Intergovernmental Oceanographic Commission
Workshop report no. 14

Report of the IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas

Abidjan, Ivory Coast, 2-9 May 1978

Unesco

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

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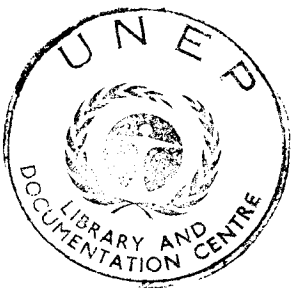
International Workshop on Marine Pollution in the Gulf of Guinea and adjacent areas

Abidjan, Ivory Coast
2 - 9 May 1978

SUMMARY REPORT



INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

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No.	Title	Publishing Body	Language(s)
1	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in East Asia (Report of the IDOE Workshop on); Bangkok, Thailand, 24-29 September 1973, UNDP (CCOP), 158 pp.	Office of the Project Manager UNDP/CCOP c/o ESCAP Sala Santitham Bangkok, Thailand	English
2	CICAR Ichthyplankton Workshop Mexico City, 16-17 July 1974, (Unesco Technical Paper in Marine Science, No.20).	Division of Marine Sciences, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
3	Report of the IOC/CFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean, Monte Carlo, 9-14 September 1974.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish
4	Report of the Workshop on the Phenomenon known as "El Niño", Guayaquil, Ecuador, 4-12 December 1974.	FAO Via delle Terme di Caracalla 00100 Rome, Italy	English Spanish
5	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources, Kingston, Jamaica, 17-22 February 1975.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
6	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, Suva, Fiji, 1-6 September 1975.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
7	Report of the Scientific Workshop to initiate planning for a co-operative investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/UNESCO/EAC, Nairobi, Kenya, 25 March - 2 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	Full text English only. Extract and Recommendations: French Spanish Russian

No.	Title	Publishing Body	Language(s)
8	Joint IOC/FAO(IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters, Penang, 7-13 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
9	IOC/CMG/SCOR Second International Workshop on Marine Geoscience, Mauritius, 9-13 August 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
10	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring, Monaco, 14-18 June 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
11	Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and adjacent regions, Port-of-Spain, Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
11 Suppl.	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and adjacent regions, Port-of-Spain, Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
12	Report of the IOCARIBE Interdisciplinary Workshop on Scientific Programmes in support of Fisheries Projects, Fort-de-France, Martinique, 28 November - 2 December 1977.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
13	Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area, 16-18 January 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
14	IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and adjacent areas, Abidjan, Ivory Coast, 2-9 May 1978.	UNEP Palais des Nations CH-1211 Geneva Switzerland	English French

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

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INTRODUCTION

As part of UNEP's preparatory activities for the development of an action plan for the protection and development of the Gulf of Guinea and adjacent areas, an International Workshop on Marine Pollution was convened jointly by IOC, FAO, WHO and UNEP in Abidjan, 2-9 May 1978, at the kind invitation of the Ivory Coast Government.

Thirty-one experts from seventeen countries were invited to review the major marine pollution problems of the region and, in their personal capacities, to provide the sponsoring organizations with scientific guidance on activities that would promote the protection of human health, fisheries resources and coastal and marine ecosystems from further degradation.

Agenda item 1

OPENING OF THE SESSION

The meeting was opened by Mr Mema Soumahoro, representing the Ivory Coast Minister of the Navy, in the Assemblée Nationale on 2 May 1978 at 10 a.m. He underlined the importance of the meeting in the fight against marine pollution in the region at the international level.

Mr R.C. Griffiths, Assistant Secretary IOC, speaking on behalf of the meeting's sponsors, welcomed the participants, thanked the national authorities for hosting the meeting and outlined the objectives of the meeting and their relation to the Global Investigation of Pollution in the Marine Environment.

Mr S. Keckes, Director of UNEP's Regional Seas Programme Activity Centre, briefly reviewed the approach of the UN system to environmental problems and stressed the role this workshop should play in the preparation of an action plan for the protection and development of the Gulf of Guinea and adjacent areas.

Mr Georges Kakadié, Director of Drainage and Sanitation of Abidjan, as Technical Chairman of the meeting, thanked the UN organizations involved for the interest they are showing in the region. Referring to the main forms of pollution in the Gulf of Guinea, he also underlined the objectives of the meeting and expressed the hope that it would help mobilize people to obtain a healthy environment.

The Minister of the Navy was the Honorary Chairman; the officers of the meeting were as follows:

Chairman : Mr Georges Kakadié, of the Ivory Coast
Rapporteur : Dr E.J.B. Tutuwan, of Cameroon
Secretary : Mr R.C. Griffiths, Assistant Secretary IOC

The Agenda is given in Annex I, and the List of Participants is given in Annex II.

Agenda item 2

LECTURES AND DISCUSSION ON FIVE MAJOR THEMES

Dr Anna Trzosinska of the Institute of Meteorology and Water Management in Gdynia, Poland, gave a talk on industrial discharges; a summary of this talk is given in Annex III.

Afterwards, several questions were raised concerning the direct application of the general principles enunciated in the talk to the actual situation in the Gulf of Guinea. For example, which groups of pollutants were likely to be the most important and dangerous in the Gulf of Guinea region? It appears that synthetic chemicals like PCBs, agricultural pesticides, organic matter from food processing, and red mud from the aluminium extraction process may create future pollution problems in the Gulf of Guinea. Of secondary importance are trace metals from local industry. It is unlikely that the action of pollutants in this region is significantly different from what it is elsewhere, but knowledge of the forms and modes of action of the metals already identified in marine waters has not yet been developed. It became quite clear that there is very little detailed information on the Gulf of Guinea. It was agreed that it would be essential to study not only the sources and sinks of pollutants but also the production, transfer and incorporation of pollutants in fish or other biological resources of nutritional value.

Mr Colin of the Centre de Recherche Océanographique in Abidjan gave a short impromptu talk on the surface and sub-surface currents in the Gulf of Guinea region, and their relationship to two anticyclones in the region of Mauretania to the north and Angola to the south. Mr Colin described their seasonal variations, as well as the surface winds and other characteristic phenonena. After the talk several questions were asked, including one on the depth of the surface currents; this depth is about 40m. The need to encourage oceanographic research was stressed, especially on the dynamics of the coastal waters. It was also thought desirable to undertake new simultaneous studies of the coastal waters of each country affected by this pollution by establishing, for example, lines of current-measuring stations so as to obtain a synoptic view of the coastal currents and follow their temporal variations.

