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AND

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
(UNESCO)

Project RAF/78/024/4/01/51

Development of Marine Science and Technology
in Africa

WORKING GROUP MEETING

Addis Ababa,
Ethiopia

5 - 9 May 1980

THE STATE OF MARINE SCIENCE
AND
TECHNOLOGY DEVELOPMENT
IN
AFRICAN COASTAL STATES

Project RAF/78/024/A/01/51
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THE STATE OF MARINE SCIENCE AND TECHNOLOGY
DEVELOPMENT IN AFRICAN COASTAL STATES

1. PREAMBLE

During the past three years, both ECA and Unesco have made an increased effort directed towards strengthening the co-operation between the two Organizations with the formulation and implementation of development programmes for Africa. As an outcome of this effort, a document entitled "Arrangement between the Director-General of the United Nations Educational, Scientific and Cultural Organization and the Executive Secretary of the Economic Commission for Africa" was signed on 10 May 1979.

As stated in this document,

"The broad objectives of co-operation and of joint programme activities between Unesco and the Commission are the following:

- (a) to provide an operational basis for conceiving, formulating, programming and initiating joint action on specific projects within areas of common concern and regional priorities;
- (b) to initiate studies and provide background information on specific problem areas in science and technology such as would provide African States with guidelines for the formulation of policies and programmes for the development of science and technology education and research relating to socio-economic progress;
- (c) periodically to review and appraise the efficiency, relevance and effectiveness of science and technology as tools for national development of Member States in the African region;
- (d) to promote national and multi-national action in programmes in intra-African co-operation in the development and utilization of facilities for scientific and technological education, training and research".

Furthermore, it was agreed that priority would be given to joint action in respect of programme activities and projects coming within the scope of this agreement in a specific number of fields, including marine science and technology.

Within the framework of this Arrangement and as a result of extensive consultation between ECA and Unesco, a project document on the Development of Marine Science and Technology in Africa was prepared as the first project for joint implementation by ECA and Unesco as Executing Agencies. The document describes the preparatory phase of the project, which has a duration of fourteen months and is funded by UNEP (US\$ 282,700). The following is an excerpt from the Project Document, which was approved by ECA, Unesco and UNDP in October 1979: ^{1/}

"A. Development Objective

1. To enhance the capability of existing marine science institutions through the development of a regional and sub-regional programme of research and training in marine science and technology, with due regard being paid to the development of marine environmental services, shipping, coastal area development and the protection of the marine environment.
2. To develop the ability of African countries in understanding and making use of their marine resources through regional and subregional co-operation, based on active exchange in scientific and policy matters, and a continuous mechanism of contacts among scientists and decision-makers in African member states.

B. Immediate Objectives

1. An up-to-date inventory of human resources, infrastructure and facilities, as well as national policies, on-going and planned programmes in marine science and technology available in East and West Africa, as a result of field missions to the following countries:

^{1/} This section gives a general account of the Project as outlined in the Project Document. For fuller information, it should be read in conjunction with the Introduction.

East: Sudan, Djibouti, Ethiopia, Somalia, Kenya, Tanzania, Mozambique, Madagascar and the Indian Ocean Islands. West: Morocco, Mauritania, Senegal, the Gambia, Sierra Leone, Guinea Bissau, Guinea, Gabon, Equatorial Guinea, Cape Verde, Sao Tome and Principe, Liberia, Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon, Congo, Zaire, Angola and Namibia. [¶]

2. A definition of the areas of priority of immediate concern to African countries in the fields of marine science and technology and marine environment as well as a comprehensive plan for the determination of a basis for a regional programme in this field, as a result of a marine science and technology workshop followed by an Intergovernmental Meeting.

C. Special Considerations

1. Advances in technology have enabled man to extract minerals from the sea - especially the hydrocarbons; but a consensus has gradually been reached that the mineral resources of the deep sea bed are a common heritage of mankind and that a portion of the resources derived from their exploitation should be turned over to an international fund to be used to help the poorer countries. This led the General Assembly to pass Resolution 2749 which declared that resources of the deep sea were "the common heritage of mankind" and that their exploitation should be undertaken only pursuant to an international regime to be agreed upon.

2. During the last decade, the international community has been trying to approach the exploitation of the resources of the sea rationally and efforts have been made to negotiate a new Law of the Sea Convention; but it has proved extremely difficult to reach an agreement particularly because there is a widening gap in marine science and technology between the developed and the developing countries. An entirely new system must be created which would include both technical capabilities and relevant infrastructural services.

