for the marine environment.

(iii] Frequency

It is recommended that a monthly sampling frequency for nutrients and water quality be adopted for the region. Monitoring for public health parameters many adopt a high frequency of say, fortnightly sampling, when necessary.

(iv) Number of stations

Each country should have a minimum of two (2) and a maximum of six (6) sampling stations based on technical capacity to ensure sustainability

2. TECHNICAL CAPACITY

(i) Manpower

The series of training workshops so far held for the region to muster capacity for nutrient analysis have successfully raised a crop of nutrient scientists in the countries of the East African Region. This, however, cannot be said of other areas of water quality monitoring especially in public health (i.e. bacteriological) tests. Most of the participating institutions/countries have not yet articulated appropriate capacity in this area.

It would therefore be necessary to train scientists in the region in bacteriological monitoring. This would be by way of a hands on Training Course on practical workshop to cover this aspect of water quality monitoring.

(ii) Equipment

From the questionnaire most countries/institutions have indicated a lack of some related take-off instrumentation. The provision of basic technical support (equipment and chemical reagents) to each country is recommended. IOC, FAO and UNEP would need to seed such complementary equipment to facilitate uniform take off of the project in the region. the individual requirements of each institution/country are as outlined in the response to the survey questionnaire

(iii) Action Plan

To enable the water quality monitoring programme take off in the region, a time-emphasized action plan has been designed as a guide to each country's implementation programme. It is recommended that this schedule be followed with commitment and political will.

3. INTERCALIBRATION STANDARDS

Intercalibration standards for nutrients and chlorophyll need to be mailed to the analysts in each country periodically. The laboratory results of such intercalibration exercise would have to be coordinated by an accredited centre in the region, say, the Institute for Marine Science Zanzibar where nutrient analysis programme has been adequately developed.

Further intercalibration exercise on a regional basis should only occur after monitoring has been commenced by countries participating in countries participating in the EAF/5 and EAF/6 projects. This should only serve as a follow-up review of already developed capacity and should include the public health scientists who are conversant with the faecal coliform/human pathogens monitoring laboratory work.

ANNEX III

LIST OF PARTICIPANTS

COMORES

Mrs ALI Fatouma Abdallah
CNDRS
BP 169
MORONI
Comores
Tel: (269) 74.41.87 (office)
(269) 73.00.18 (home)
Fax: (269) 73.15.50

KENYA

Mr MUNGA Daniel
Kenya Marine & Fisheries
Research Institute
P. O. Box 81651
MOMBASA
Tel: (254)(11) 475151-5
Fax: (254)(11) 472215

MAURITIUS

Mr SHEIK FAREED Vacil
Central Environmental Laboratory
Department of Environment
Ministry of Environment
2nd Floor, Ken Lee Building
Line Barracks St.
PORT LOUIS
Tel: (230) 212.8992
Fax: (230) 212.6671

MOZAMBIQUE

Mr. HALARI A. J.
Laboratorio Nacional Hig Aguas
e Alimento
Misau
LNHAA - Health Ministry
P.O. Box 264
MAPUTO
Tel: (258) 1.42.51.78
Fax: (258) 1.49.19.06
(c/o FAO) MAPUTO

Mr WAMUSSE Rogerio
Comissao Nacional do Meio Ambiente
Av. Acordos de Lusaka 21 15
P.O. Box 2020
MAPUTO
Tel: (258) 1. 46.48.33/48/51
Fax: (258) 1. 46.58.49

NIGERIA

Ms ABOHWEYERE Parcy
Senior Research Officer
Nigerian Institute for Oceanography
and Marine Research (NIOMR)
PMB 12729 - Victoria Island
LAGOS
Tel/Fax: (234) 1.2617530
or 619517

SEYCHELLES

Mr PALYMRE Philippe
Director
Public Health Laboratory
P.O. Box 52
Ministry of Health
Tel: (248) 22.44.00
Fax: (248) 22.47.92

Mr RADEGONDE Vivian
Senior Research Officer
ASSET
P.O. BOX 648
Victoria, MAHE
Tel: (248) 37.53.33
Fax: (248) 37.51.51

TANZANIA

Mrs SAID Khayrat Ubwa
Senior Technician
Institute of Marine Sciences
P.O. Box 668
ZANZIBAR
Tel: (255) 54.30741/32128
Fax: (255) 54.33050

Dr OTHMAN O. C.
Chemistry Department
University of Dar es Salaam
P.O. Box 35061
DAR ES SALAAM
Tel: (255) 51.43038/24117
Fax: (255) 51.43038
Tlx: 41327 UNISCIE

Mr MGANA Shaaban
Ardhi Institute
P.O. Box 35176
DAR ES SALAAM
Tel: (255) 51.71263/4, 75004
Fax: (255) 51.71853

FAO REPRESENTATIVE

Mr WARUINGE Dixon G.
Co-ordinator EAF/5
and EAF/6 Projects
FAO/United Nations Environment
Programme UNEP/OCA-PAC
P.O. Box 30552,
NAIROBI
Kenya
Tel: (254) 2. 622025
Fax: (254) 2. 622788
Email:

LECTURERS

Dr ANURIGWO Samuel C.
Director
Imo State Environmental
Protection Agency
Government House
OWERRI
Nigeria
Tel: (234) 83.234.986
Fax: (234) 83.234.096

Dr LIPSCHULTZ Fredric
Bermuda Biological Station
for Research, Inc.
Ferry Reach GE 01
BERMUDA
Tel: (1) (809) 297.1880
Fax: (1) (809) 297.8143
Email: FRED@BBSR.EDU

SECRETARIAT

Mr MOHAMMED Mzee Salim
Research Fellow
Institute of Marine Sciences
P.O. Box 668
ZANZIBAR
Tanzania
Tel: (255) 54.30741/32128
Fax: (255) 54.33050

Ms KILUNGO Fatuma
Office Management Secretary
Institute of Marine Sciences
P.O. Box 668
ZANZIBAR
Tel: (255) 54.30741/32128
Fax: (255) 54.33050

Ms HINSON Fanny
UNESCO/IOC
1, rue Miollis
75015 PARIS
France
Tel: (33) 1. 45.68.39.05
Fax: (33) 1. 40.56.93.16