Mr Paul Jeffery of the Warren Spring Laboratory, UK, gave a talk on oil pollution; a short summary of this talk is given in Annex IV.

In the discussion that followed it became clear that, although the fact of oil pollution in the Gulf of Guinea region was established, its magnitude remained largely unknown to most of the countries in the region. The question of the effects of dissolved hydrocarbons was raised and it was explained that some of the components are transformed biologically in the water column by certain bacteria. Some hydrocarbons may not pollute the marine environment; it depended on how pollution was defined, and the definition by GESAMP* was recalled. As to whether the effect of

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* IMCO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on Scientific Aspects of Marine Pollution.

dispersants was physical or chemical, Mr Jeffery explained that it was entirely physical. The ratio of dispersant to oil depends on the dispersant under consideration, but it is often 1 to 10.

It was asked whether a combination of various methods of combatting oil pollution would not be more effective. All the factors have to be taken into account, and no one method is suitable under all circumstances. Dispersants or burning may be used in the open sea, whereas skimmers may work better in ports, on rivers and in lakes. Asked whether research had been carried out on the use of micro-organisms to combat oil spills, Mr Jeffery explained that the oil components are metabolized by certain bacteria in the nutrient-rich environment, but there remained the difficulty of bringing to bear enough bacteria to degrade a substantial amount of oil in a reasonably short time. It was confirmed that research in France had lead to similar conclusions.

Hydrocarbon pollution was attributed principally to maritime transport and, to a lesser degree, to extraction and refinery. It is clear that it is impossible to avoid pollution due to oil extraction, or to the discharge of oily ballast water in the sea, without recourse to multilateral international conventions. On a global scale, 6.1 million tons of oil, or 0.3% of the total production, enter the marine environment annually from various sources. The largest inputs of oil are from normal operations and are intentional discharges, whereas accidents account for only about 6% of the global input.

Dr Louis Atayi of the World Health Organization gave a talk on the health aspects of coastal water pollution; a summary of this talk is given in Annex V.

During the discussion the problem of whether or not the danger from chemicals was greater was raised, since a relatively small proportion of the population was in direct contact with the sea. Although it was admitted that chemicals pose a considerable threat, it was not correct to say that only a small part of the population was exposed.

As regards the question of whether pathogens enter coastal waters via underground water from septic tanks, it was made clear that the extent of pollution from this source cannot be great in relation to other sources of pollution in view of the high die-off to which all forms of bacteria are subjected during the percolation of septic tank effluents through the soil and groundwater before entering the sea.

It was noted that the situation seemed paradoxical in that the domestic and municipal wastes, which should be treated before discharge into the sea, might serve as nutrients for phytoplankton and consequently for organisms at the higher trophic levels. It was pointed out, however, that food is relatively abundant since parts of the Gulf of Guinea are upwelling areas and therefore rich in nutrients. On the other hand, the discharge of domestic or industrial wastes into lagoons or estuaries is harmful since their decomposition uses up the oxygen dissolved in the water and kills the fish. It would be better to discharge these wastes through pipelines extending well into the sea.

The effects of marine pollution on tourism were considered, taking into account health effects. This pollution limits tourism as a source of foreign exchange for developing countries. It would be important to decide whether to give priority to domestic or industrial waste discharge. In any case it would be necessary to develop harmonious legislation among the countries of the region governing the treatment of wastes in each country. It was recognized that this was only of value where pollution constituted an actual or serious danger to man and his environment. Unfortunately, very little is known of pollution by heavy metals in the Gulf of Guinea and hence of the effects on biological systems. This lack was regretted and it was stressed that research should continue.

As regards the conditions under which waste could be discharged into the sea, it is necessary to know the determinant factors in any given area, such as currents and wind directions, although the main concern should be to treat wastes before discharge, as far as the limited resources of the region will allow.

Regarding the relations between the organizations of the UN system with respect to research and development in the region, the UNEP representative gave details of the respective roles of the relevant organizations.

The problems of floating logs and coastal erosion as pollution factors in the Gulf of Guinea were next discussed.

The Chairman cited a UNEP report which noted the dangers from floating logs and gave several examples, including local ones.

One of the participants supported this observation, and added that rafts of vegetation detritus up to a kilometre long may be formed off the coast of the region, and provide favourable surfaces for certain harmful micro-organisms. It was asked whether the rafts brought such organisms with them or whether they were already normally present in the sea; the latter explanation is the correct one, although the rafts favour their reproduction.

The majority of the participants noted that even with substantial logging operations in their respective countries, floating logs do not pose a problem of congestion or pollution in their ports.

In the discussion of coastal erosion, the participants noted that this was usually most severe where coastal construction, such as quays and breakwaters, had been undertaken. It also occurred in the vicinity of marine sand and gravel extraction sites. Several examples were given to show that the problem could reach serious proportions, posing a threat to a large number of people, as well as leading to material losses.

Some doubt as to whether this was a regional problem that could be studied on a regional basis was expressed. Evidently, the problem differed in nature and degree in each place, depending on physical factors such as sea currents, coastal topography, etc.

Agenda item 3

SUBJECTS REQUIRING SPECIAL ATTENTION

Based on general discussion which followed the presentation of the major pollution problems of the region (Agenda item 2) and on the replies to a questionnaire circulated among the participants, the most important sources and effects of pollution as well as the priority actions were defined as follows (listed in order of priority as perceived by the participants):

a) Major sources of marine pollution:

(i) petroleum hydrocarbons (mainly from maritime transport);
(ii) industrial waste;
(iii) sewage (domestic waste);
(iv) agricultural waste (pesticides, fertilizers).

b) Degree of importance of various pollution effects:

(i) effects on human health;
(ii) effects on fisheries resources;
(iii) effects on marine and coastal ecosystems;
(iv) effects on tourism.

c) Activities which should be promoted and assisted by the UN system:

(i) training of local scientists and technicians in techniques used in the determination of pollutant concentrations in the marine environment;

(ii) providing national institutions with the equipment needed for the analysis of the levels, and determination of the effects of pollutants;

(iii) training of local scientists and technicians in the techniques used to measure the effects of pollution on human health, fisheries resources, marine and coastal ecosystems;

(iv) training of local scientists and technicians in basic marine sciences;

(v) training of local scientists, technicians and administrators in methods of establishing acceptable environmental (water, seafood) quality criteria and effluent standards.

To improve the presently inadequate data on the sources of marine pollutants, a quantitative survey of land-based and maritime sources of pollutants was recommended.