[¶] North African countries have not been included in this project because they are already engaged in a complexity of programmes, e.g., the UNEP Mediterranean Action Plan. Programmes in execution in the Mediterranean will be taken into account during the other stages of execution of this project.

3. In addition to achieving the long term objective of enabling African countries to develop scientific and technological capabilities for the exploration and exploitation of marine resources as well as for non-resources oriented activities such as shipping, coastal area development and the protection of the marine environment, the project is also expected to:

- (a) assist in the process towards complementarity in co-operation and development;
- (b) promote technical co-operation between Africa and the other developing regions, which is one of the global economic goals established by the governing authorities of the United Nations Development Programme.

D. Background and Justification

1. The long coast line of Africa, and its oceanic and inshore water areas are generally characterized by high productivity and rich fisheries, when compared to the less productive areas in the semi-closed seas. Upwelling which enhances high productivity occurs along the West coast of Africa and is also associated with the circulation along the East coast of Africa.

2. The coastal zone and the near-shore environment in the region have many potential resources such as fish-stocks, possibilities of mariculture, heavy minerals and evaporites, tourism, etc. The marine resources of Africa are greatly underdeveloped, and not fully exploited. Many are exploited by foreign fleets with marginal benefits to the countries concerned. The growing numbers of population, and the threat of drought in certain regions are among the reasons for the increasing interest of many African States in developing their capability in understanding and exploiting their seas. Under such conditions, it is necessary that the main resources be exploited by man to the optimum level, and that such exploitation provide maximum benefit to the people of Africa. In order to attain such an objective, it is essential to develop and create a scientific manpower of well-trained specialists in Africa. This will require very strong educational training and research programmes in marine science and technology to strengthen and generate the indigenous scientific and technological manpower that could provide the marine administrators, and decision makers with the basic data and scientific conclusions necessary for the best management

3. Past and present activities to develop marine science and technology in Africa include the following:

- (a) Co-operative Investigations of the Northern Part of the Eastern Central Atlantic (CINECA) of the Intergovernmental Oceanographic Commission (IOC) of Unesco; the CINECA programme was organized by ICES, with the assistance of IOC and FAO (CECAF).
- (b) Scientific Workshop to initiate planning for a co-operative investigation in the North and Central Western Indian Ocean (CINCWIO) of IOC/Unesco, Nairobi, March-April 1976; and the first meeting of the countries of the CINCWIO region, Nairobi, March 1979.
- (c) The international conference on Marine Science Resources Development for Eastern Africa held in Dar-es-Salaam in 1974, recommended the establishment of a Marine Resources Development Centre in Tanzania that would form a knowledge base for conservation and rational utilization of both human and material resources for national and regional needs.
- (d) Two subregional meetings on Training, Education and Mutual Assistance (TEMA) of IOC were held in Casablanca in 1974 for West African countries and in Cairo in 1975 for Arab countries and Iran.
- (e) UNEP sponsored action plan for the protection and development of the marine environment and coastal areas of the West African Region.
- (f) FAO (FI): Fisheries department has also been carrying out activities to strengthen the scientific capabilities of African countries and promote intra-regional co-operation through:
 - (i) FAO fishery bodies (GFCM for the Mediterranean, CECAF for West Africa and IOFC for the Indian Ocean) and their subsidiary bodies.
 - (ii) two inter-regional projects of FAO in the Indian Ocean and off West Africa which are very active in assessing present means and constraints, organizing regional training centres in all fields at all levels of fishery science and supporting regional or sub-regional activities such as workshops or seminars.

(g) Organizations such as ICSEAF (for the South East Atlantic) and ICCAT (tunas) are particularly active in organizing training seminars and offer an efficient structure for regional collaboration in the field of fishery sciences.

4. General Assembly Resolution 3201 (S-VI) and 3202 (S-VI) of 1974 contained the Declaration and Programme of Action on the Establishment of a New International Economic Order, while General Assembly Resolution 3281 (XXIX) of 1974 contained the Charter of Economic Rights and Duties of States which called on developing countries to develop and mobilize adequate scientific, technical, managerial and other trained manpower resources in order to sustain the required capability for the exercise of sovereignty over their natural resources, for the control of their economic activities and for the transfer of science and technology.