The need for co-ordination, on regional and national levels, of the activities listed under c), and described later as priority programmes, was repeatedly stressed. In this connection a detailed survey of national

institutions (directory of scientific institutions and relevant administrative authorities) which do, or could, participate in pollution control activities was also recommended. A preliminary, incomplete list of these institutions was assembled during the meeting and is attached as Annex VI.

Assistance from the UN system would be essential to initiate and strengthen the ongoing pollution control activities. The main forms of this assistance are:

(i) establishment of a mechanism for co-ordinating activities requiring co-operation between countries;

(ii) training (fellowships for local scientists, technicians and administrators);

(iii) equipment for the detection and control of pollutants;

(iv) foreign experts.

Environmental protection activities should be based on sound information on the risks involved in pollution from various sources. Such information should be assembled, complemented with cost/benefit analyses in a perspective of long-term socio-economic development on an ecologically sustainable basis, and disseminated to relevant national authorities and the public at large.

Agenda Item 4

SUBJECT-MATTER WORKING GROUPS

Taking into account the views expressed during the discussion of agenda items 2 and 3, four groups were formed to prepare the draft proposals on the following subjects:

(i) pollution by petroleum hydrocarbons;
(ii) pollution by industrial waste;
(iii) pollution by sewage;
(iv) pollution by coastal erosion and siltation.

Agenda item 5

CONSIDERATION OF WORKING GROUP REPORTS

Four draft outlines for possible co-operative activities were prepared by the working groups established under agenda item 4. These drafts were discussed in plenary sessions and the workshop agreed that erosion phenomena (including sediment transport and siltation) and the presence of logs do not in themselves constitute pollution but that they can give rise to certain problems along the coasts of the Gulf of Guinea.

Although the workshop decided against proposing a pilot project on the subjects of coastal erosion and floating logs, it nevertheless

recommended: (i) the creation among the countries concerned of a mechanism for the exchange of information on the basic research on erosion and the application of research findings in these countries; (ii) the training of scientists and technicians in the study of erosion and its consequences so as to facilitate its control; (iii) the keeping open of the possibility of establishing a pilot project if the problem of erosion becomes significantly greater in the Gulf of Guinea region.

The remaining proposals served as a basis for the following three priority pilot projects which are recommended for implementation as part of an Action Plan for the Protection and Development of the Gulf of Guinea and Adjacent Areas. Short-term objectives set for each pilot project are those to be achieved during the life of the project; the long-term objectives are those to be achieved as a result of effective follow-up of each pilot project over a period of several years.

A. POLLUTION BY PETROLEUM HYDROCARBONS

Introduction

Pollution by petroleum hydrocarbons is increasing in the coastal waters and on the beaches along the whole coast of the Gulf of Guinea and adjacent areas. Effects observed locally indicate that some damage is being done to the coastal ecosystems and fisheries resources. The origin of this pollution is primarily the heavy maritime transport of crude oil, and to a lesser extent the local exploration, exploitation and refinement of petroleum. The presently available information on the extent of this type of pollution is very fragmentary and inadequate. Therefore, a continuous surveillance of the trends in the pollution of beaches and coastal waters of the Gulf of Guinea and of the adjacent areas is recommended.

Short-term objectives

(i) Development of applicable methods (based on those developed for similar problems elsewhere, notably under IGOSS) providing comparable data on the extent of pollution by petroleum hydrocarbons of coastal waters and beaches;

(ii) survey of sources discharging petroleum hydrocarbons directly into the coastal waters or into estuaries and rivers;

(iii) systematic observation of the pollution caused by tar balls on a few selected beaches used as reference points;

(iv) visual observation of oil slicks by ships, helicopters and airplanes of opportunity.

Long-term objectives

(i) Establishment of a co-operative network of observation stations along the coast of the region to provide, on a continuous basis, data on trends of petroleum hydrocarbon pollution of beaches and coastal waters;

(ii) regular surveys of the offshore waters for oil slicks;

(iii) elucidation of coastal (small-scale) current patterns which may influence the distribution of petroleum hydrocarbons along the coast of the region;

(iv) development of contingency plans for dealing with oil pollution emergencies (maritime accidents) on the basis of knowledge of the expected surface transport of oil and the vulnerability of ecosystems that might be affected;

(v) in harmony with the existing international treaties, the encouragement of the development of regional legislation by governments to regulate discharges of petroleum hydrocarbons and co-operation between countries in cases of emergency.

Implementation

To achieve the objectives the full co-operation of existing national scientific institutions and administrative structures and the UN system will be necessary. Institutions already in existence would have to be strengthened (training, equipment, additional personnel, foreign experts) and others created in countries where they do not exist.

B. INDUSTRIAL AND AGRICULTURAL WASTE

Introduction

Rapidly increasing industrial development of the region, particularly in the coastal zones and along the major rivers, is likely to lead to an increase in the volume and diversity of industrial wastes discharged without adequate treatment into the marine environment. Detrimental effects of these discharges have been observed in many places, and yet practically no records exist on the amounts discharged, on the concentration of these pollutants in the marine environment or on their effects on marine life and human health. The same applies to the various pesticides and fertilizers which are used in increasing quantities. Considering that the living marine resources, which are easily damaged by these types of pollutants, constitute an important source of revenue and food for the population of the region, a pilot project to assess the magnitude of the problem caused by discharges of industrial and agricultural wastes into the marine environment is recommended.

Short-term objectives

(i) preparation of a detailed survey of land-based sources of industrial and agricultural pollutants;

(ii) formulation of locally applicable principles and guidelines governing the discharges of industrial and agricultural wastes;

(iii) initiation of baseline studies on the levels and effects of selected industrial and agricultural waste products on commercially important marine organisms.

Long-term objectives

(i) Establishment of regionally applicable standards for the management and control of industrial and agricultural pollutants.

Implementation

To achieve these objectives the co-operation of existing national scientific institutions and administrative structures and the UN system will be necessary. Existing institutions would have to be strengthened (training, equipment, additional personnel, foreign experts) and others created in countries where they do not exist.

C. DOMESTIC WASTE (SEWAGE)

Introduction

Untreated or inadequately treated sewage contains high concentrations of nutrients and micro-organisms. Nutrients may lead to eutrophication of coastal receiving waters and lagoons with various negative consequences (plankton blooms, oxygen depletion, fish kills). Depending on the type of carriers, micro-organisms discharged with sewage include various pathogenic forms which are a risk for bathers and to those who eat contaminated sea-food (shellfish in particular).