5. On the national level, many African countries have become aware of the vital role that can be played by marine science and technology in their national economy. Marine sciences were introduced to a number of the Universities either as regular courses or postgraduate research. Few universities offer degrees in marine sciences. Among the Universities which became active in marine sciences or are planning to do so are the Universities of Dar-es-Salaam, Nairobi, Addis Ababa, Mogadiscio, Khartoum, Dakar, Fourah Bay College (Sierra Leone), University of Ghana (Legon) and Lagos University. Independent governmental research institutes in marine sciences and in fisheries are found in Zanzibar and Mombasa, Port Sudan, Nosy Bé, Nouadhibon, Dakar, Abidjan and Lagos. The established fishery and oceanographic laboratories of Pointe Noire (Congo), Tema (Ghana) and Casablanca (Morocco) are also worthy of mention.

6. As a general feature, these institutions keep some scientific contacts with overseas institutions while their contacts among themselves are considerably weak. A stronger effort is required to activate scientific exchange among these institutions as well as with the advanced institutions outside Africa.

7. Although the Law of the Sea Conference has not yet completed its work, it is now evident that when a Convention is finally arrived at, it will most likely include the establishment of:

- (a) An International Sea-Bed Authority which would be charged with research, exploration and exploitation of the sea-bed resources beyond the limits of national jurisdiction;
- (b) A 12-mile territorial sea;
- (c) A 200-mile Exclusive Economic Zone wherein the coastal state will have jurisdiction over all resources - living and non-living.

8. This project will enable African States to handle new decisions emanating from the Law of the Sea Conference and, especially, to establish working relations with the proposed International Sea Bed Authority. Moreover, the proposed project in its second phase will be able to produce scientists and research workers who will conduct research and enable African countries to undertake the exploitation of their resources in the Exclusive Economic Zone.

E. Output

During the preparatory assistance phase, the output will be:

- (a) An assessment of the existing situation and potential (national policies, research and development activities and institutions, traditional technology, current or proposed projects, training and professional facilities, etc.);
- (b) A compilation of documentation on research related to marine science and technology and the marine environment;
- (c) A comprehensive plan to determine a regional programme of action on the development of Marine Science and Technology in Africa and aimed at the solution of problems connected with rapid urbanization, port development, industrialization and the preservation of the marine environment and the fishing industry.

F. Activities

<u>Description</u>	<u>Location</u>	<u>Time</u>
1. A project co-ordinator will be appointed to assist in implementing the various stages of the Preparatory Assistance Phase of the project and eventually participate in one or two of the missions planned.	Addis Ababa	January 1980
2. A Working Group of African marine specialists as well as a few from other developing regions will be convened jointly by ECA and Unesco with the participation of UNEP, WMO and FAO to define the terms of reference, including the format of the mission report of the missions, as outlined in the immediate objective of this project document.	Addis Ababa	5-9 May 1980
3. A joint ECA/Unesco mission composed of three teams of African marine specialists assisted by ECA and Unesco staff or consultants will make an up-to-date inventory of human resources, facilities available, and conduct discussions with government officials and marine specialists in African countries interested in marine science and submit a report.	Countries listed under immediate objectives	May-August, 1980
4. A Marine Science and Technology Workshop jointly convened by ECA/Unesco with the participation of all interested UN bodies and other agencies will discuss the outcome of the mission and advise on areas of priority and propose a detailed work plan for a second phase project to be executed jointly by ECA/Unesco.	Addis Ababa	March 1980
5. An intergovernmental meeting to which all interested UN bodies and other agencies will be invited will be requested to endorse the second phase project and its workplan and discuss further steps required to develop the	Addis Ababa	June 1980

G. Inputs

(a) Government participation

Governments will provide the international experts on mission in their respective countries with local transport and other facilities which may further the success of the mission. They are also requested to provide their local experts with any facilities needed to enable their countries to be effectively represented at the meetings provided for in the work plan of the project.

(b) UNDP

The total cost of the activities mentioned in section F above is estimated at US\$282,700 during the preparatory assistance period of 14 months (January 1980 - February 1981), which will be met by UNDP.

(c) Unesco

Unesco will assist ECA in guiding and supervising the missions and will participate in the implementation of the project.

(d) UNEP

As associated agency, UNEP's co-operation on the project will include:

- (i) participation in the meetings envisaged by the project
- (ii) putting at the project's disposal all information and documentation prepared for the WAAP, as soon as it can be released, in addition to documentation already communicated to ECA
- (iii) assistance if required in the selection of consultants
- (iv) UNEP will continue to invite UNDP, ECA and other organizations participating in the project to UNEP-sponsored meetings relevant to the development and implementation of WAAP.

(e) ECA

ECA assumes responsibility for the compilation of the background documentation for the project. ECA will provide office space and secretariat support for the experts.

H. Resources required

- (a) a Project Co-ordinator
- (b) a meeting of the Working Group of Marine Specialists
- (c) three missions comprising three consultants each to visit:
 - (i) East African countries
 - (ii) West African countries (French speaking)
 - (iii) West African countries (English speaking)
- (d) a Workshop on Marine Science and Technology
- (e) an intergovernmental meeting. "

2. INTRODUCTION: PROJECT RATIONALE AND EXECUTION

2.1 Project Rationale

The rationale and justification of the Project are based on the following general premises:

1. The state of the general economy of the world has in recent years forced nations (especially developed nations) to look more and more to the sea as an important source of food for the rapidly increasing human population, and to different kinds of raw materials and energy for the maintenance and development of industries. In developed countries, this awareness of the great potential of the oceans has been stimulated and encouraged by the great advances in science and technology in recent times. These advances in science and technology have not only made practically all the resources of the oceans accessible to man's exploitation but they have also increased the curiosity of scientists and technologists to learn more about the human environment, including the oceans and also outer space. The appreciation of the importance of the sea as part of the human environment has also received great impetus in recent years through its increasing use as a medium of communication and transportation, both during peace time and war, and through recent scientific discoveries showing that the influence of the oceans on terrestrial weather and climate is much greater than was originally thought.

2. The increasing use of the oceans, including the sea bed, for all sorts of human activities, such as navigation and sea transportation, exploration and drilling for minerals and oil, together with the development of the coastal areas for such activities as harbour construction, tourism, etc. has created the problem of marine pollution which is a great threat to the living resources of the sea. Furthermore, it is now realized that such natural phenomena as sea waves and surges, and ocean currents, together with land erosion, can cause great damage to the coastal areas of continents and islands. Thus, in order to protect the marine and coastal environments and the resources therein against pollution and destruction, it is necessary to develop mechanisms of controlling and regulating human activities and destructive natural forces in these environments. Such protective mechanisms would include the prevention and control of oil and other forms of pollution and the regulation of fishing and of exploration and extraction of non-living resources.

3. The Third UN Conference on the Law of the Sea has considered the right of coastal states to establish a 200 mile wide "Exclusive Economic Zone" along their coasts. This action has brought vast living and non-living resources under the jurisdiction, management, control and ownership of coastal states. The management, control and rational exploitation and utilization of such resources calls for a highly complex legal, administrative, scientific and technological machinery. If African coastal states do not, as a matter of urgency, take steps to set up and develop such a machinery, these vast resources are likely to remain on paper and will, in all probability, mysteriously find their way towards the further enrichment of outside countries. The Third UN Conference on the Law of the Sea has also considered the establishment of the resources of the sea and the sea bed beyond the "Exclusive Economic Zone" as "the common heritage of mankind", to be used mainly to assist development in developing countries. This arrangement will only be meaningful to African countries if they can, within a reasonable time limit, develop the necessary scientific capability and technological know-how to be able to participate on an equal footing with developed countries in the exploration and exploitation of such resources.

4. The rational exploitation of marine resources requires a proper understanding of the nature of the resources, the extent and distribution of their occurrence and the proper technological know-how. This is necessary in order to avoid environmental pollution, degradation and resource wastage. The rational exploitation of living resources must be planned and carried out on a sustainable-yield basis, as a result of careful ecological and biological studies. In most African coastal states, the exploitation of marine resources is not at present based on this scientific and technological understanding and cannot therefore be regarded as rational in the ecological and environmental sense.

5. Practically all African coastal states (within the context of this Project) are at present making only minimal use of their marine resources owing to limitations in the necessary scientific knowledge and technological know-how and efficient organizational machinery.

6. In practically all these states, even this minimal use of their marine resources is limited to the inshore or nearshore living resources, mostly fisheries. There is, admittedly, in some of these states some extraction of

table salt (NaCl) and some harvesting of marine algae (sea weeds) of commercial value. The farming of the sea (mariculture) which is gaining momentum in many developed countries is still very much underdeveloped in African coastal states. There is at present no African coastal state seriously engaged in the exploitation of its deep sea resources, and these resources are currently being exploited by foreign fishing fleets from developed countries.

7. In most African coastal states, the methods used in the exploitation of marine resources are, for the most part, primitive and inefficient and are not based on sound scientific and technological experience. In some cases some destructive methods (e.g., fishing with dynamite, and indiscriminate fishing nets) are practised. In very few of these states are there as yet any concrete and comprehensive programmes aimed at the protection, development and conservation of the marine environment and the resources therein against pollution, over-exploitation, destruction and extermination.