The degree of sewage treatment and the disposal practices in the region are not satisfactory at present and therefore a pilot project to assess the magnitude of the problem and the negative consequences of pollution caused by sewage and to provide a basis for environmentally sound management of the sewage treatment and disposal is recommended.

Short-term objectives

(i) Preparation of a survey of present sewage treatment and disposal practices in the region;

(ii) development of principles and guidelines for sewage disposal practices, including locally applicable effluent standards based on the evaluation of waste-receiving capacity of the receiving waters;

(iii) initiation of systematic surveys (monitoring) of the microbiological (sanitary) and biological quality of recreational waters, shellfish-growing waters and seafood;

(iv) initiation of epidemiological studies on the relationship between the quality of coastal waters (including edible organisms) and the incidence of waterborne diseases.

Long-term objectives

(i) Establishment of regionally applicable standards for the control and disposal of domestic wastes (sewage).

Implementation

The proposed pilot project should be carried out by national institutions of the region organized in a co-operative network. Institutional arrangements should be made to co-ordinate the work of this network, to provide guidance in selection of methods and in the evaluation of the results, to assist with training of local scientists, technicians and managers, and to provide laboratory and field equipment and material to the collaborating national institutions.

Agenda item 6

ADOPTION OF THE REPORT OF THE WORKSHOP

The report was adopted by the participants.

Agenda item 7

CLOSURE OF THE WORKSHOP

Mr R.C. Griffiths, Assistant Secretary, IOC, speaking on behalf of the sponsoring organizations, reviewed the results of the Workshop. He thanked the participants for their active co-operation in making it a success and, speaking also on their behalf, thanked the Ivory Coast government for hosting the meeting in Abidjan. He also thanked the supporting staff for their great help.

Mr Mema Soumahoro, representing the Minister of the Navy, in closing the Workshop, congratulated the participants on their work and expressed the hope that the sponsoring organizations would follow up the recommendations of the Workshop. He declared the meeting closed at 1600 on 9 May 1978.

International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas

Abidjan, Ivory Coast
2 - 9 May, 1978

AGENDA

1. Opening of the Session.

2. Lectures and discussion on five major themes:

   sewage;
   industrial wastes;
   logs;
   oil, and
   coastal erosion.

3. Subjects requiring special attention.

4. Subject-matter working groups.

5. Consideration of working group reports.

6. Adoption of the report of the Workshop.

7. Closure of the Workshop.

ANNEX II

International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas

Abidjan, Ivory Coast
2 - 9 May, 1978

LIST OF PARTICIPANTS

ALUKO, T.M.
Faculty of Engineering
University of Lagos
LAGOS
Nigeria

COLIN, C.
Centre de Recherche Océanographique
B.P. V-18
ABIDJAN
Ivory Coast

DAOU, M.D.
World Health Organization
B.P. 320
NOUAKCHOTT
Mauritania

DEBRAH, J.K.
Fisheries Research Unit
P.O. Box B-62
TEMA
Ghana

JEFFERY, P.G.
Department of Industry
Warren Spring Laboratory
STEVENAGE, Herts
U.K.

KAKADIÉ, G.
Direction de Drainage et Assainissement
B.P. 21 181
ABIDJAN
Ivory Coast

KPEKATA, A.E.
Institute of Aquatic Biology
P.O. Box 38
ACHIMOTA
Ghana

LEMASSON, L.
Antenne ORSTOM
Station INRA
Ave. de Corzent
74203 THONON
France

MBEMBA, E.
Direction de l'Environnement
Ministère de la Construction, de
l'Urbanisme et de l'Habitat
B.P. 2099
BRAZZAVILLE
Congo

MOUTSARA, A.	Ministère de la Construction, de l'Urbanisme et de l'Habitat B.P. 2099 BRAZZAVILLE Congo
NENONENE, K.D.	Service National d'Assainissement Santé Publique LOMÉ Togo
OKERA, W.	Fourah Bay College University of Sierra Leone FREETOWN Sierra Leone
OREKOYA, T.	Nigerian Institute for Oceanography and Marine Research Victoria Island PMB 12729 LAGOS Nigeria
REBERT, J-P.	CRODT B.P. 2241 DAKAR Senegal
ROTSCHI, H.	Centre de Recherche Océanographique B.P. V-18 ABIDJAN Ivory Coast
TRZOSINSKA, A.	Institute of Meteorology and Water Management Waszyngtona 42 81316 GDYNIA Poland
TUTUWAN, E.J.B.	Faculty of Science University of Yaoundé B.P. 812 YAOUNDÉ Cameroon

Local observers

AYMÉ, P.	SETU DDA B.P. 21181 ABIDJAN Ivory Coast
BAGOU, O.	SETU B.P. 21181 ABIDJAN Ivory Coast

CAPREZ, C.	SETU B.P. 21181 ABIDJAN Ivory Coast
CHAPELLIER, F.	Direction Centrale de l'Assainissement B.P. V-83 ABIDJAN Ivory Coast
COMBES, J.	SETU DDA B.P. 21181 ABIDJAN Ivory Coast
KLUR, F.	Laboratoire des Pêches B.P. V-19 ABIDJAN Ivory Coast
KONÉ-OBRÉ, H.	Ministère de la Marine B.P. V-67 ABIDJAN Ivory Coast
MIAN, E.G.	Marine Nationale B.P. V-12 ABIDJAN Ivory Coast
OKA, L.B.	Ministère de la Marine B.P. V-67 ABIDJAN Ivory Coast
STRETTA, J-M.	Centre de Recherches Océanographiques B.P. V-18 ABIDJAN Ivory Coast
ZABI, S.G.	Centre de Recherches Océanographiques B.P. V-18 ABIDJAN Ivory Coast

Representatives of international organizations

United Nations

ODUNTON, N.A.	United Nations New York N.Y. 10017 U.S.A.
OTIENO, A.	Economic Commission for Africa Box 3001 ADDIS ABABA Ethiopia

United Nations Environment Programme

BLISS, P.	UNEP Palais des Nations CH-1211 GENEVA 10 Switzerland
KECKES, S.	UNEP Palais des Nations CH-1211 GENEVA 10 Switzerland
TANGI, M.	UNEP Palais des Nations CH-1211 GENEVA 10 Switzerland

Food and Agriculture Organization

NAEVE, H. (also representing CECAF **)	FAO Fishery Resources and Environment Division Via delle Terme di Caracalla 00100 ROME Italy