8. In most cases there is still little or no understanding of the type and nature of the resources and their distribution, e.g., minerals and deep sea living resources. This situation can only be remedied by a carefully planned and competently executed geological exploration and fishing survey of the whole "Exclusive Economic Zone" and its detailed mapping.

9. The shipping and navigation services which are so vital for the management, control and exploitation of marine resources are still very much in their infancy in most African coastal states. The development of such services (modern navigation, boat building industry, boat and ship repair facilities, land-sea communication, etc.) is therefore an important pre-requisite for the establishment and maintenance of a thriving marine resources exploitation (including fisheries) undertaking.

10. In many African countries, the teaching of marine science and marine technology in universities is a recent development and in many of the universities there are as yet no comprehensive study programmes covering the whole spectrum of marine science and technology at the undergraduate or postgraduate level. The situation in regard to research in marine science and technology is equally unsatisfactory. Although there were

some programmes of research in many African coastal states during the colonial era, most of such research programmes were narrow in outlook, short-term in objective and not sufficiently comprehensive. The knowledge that has emanated from such research programmes, even when accessible, has for this reason not provided an adequate base for the development of a rational marine resource exploitation undertaking. Moreover, very few scientists were trained during the colonial period, with the consequence that at the time of independence these countries found themselves with practically no indigenous scientific manpower to carry on the research activities. Thus, the development of sound research and training programmes is a basic and most important step towards enhancing the capability of African coastal states to make full use of their marine resources.

11. Marine technology is also very much underdeveloped in many African coastal states. In very few of these countries are there marine technology training centres with comprehensive programmes concerning all aspects of marine technology - marine engineering, fishing and fishing gear, boat building and repair, navigation, instrumentation repair and maintenance (including electronic equipment) fish processing and preservation, economics and marketing, etc. The training of marine technologists is just as important as, and in some cases even more urgent than, the training of marine scientists. Indeed, the thrust should be towards the urgent training of both the scientist and the technologist since their actions in the development and rational exploitation of marine resources are complementary, as in all aspects of science and technology for development.

12. The most immediate requirement, and one that is likely to make a favourable impression on African Governments, would be concrete suggestions and steps aimed at the improvement of their efficiency in fishing. There is an urgent need in most of these countries for a great increase of cheap fish supplies. This would go a long way towards solving the almost ubiquitous protein malnutrition problem in the region. This achievement would depend on the development of marine technology (see above) coupled with an efficient transportation system for distribution.

13. The solution of some of these problems, e.g., efficient exploration, exploitation, surveillance and control of the resources of the deep sea within the 200 mile "Exclusive Economic Zone", would be beyond the capability of most African states working on their own. It is in such areas that

regional and subregional co-operation would be most needed, useful and appropriate. This kind of co-operation would also be useful in such areas as high-level specialist training of marine scientists and technologists, deep sea research, shipping and navigation, data and information collection and exchange, creation of intra-regional markets and the exchange of research results and ideas through seminars, workshops, conferences, etc.

2.2 Project Execution

1. This project is essentially a diagnostic exercise, the main purpose of which is to carry out a thorough study and analysis of the state of affairs obtaining to marine science and technology development in African coastal states, to find the main weaknesses and strong points that apply generally to the whole region and those that are only found in individual countries and, finally, to suggest remedial measures that are aimed at an overall improvement of the situation. As in the case of a doctor dealing with a human disease, the first and most important step is the carrying out of a proper and correct diagnosis of the disease. Without a proper and realistic diagnosis, no real cure can be obtained. Thus, the first and most important step in finding a correct and lasting solution to the problem of under-utilization of marine resources in African coastal states lies in the carrying out of a thorough, correct and realistic diagnosis as to the conditions responsible for the low level of scientific and technological development in marine sciences in these countries and the factors that tend to perpetuate the situation and thus hinder improvement.
2. The Project Co-ordinator's preliminary activities included consultations with relevant Divisions of the ECA in Addis Ababa; with the Division of Marine Sciences and the Intergovernmental Oceanographic Commission (IOC), Unesco, Paris; with the Department of Fisheries, FAO, Rome; and with UNEP, WHO and WHO, Geneva. During these consultations, detailed discussions were held on past, present and planned activities by these organizations and agencies which are related to marine science and technology development in African coastal states. Opportunity was also taken to refer to relevant documents in these organizations in order to obtain detailed information on these activities.
3. These preliminary consultations by the Project Co-ordinator, and the discussions to be held by the Working Group, are aimed at giving the