World Health Organization

ATAYI, L.	OMS B.P. 2494 ABIDJAN Ivory Coast
HELMER, R.	WHO Avenue Appia CH-1211 GENEVA 27 Switzerland

United Nations Educational, Scientific and Cultural Organization

GRIFFITHS, R.C.	Intergovernmental Oceanographic Commission Place de Fontenoy 75700 PARIS France

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** Fishery Committee for the Eastern Central Atlantic (of FAO)

Secretariat

GRIFFITHS, R.C.	Intergovernmental Oceanographic Commission Place de Fontenoy 75700 PARIS France
NAEVE, H.	FAO Via delle Terme di Caracalla 00100 ROME Italy
KECKES, S.	UNEP Palais des Nations CH-1211 GENEVA 10 Switzerland
KIRWIN, G.W.	Intergovernmental Oceanographic Commission Place de Fontenoy 75700 PARIS France

SUMMARY OF TALK ON INDUSTRIAL DISCHARGES
INTO THE MARINE ENVIRONMENT, by
Dr Anna Trzosinska

Annex III

The specific feature of industrial effluents is the variety of their chemical composition and physical parameters, which depend not only on the manufacture but also on the technology applied. For example, the effluents from the chemical and pharmaceutical industries are generally very complex and toxic but their volume is usually small. There are, however, industries, such as food production, that discharge non-toxic wastes which have a high content of organic matter. The degradation of these effluents depletes the oxygen dissolved in sea water and causes hydrogen sulphide to appear.

Relatively little is yet known about the discharge of industrial waste into the sea. This is partly because we have paid much more attention to pollution problems in inland waters, and less attention to the marine environment. There are some factors which are different and much more complex for large bodies of water; they prevent the direct translation of the technology developed for river pollution control to the sea, and there are some factors unique to coastal waters. This complexity is due to the fact that:

- the physical behaviour is variable in time and space, consequently there are variable chemical and biological interactions which occur between the pollutants, the water and the marine organisms;
- besides run-off and/or discharge through outfalls, the atmosphere is an equally important source of many marine pollutants;
- the international character of the marine environment, as well as some of its pollution sources (atmosphere, transportation) causes some problems of control and protection.

These factors complicate the assessment of the contribution of various sources. The most difficult task, however, is to determine the exact

chemical and biological interactions that give rise to the problem. Because of the relatively high rate of dilution of most wastes discharged into the sea, incremental pollution loads cause relatively small incremental changes in water quality. As such, the resulting effects on the ecological balance are likely to be rather subtle and manifestation of cumulative effects can be delayed for long periods of time.

The main synthetic organic compounds are: pesticides, polychlorinated biphenyls (PCBs), halogenated benzene derivatives and phthalate esters. Oceans are the recipient and ultimate accumulation sites for persistent pollutants like organochlorines. It has been estimated that one-quarter of all DDT applied to the land has found its way to the sea. Although all these compounds are industrial products, they can be divided into two groups according to their fields of application:

1. Pesticides, including:
   - insecticides :- chlorinated hydrocarbons (DDT, aldrin, dieldrin, etc.),
     - organophosphates (melathion, parathion, etc.),
     - carbamates,
   - fungicides :- dithiocarbamates,
     - nitrogen-containing compounds like triazines,
     - heterocyclics,
     - quinones,
     - hexachlorobenzene,
     - inorganics, such as heavy-metal salts
   - herbicides :- phenoxy-acids,
     - a large number of other organic compounds.

2. Industrial toxicants, including:

- polychlorinated biphenyls which are used in many fields of modern man's activity. Their industrial uses depend upon the following special physico-chemical characteristics: high stability, non-flammability, low water-solubility and volatility, and high dielectric constant. The utilization of PCBs falls into two categories:

  a) recoverable - in closed system such as dielectrics (in transformers);

  b) dissipative - in which there is some loss to the environment (hydraulic fluids, especially in the systems which demand high temperatures, heat transfer fluids, plasticizers, lubricating oils, paints).

- phthalate esters which were introduced in the 1920s in the plasticizer industry. They are widely used in many fields (construction, furnishing, clothing, food wrappings, medical products). The evidence that they are readily assimilated into the blood from plastic storage bags and other medical devices gave rise to the fear that the human population might be continuously exposed.

World-wide production data for PCBs and other chlorinated hydrocarbons are not available as a function of time. The estimated cumulative global production of PCBs since the 1930s is about one million tons. The production of chlorinated hydrocarbons in many highly industrialized countries reached a peak in the 1960s and 1970s. After recognition that they may

threaten environmental resources and represent a direct hazard to human health, there was a decided drop in the production of DDT and PCBs following the legislation restricting their use in many countries. The production of phthalates is still very high; for instance, in the USA it exceeded 0.5 million tons in 1974.

The effects of synthetic organics on the marine environment may occur at various ecological levels: decreased growth of oysters due to pesticides, reproductive failure in bald eagles, or mass fish mortality. Although most organophosphate and carbamate pesticides are considered to be short-lived, there is evidence that some may not be. Furthermore, there are some suggestions that the metabolism of carbamates by animals leads to nitroso-compounds, which are well-known carcinogenic agents. The presence of oil in the sea increases the accumulation effect of polychlorinated hydrocarbons because of their lipophilic character; this feature allows also biological accumulation and food-chain magnification.

Many metals in trace amounts are essential to all life systems, but excess amounts are toxic. Beside the natural input of metals due to weathering and degassing processes, metals are released into the sea mainly from the combustion of fossil fuels and from industry. Special attention should be given to areas of:

- mining
- smelters
- metal-plating plants
- cement production
- desalination plants
- dredge spoils and sewage-sludge disposal areas
- chloralkali, electrical equipment and paint production (mercury).

Because trace metals occur naturally in the marine environment, the problem of determining their anthropogenic contribution is more difficult than with halogenated hydrocarbons. Although the world production of many metals and their routes of entry into the sea are defined (see FAO Fisheries Report No.99) we have more detailed information on only 36 elements and of these only 18 have toxicity data listed; and of the 18, perhaps 4 (Hg, Cd, Cu, Zn) are sufficiently documented to allow the formulation of water quality criteria.

When viewed as a whole, ocean systems appear to be unlimited in their ability to dilute human discharges. But ocean waters, and especially estuaries, are not uniformly mixed, and non-uniform dilution can cause local concentration of metals. Estuaries, because they are landward extensions of the sea, become centres of industrial, commercial and related activities. As a consequence, coastal zones, including gulfs,bays, lagoons etc. have received an increasing input of metals.