participants in the field missions as much information as possible on reports, surveys, conferences, seminars, workshops, etc., carried out under the auspices of the governments of the relevant countries, the UN agencies and other organizations, concerning the state of marine science and technology development in African coastal states; on steps that have been taken in the past, are being taken at present or are planned for the future, aimed at improving the situation, and what success, if any, has been achieved or is expected. There is no doubt that the situation in this regard will differ from country to country, and an attempt will be made to put together as much information as possible on the history of marine science and technology development in individual coastal states of the region. This background information will form a useful guide and source of reference to the field missions. The information will also be useful to the Working Group Meeting in formulating the guidelines of the field missions. It is to be expected that this information will be improved upon by contributions from the participants of the Working Group, especially in regard to the countries and/or regions from which they come.

4. The Working Group will finalize and agree upon a questionnaire designed to obtain as much information as possible on the state of marine science and technology development in all its aspects in different African coastal states, the strong points that could be emulated in other states or regions, the weak points that could be improved or avoided altogether, the future plans and needs, etc. They will also discuss and agree on the format of the mission report.

5. The field missions will examine and study the real situation as it exists at present in the different countries of the region in regard to marine science and technology development. They will use the questionnaire adopted by the Working Group as a guide, and will ask relevant government officials and marine scientists and technologists in these countries such questions as: how many marine scientists and technologists of different specialities they have in the country and their qualifications; what training facilities for marine scientists and technologists there are in the country; what research activities are being carried out; what marine technology institutions there are in the country and what technologists are being trained; what is the marine fishery industry like and how is it

organized and run; what fishing gear is used in the fishing industry; how does the price of fish compare with the price of other sources of animal protein; is any deep sea fishing done; what other marine resources are being exploited apart from fisheries; what methods of exploitation are being used for these other resources; is there any marine resources exploration being carried out or planned; what level of awareness is there in the country about environmental pollution generally and marine pollution in particular; are there any environmental protection and conservation services in the country and how efficient are these; what plans have been made or are being made by the government in regard to the exploitation of the resources in the 200 mile "Exclusive Economic Zone"; what co-operative arrangements in marine science and technology development are there with other African countries or with countries outside Africa, etc...

6. The Workshop will be composed of the field mission teams, national experts, and specialists from relevant and interested UN agencies and other organizations (e.g., universities and research institutions), invited on the merit of their special knowledge and experience in different aspects of marine science and technology development and the problems related thereto, especially in the African context.

7. The field missions will present their report (prepared and compiled by the Project Co-ordinator) on the actual state of affairs obtaining to marine science and technology development in the African coastal states generally, and in individual states, and will highlight all the shortcomings, the weaknesses and the strong points. They will suggest what, in their opinion, would be the best remedial measures. The invited participants will present their views and experience, and participate in a discussion on specific problems of marine science and technology development in developing countries, especially as they relate to the African situation. They will make suggestions as to what, in their opinion and experience, would be the best way of going about the problems highlighted by the mission's report. As a result of a thorough discussion of the mission's report and of the invited experts' presentations, the Workshop will prepare a Workshop Report embodying a list of recommendations to be submitted to ECA and Unesco, suggesting the steps that should be taken by the two Agencies in collaboration with other relevant UN organizations and the Governments of African coastal states, regionally and individually, to enhance the development of marine science and technology in these countries, with a view to enabling them to derive maximum benefit from their marine resources, both living and non-living and both inshore and in the deep sea.

8. The Workshop Report with recommendations and a draft project document for the second phase project will be submitted for discussion and approval to the Intergovernmental Meeting. It is expected that all aspects of marine science and technology and their application to marine resources development will be considered during the course of this work.

3. GENERAL ACTIVITIES RELATED TO MARINE SCIENCE AND TECHNOLOGY DEVELOPMENT CARRIED OUT UNDER THE AUSPICES OF UNITED NATIONS ORGANIZATIONS AND OTHER AGENCIES

In the past, there have been several activities related to marine science and technology in most African coastal states and today there is hardly any such state without some form of that kind of activity going on. These activities have been and are being carried out under the auspices of the governments of the countries concerned and/or that of UN or other agencies. All these activities have contributed in one way or another to the development of marine science and technology in these countries and the achievements and experience gained are useful and must be taken into consideration in the working-out of this project, in order to obtain a realistic base and a proper perspective of the situation. Perhaps the most important short-coming of these activities is that most of them were conceived, planned and executed as separate projects with narrow and sometimes short-term objectives and with little or no co-ordination. Hardly any of them was conceived as an all-embracing comprehensive programme looking at the problem in its totality both as regards regional coverage and the inclusion of all aspects of marine sciences and technology. This was most probably due to the fact that most of these activities were planned and executed by single UN or other agencies acting on their own or at best in collaboration with a few bodies with similar interest in a comparatively narrow field.

This project has been planned with a view to overcoming these earlier shortcomings. Firstly, it is being executed by two UN agencies, both with very wide interdisciplinary interests, which have enlisted and invited the co-operation of other interested organizations; and, secondly, the project covers the whole of the African region (except the Mediterranean African countries) and is to consider all aspects of marine science and technology and their applications including fisheries, biological oceanography, chemical and physical oceanography, marine geology, food processing and preservation, economics and marketing, marine engineering, pollution, mariculture, coastal area development, training and research in marine science and technology, etc.

Another point which might be of advantage is that most of the key personnel involved in the execution of this project are people of experience who are indigenous to the region and therefore with a good understanding of the region and its needs.

In the following pages, the main past and present activities related to marine science and technology in African coastal states are summarized first on a regional basis and then in individual countries. This information was collected from reports of various UN organizations and agencies such as ECA, FAO, IMCO, IOC, UNDP, UNEP, Unesco, WMO and other organizations and from relevant correspondence in Unesco and ECA files. No claim is being made about the completeness of this information. In a quick search of this kind, some omissions and oversights are almost inevitable, but as this report is only aimed to serve as a general introduction and guide, this discrepancy is not a serious one. Moreover, some of the information will undoubtedly be found to be out-of-date, especially in relation to ongoing activities. It is hoped and expected that this information will be greatly improved upon and updated by the field missions.

3.1 United Nations Educational, Scientific and Cultural Organization (Unesco)

Unesco's marine science activities can be divided into two main categories: those of the Division of Marine Sciences (OCE) and those of the Intergovernmental Oceanographic Commission (IOC). During the sixties, Unesco's marine science programme continued to increase in scope, until it was decided in 1972 to divide the functions of the Office of Oceanography into the 'Secretariat of the IOC' and the 'Division of Marine Sciences'. The roles of the two units are complementary. The separation has been salutary in that each Secretariat has concentrated on its own mission, giving enhanced effectiveness to its programme actions. Simplistically, the separation of function is that the Division of Marine Sciences helps Member States to attain high quality marine science programmes and infrastructure so that they can participate in IOC-organized and co-ordinated scientific programmes, while meeting their other marine science needs as well. The Division of Marine Sciences

is an integral part of Unesco, and the Intergovernmental Oceanographic Commission (IOC) is an autonomous body 'established within Unesco', the membership of which (more than 100 Member States) differs somewhat from Unesco. The scientific programme of IOC is determined by its members through the IOC Assembly.

The programme of Unesco's Division of Marine Sciences is designed to respond to marine science needs of all Unesco Member States and especially to those of the developing countries. Unesco develops co-operation between scientists (and their governments) at three levels - globally, regionally and nationally - with the object of strengthening marine science at all three levels, which is done closely with the Intergovernmental Oceanographic Commission and other components of the UN system. Many of the activities are executed directly in association with IOC or in response to specific IOC recommendations. Similarly, Unesco works closely with the Scientific Committee on Oceanic Research (SCOR) of the International Council of Scientific Unions (ICSU). Finally, the Division works with certain other United Nations bodies (such as ECA, FAO, IAEA, IMCO, UN, UNEP and WMO).

The programme of the Division of Marine Sciences includes the following major components:

- (i) Dissemination of knowledge in the marine sciences, including publications and information services;
- (ii) Development of the scientific basis for the understanding and management of the marine environment and resources, especially coastal;
- (iii) Development of national and regional infrastructures in the marine sciences;
- (iv) Training and education of specialists in the marine sciences.

Those are the activities of immediate concern to the development of marine science in African member states through Unesco's regular programme or through large development projects carried out by extrabudgetary funds.