Metals can be introduced directly from contaminated rivers and land run-off, or directly by pumping from land-based industrial plants, ships and barges. The importance of the atmosphere as a carrier of trace metals to the aquatic environment has not generally been appreciated for a long time. Only in recent years have papers appeared which take into account atmospheric fallout and precipitation in the trace metal budget.

Metals tend to be concentrated at air-sea, water-sediment or fresh water-sea water interfaces and the boundaries between the water and living, as well as dead, suspensions. Some metals discharged even in small quantities can be accumulated to a high level by certain marine biota.

It must be recognized that it is not necessarily the total amount of a metal present in sea water or marine sediments but the form of the metal that may be important in the metal's effect on marine organisms. Besides many different chemical forms we have also dissolved and particulate metals. Particulate metals occurring in high concentrations near industrial outfalls or ocean dumping sites, including dredge spoil dumping, are likely to affect filter-feeding organisms, which ingest and concentrate particulate matter. Consequently, the form of the metals may be the dictating factor in the environmental response to trace metals. In many cases this response is specific for a given metal.

There are some other specific types of industrial wastes that might be of interest for the Gulf of Guinea and adjacent areas. The common feature of these wastes is that thepotential harm to the marine environment can arise not necessarily from their toxicity but from mechanical or physical effects of suspensions of them in the sea:

- Acid wastes from titanium dioxide production contain mainly sulphuric acid and ferrous sulphate. The experiment carried out in the German Bight (North Sea) proved that because of the high buffering capacity of sea water these acid wastes brought about only small changes in the pH value. What is noteworthy is that no increase in iron content could be detected in the bottom sediments. The main part of the iron from the wastes precipitated and formed a suspension close to the sea bottom, and was removed far from the dumping site by sea currents. There was, however, the negative influence of ferric hydroxide on benthic fauna associated with an increased transport of flocculated material through the digestive tract. The high mortality was caused

by a loss of organic material and a reduction in food available to the animals, but not by acute toxicity of ferric hydroxide;

- Red mud is an alkaline product of aluminium extraction from bauxite, primarily consisting of ferric oxide and aluminium hydroxide. None of these components seems to be very toxic. Their possible harmful effect arises from an accumulation in the digestive tracts of various filter-feeders, thereby reducing the food intake and the chance of survival of these organisms;

- Asbestos waste products (tailings) discharged into the sea have a grain size smaller than 1 mm. Studies made of Mytilus edulis as a biotest organism showed enormous damage to the tissues. These changes are irreversible and probably can affect the organisms of the higher trophic levels.

SUMMARY OF TALK ON OIL POLLUTION IN THE MARINE ENVIRONMENT, by Mr Paul Jeffery

Mr Paul Jeffery gave a lecture on oil pollution. He noted that oil had only become important as a fuel well into the present century and would probably decline in importance before the end of it. Now it was by far the most important fuel in human history. In spite of general impressions to the contrary, it was still a comparatively cheap fuel. Most of it is transported from where it is produced to centres of consumption. The first boat designed to carry oil was laid down in 1886. It was about 100 m long and had a capacity of 3,000 tons. Now, modern supertankers are over 300 m long and have a capacity of half a million tons. Supertankers are not more prone to accidents than other types of ships; in fact, rather the contrary. Most accidents are nearshore or on it; large vessels stay offshore until nearing their arrival point. When a supertanker is wrecked, however, it is a very big accident. The mess made of beaches, harbours etc. is unbelievable. Yet, more serious overall are the accidental and operational discharges at oil terminals and in oil ports. They are due to overloading, pump failure, rupture of piping and pipe couplings. These discharges are small in volume but frequent, and have an adverse effect on port and terminal operations and their surroundings.

Ships burn oil and discharge bilge, often at night in busy shipping lanes. There are very few bilge-reception facilities anywhere, and this

is particularly true for the Gulf of Guinea area and adjacent regions. The same is true of the Persian Gulf. The main traffic is between the Gulf and Europe, passing around the coast of Africa, and between the Gulf and Japan.

The whole ocean is polluted by oil; not just the inshore areas even though tar balls are deposited on the beach. The problem is thus world-wide. Besides tar ball pollution of beaches, severe damage may be done to bird colonies; for some species at a low level of abundance, such damage is potentially fatal to the species. Fish can generally avoid areas of high petroleum pollution and remain hardly affected; nevertheless, tainting may occur, rendering worthless the food value in relevant species. Shellfish, being generally immobile, are in a more difficult position. Limpets cannot stick to oiled rocks, however, and fall prey to birds. Certain compounds in petroleum interfere with chemical signals used in mating in certain fish and shellfish.

There are three forms of abatement: burning, dispersing or removing. All are difficult under maritime conditions. Burning is not easy because of the need to make air available inside the tankers. Once oil has mixed with water it takes up water to a level of about 75% on the sea surface, and cannot be burned. It may be possible to sink oil to the bottom: the best way is to bring up sand from the bottom, treat it chemically to make the oil stick to it, and then to spray it on the oil slick which is carried down by the sand. This method is expensive and not generally used. The commonest method is dispersants. The dispersant/oil combination is degraded by biological action. Dispersants may do harm to marine organisms but this is relatively short-lived. Dispersants are no good for tar balls.

In theory the best method is removal. This is not easy. On beaches it may be easier to remove a whole beach and then bring in new sand, which would be very costly. Tar balls can be picked up mechanically, though many are very small and may be missed. Skimmers, designed to take the oil off the sea surface, are not effective in the open sea, though they can be useful on rivers and lakes.

The best solution is to prohibit discharge from ships at sea; international law must be applied. Even so, there is a need for preparedness for emergency action.

SUMMARY OF A TALK ON HEALTH EFFECTS OF COASTAL WATER POLLUTION, by Dr Luis Atayi

In the Gulf of Guinea, as elsewhere, growing coastal populations of both residents and tourists result in increasing pollution loads in the adjacent environment. Wastes often remain untreated and are dumped into the nearest river or lagoon or onto the nearest beach.

The most serious effect of such practices on human health is the transmission of disease by either the ingestion of contaminated seafood or by direct bodily contact with pathogenic organisms in seawater or on beaches. Other objections to the improper disposal of sewage and other wastes concern the ecological hazards of indigenous flora and fauna, with potentially disastrous effects on local fisheries, and aesthetic insult to the inhabitants and visitors.

An adult eliminates approximately 1 kg (wet weight) of excreta per day and this, along with suspended debris, food leavings, detergents and household chemicals, and wastes from small industries, slaughterhouses, hospitals and other institutions, forms the content of municipal sewage.

In the Gulf of Guinea region, sewage systems are rare, waste treatment plants are in the planning stage only, and with few exceptions wastes are dumped into the sea or onto beaches with impunity. It can be assumed that when a relatively large reservoir of disease exists in a community, which is largely the case in the towns and villages of West Africa, such practices constitute an especially serious health hazard to local inhabitants.

The Gulf of Guinea is a relatively heavily populated region of Africa. In the 19 countries of the region, about 8% of the total population live in coastal towns. The port capitals are located in areas

where major industrial and other socioeconomic activities are concentrated. The tourist industry is growing rapidly and may at times increase the effective population of certain coastal areas significantly. It is thus expected that the coastal areas around such population centres and areas of activity will be the foci of health problems associated with coastal pollution.

Pollutants from industrial sources are highly varied and difficult to characterize. Industrial wastes usually contain variable amounts of the raw materials, intermediate products, final products, and by-products of the manufacturing process, along with ancillary and processing chemicals. Among the thousands of substances potentially present in industrial wastewaters are detergents, solvents, cyanides, heavy metals, mineral and organic acids, nitrogenous substances, fats, salts, bleaching agents, dyes and pigments, phenol compounds, tanning agents, sulfides and ammonia. Many of these have chronic and/or acute toxic effects.

Industrial development is proceeding relatively rapidly in the Gulf of Guinea region, and major industries include oil refineries, phosphate plants and sugar factories. Proposed industries which may be highly polluting are pulp and paper mills, chemical industries, and cement and fertilizer factories.

Pollution from agricultural practices comes from animal wastes, erosion, fertilizers, herbicides, pesticides, and inorganic salts and minerals resulting from irrigation. Nutrients (mostly phosphorus and nitrogen) and persistent organochlorine compounds (pesticides) are the most troublesome of these and, although they have little or no known effect on human health at present environmental concentrations, they can

greatly affect coastal marine communities, especially where the nutrients and toxic compounds are concentrated in lagoons and estuaries.

Rivers, transporting many of the above-mentioned pollutants from their inland sources, have been found to be the largest contributors to coastal pollution in the Mediterranean, and as inland industrial development proceeds in West Africa it is likely to lead to a similar situation. Industries located inland at present are a chemical plant (Ghana), aluminium industry (Guinea), diamond mine (Sierra Leone) and iron ore industry (Liberia).

Pathogenic organisms present in domestic sewage are considered a good indication of the nature and incidence of infection in a community, although pathogens found in coastal waters can also originate from slaughterhouse and farm wastes, domestic animals, rodents living in the sewers, or simply from natural populations in marine waters and sediments.

We may distinguish two major pathways of infection caused by pathogenic organisms in polluted coastal waters. They are (1) direct body contact with pathogens in the water, and (2) ingestion of pathogens in contaminated seafood.

As the popularity of ocean bathing increases and coastal areas undergo industrial growth, the number of individuals exposed to health hazards associated with coastal pollution increases rapidly. Exactly how much microbial pollution constitutes a health hazard, if it does at all, is a subject of controversy. Evidence is inconclusive, partly due to difficulties in epidemiological methodology discussed above.

It is clear that the risks associated with bathing in sewage-polluted water is minimal when compared with that which occurs from eating improperly prepared or handled seafood. However, even here the evidence

is largely indirect, and consists of the isolation of pathogenic bacteria from various shellfish and enteric viruses from oysters taken from polluted water. Bacterial infections constitute the greatest proportion of fish- and shellfish-borne diseases, perhaps partially due to the ability of filter-feeding organisms such as oysters, clams, mussels and scallops to concentrate bacteria, and probably viruses, many times over their levels in the surrounding water.

Vibrio cholerae, the causative agent of cholera, is not normally found in the marine environment, but occurs in sewage from communities where the disease occurs. It is highly contagious and persists in brackish coastal water for variable periods. There is evidence that shellfish can serve as the vehicle of infection for this organism. Seafood organisms can accumulate these vibrios directly from seawater or during any stage of handling, transport or storage.

Vibrio parahaemolyticus occurs naturally in marine waters, sediments, invertebrates and fish throughout the world. It is not generally associated with sewage outfalls, but can occur in elevated numbers in seawater near shrimp-processing factories. The organism is most commonly found in crustaceans, and large numbers are necessary for intoxication.

A study has shown that since brackish lagoons and lakes are typical of the coastal region between Nigeria and the Ivory Coast, it is likely that V. parahaemolyticus is a widespread pathogen in these areas.

Typhoid and paratyphoid fevers, caused by the organisms Salmonella typhi and S. paratyphi respectively, are the most common diseases associated with the consumption of shellfish, particularly raw molluscs, from sewage-polluted waters. They are endemic and often epidemic in subtropical and tropical areas. Shellfish and fish, by filtering water through their

gills, can concentrate the bacteria and, although these provide the major channels of infection, there are reports of instances where typhoid was caused by contact with a sewage-polluted beach or swimming in highly contaminated water.

Salmonellae are widespread in the environment due to contamination from human and animal excreta, and both warm- and cold-blooded animals may serve as reservoirs without developing disease symptoms. Shellfish taken from sewage-polluted water may contain salmonellae or may acquire them from contact with polluted water or soil, infected domestic animals, or food handlers.

Bacteria of the genus Shigella (Sh. dysenteriae, Sh. flexneri, Sh. boydii and Sh. sonnei) may be transmitted through food, water or, more commonly, through direct human contact. They survive for only a short time in the marine environment, but the infective dose is very low.

Dr Atayi noted that there were also several other bacteria that might pose a danger under certain circumstances.

Viruses which multiply in the human alimentary tract may be found in considerable amounts in sewage and polluted water. There is evidence that, under some circumstances, virus particles remain viable in seawater considerably longer than bacteria such as E. coli.

Chemicals that are potentially hazardous to residents of polluted coastal regions are metals and organochlorine compounds from industry and agriculture.

The well known and dramatic Minamata case involved the deaths of 40 Japanese villagers and the debility of many more from the consumption of seafood containing organomercury compounds. Most organic mercury compounds

decompose into the inorganic form in the marine environment (sediments), after which they are transformed by microorganisms into methylmercury, $(CH_3)_2Hg$, an extremely toxic compound which can concentrate in the food chain.

Cadmium is another metal implicated in serious human disease, notably the "itai-itai" disease in Japan. Cadmium tends to be adsorbed from solution by suspended particles and bottom sediments and may be difficult to detect in the water column.

Among other metals which may become concentrated to toxic levels in marine animals are antimony, arsenic, barium, beryllium, lead, selenium and zinc.

Organochlorine compounds are fat soluble and tend to accumulate in aquatic animals. Pesticide residues from agriculture and manufacturing adsorb onto suspended particles in water where they undergo sedimentation or are consumed by filter-feeding organisms.

Two especially persistent and toxic pesticides, DDT and dieldrin, have been used for many years in antimalarial programmes throughout Africa, but at present pesticide use in West Africa appears to be largely agricultural. In six Gulf of Guinea countries during 1972, nearly 10,000 metric tons of pesticide (unspecified) were used in agriculture. Use had increased by 1974 to over 8,000 tons in only two countries. It is expected that much of this will end in the sea, coastal lagoons and estuaries.

Polychlorinated biphenyl compounds (PCBs), which originate from industrial sources, are frequently found in municipal sewage and waters receiving industrial wastes. Chemical industries in the Gulf of Guinea region may be a potential source of these compounds.

The general persistence of organochlorines and the lack of information on their long-term effects on humans and ecosystems make them a potential health problem in any area where agriculture and industrial activities take place adjacent to fisheries and aquaculture areas.

Oil, while not a direct threat to human health, can taint seafood and make it useless to those who are dependent on it for nutrition or income. Oil may persist in the tissues of shellfish for months after a spill. Pollution of coastal waters and beaches by oil has been identified as one of the major pollution problems in the Gulf of Guinea region.

In 1974 about 132.4 million tons of oil was produced in Nigeria, Gabon and Angola, about 90-93% of which was exported as crude petroleum. New reserves have been discovered in Zaire and Congo. It is thought that a significant source of oil pollution along the Gulf of Guinea coastline is discharge from ships transporting oil along offshore routes.

Any attempt to diminish the risk to health from domestic and industrial pollution through the establishment of formal control measures necessarily involves four successive stages of activity. These are as follows:

(1) assessment of the degree of pollution and associated risk through monitoring and surveillance programmes;

(2) determination of water quality criteria on the basis of predictive models and epidemiological studies;

(3) translation of criteria in "acceptable risk" guidelines and regulatory standards; and

(4) development of appropriate control strategy and associated legislation.

LIST OF INSTITUTIONS WHICH MAY PARTICIPATE IN THE ASSESSMENT OF THE SOURCES, LEVELS AND EFFECTS OF POLLUTANTS

CAMEROUN

Institute of Zootechniques
ONAREST
Ngaoundere
Cameroun

Department of Organic Chemistry
Faculty of Science
BP 812
YAOUNDÉ, Cameroun

Department of Fisheries
Ministry of Agriculture
DOUALA, Cameroun

CONGO

Centre de Recherches Océanogrpahiques de Pointe Noire
B.P. 1286
POINTE NOIRE, Congo

Section Océanographique
Faculté de Sciences
Université Marien N'Gouabi
BRAZZAVILLE, Congo

Direction de l'Environnement
Ministère de l'Urbanisme
B.P. 2099
BRAZZAVILLE, Congo

GHANA

Institute of Aquatic Biology
CSIR
Box 38
ACHIMOTA, Ghana

Fisheries Research Unit
Fisheries Department
Box B-62
TEMA, Ghana

Zoology Department
University of Cape Coast
CAPE COAST, Ghana

Zoology Department
University of Ghana
Legon
ACCRA, Ghana

Environmental Protection Council
Parliament House
ACCRA, Ghana

GHANA (contd.)	Chemistry and Biology Departments University of Science and Technology KUMASI, Ghana
IVORY COAST	Direction du Drainage et Assainissement SETU - DDA BP 21181 ABIDJAN, Ivory Coast
	Société de Recherches des Mines (SODEMS) Ministère des Mines ABIDJAN, Ivory Coast
	ORSTOM BP 20 ABIDJAN, Ivory Coast
	CRO Ministère de la Recherche Scientifique BP V-18 ABIDJAN, Ivory Coast
	IDREM Ministère de la Marine Nationale ABIDJAN, Ivory Coast
	Société Ivoirienne de Raffinage ABIDJAN, Ivory Coast
NIGERIA	Nigerian Institute for Oceanography and Marine Research Victoria Island PMB 12729 LAGOS, Nigeria
	University of Lagos Faculty of Science LAGOS, Nigeria
	Department of Biology University of Calabar CALABAR, Nigeria
	Department of Biological Sciences University of Port Harcourt PORT HARCOURT, Nigeria
	Federal Institute of Industrial Research Oshodi LAGOS, Nigeria
	Department of Chemistry University of Lagos Akoka LAGOS, Nigeria

NIGERIA (contd.)	School of Biological Sciences University of Lagos Akoka LAGOS, Nigeria
	Department of Environemtnal Design University of Lagos Akoka LAGOS, Nigeria
	Department of Chemistry University of Ibadan IBADAN, Nigeria
	Department of Biological Sciences University of Ife ILE-IFE, Nigeria
SENEGAL	ISRA CRODT BP 2241 DAKAR, Senegal
	Institut Pasteur DAKAR, Senegal
SIERRA LEONE	Institute of Marine Biology & Oceanography Fourah Bay College University of Sierra Leone FREETOWN, Sierra Leone
	Department of Chemistry Fourah Bay College University of Sierra Leone FREETOWN, Sierra Leone
	Fisheries Division Ministry of Agriculture & Natural Resources Tower Hill FREETOWN, Sierra Leone
TOGO	Direction du Service de l'Hydraulique et d'Electricité Ministère des Mines, de l'Energie et des Ressources Hydrauliques LOMÉ, Togo
	Service National d'Assainissement Direction Générale de la Santé Publique LOMÉ, Togo
	Service des Mines et de Géologie Ministère des Mines, de l'Energie et des Ressources Hydrauliques LOMÉ, Togo

TOGO (contd.)

Direction du Plan
Ministère du Plan et de l'Industrie et
de la Reforme administrative
LOMÉ, Togo

Université du Bénin
Ecole des Sciences
Ministère de l'Education nationale et
de la Recherche scientifique
LOMÉ, Togo

Service National des Pêches
Ministère de l'Amenagement Rural
LOMÉ, Togo