During the last decade, and particularly during the last few years, the marine sciences in Unesco have undergone a major evolutionary step in their development, which can be seen in two aspects of Unesco activities: (i) the extrabudgetary marine science development programme has grown rapidly to significant size, and (ii) research guidelines concerning a suite of relevant marine ecosystems have been developed to

Unesco is working with Member States and SCOR to develop scientific programmes that are sound scientifically and are also relevant to a nation's development needs. Such programmes will allow a scientist both to contribute responsibly to his country's development and also to contribute to the advancement of science at the same time. An example is the mangrove programme being developed in Asia in order to provide a scientific basis for the more applied aspects, such as fisheries investigations and management of the mangrove environment. This mangrove programme already serves as the nucleus for regional co-operation and related projects are being established by nations on other continents. The national efforts are buttressed by international workshops, working groups and research projects, partly within the context of Unesco's Man and Biosphere Programme.

The increasing interest of the Member States in the coastal zones led to an evolution in the policies and programmes of the Division of Marine Sciences of Unesco, where emphasis on coastal research is gradually building up to the establishment of a major regional project on integrated management research of coastal marine ecosystems (COMAR). The inter-regional interdisciplinary research and training programme for the management of the coastal ecosystem will consist of a network of activities and pilot projects in different regions, including all sub-tropical sub-regions concerned in Africa, Asia and Oceania, the Mediterranean, Red Sea and adjacent Gulfs of the Indian Ocean and in Latin America and the Caribbean. Most of the work done in Unesco within the framework of this project was on coastal lagoons, mangroves and coral reef study. Among the activities carried out in Africa were two meetings, one on coastal lagoons on the north coast of Africa, 'Coastal ecosystems of the southern Mediterranean: lagoons, deltas and salt marshes', which took place in Tunis, 25-27 September 1978, and the other on 'Coastal ecosystems, with special reference to the coastal lagoons and estuaries on the West coast of Africa', which was convened in Dakar, 11-15 June 1979.

As a step towards the preparation of the Dakar Workshop, two Unesco consultants visited the coastal states of West Africa in 1978 in order to assess the needs of the region in coastal research. The findings of the Workshop were taken into consideration when formulating the UNEP Action Plan for West Africa (Libreville, Gabon, 5-9 November 1979). A project on coastal lagoons of West Africa is under preparation by Unesco and UNEP.

References

Workshop on Coastal Ecosystems with Special Reference to Coastal Lagoons and Estuaries on the West Coast of Africa, Dakar, 11-15 June 1979, Unesco, MARINF/28.

Coastal ecosystems of the Southern Mediterranean: lagoons, deltas and salt marshes. Report of a meeting of experts, Tunis, 25-27 September 1978, Unesco reports in marine science 7, 26 pp.

3.2 Intergovernmental Oceanographic Commission (IOC)

According to its Statutes (revised 1970), the Intergovernmental Oceanographic Commission is "to promote scientific investigations with a view to learning more about the nature and resources of the oceans through concerted actions of its members". Of the presently 103 State Members of the Commission, 11 are from the West African region (Cameroon, Congo, Gabon, Ghana, Ivory Coast, Mauritania, Morocco, Nigeria, Senegal, Sierra Leone and Togo) and 6 from the East African region (Kenya, Madagascar, Mauritius, Seychelles, Somalia and Tanzania).

At the eleventh session of its Assembly (Paris, October/November 1979), the IOC established a Programme Group for Scientific Investigations in the North and Central Western Indian Ocean (IOC resolution XI-9). At the same session, the IOC Assembly decided in resolution XI-18 to arrange, in collaboration with the Division of Marine Sciences of Unesco, a Workshop on Marine Science Co-operation in order to provide the basis for a Marine Science Association for countries of the Atlantic coast of Africa. The proposed Workshop is scheduled for 1981.

The Commission's operational activities may be said to fall into the following categories: (i) Ocean Science, i.e., marine scientific research, (ii) Ocean Services, including transfer of knowledge and technology, and (iii) Training Education and Mutual Assistance in the marine sciences (TEMA).

Of particular interest for African countries are the Commission's activities in the field of ocean services, which include the promotion of exchange and archiving of oceanographic data from both national oceanographic efforts and from all marine programmes sponsored or supported by UN Specialized Agencies, and also the co-operation, with other UN bodies, in the development of information service related to marine science, including promotion and provision of guidelines for the development of

3.3 Food and Agriculture Organization (FAO) of the United Nations

The Food and Agriculture Organization (FAO) of the United Nations has carried out and is carrying out several activities in many African coastal states. These activities have been mainly aimed at increasing and improving the capability of these countries in making fuller and more rational use of their fishery resources. These activities can be said in general terms to have been concerned with the development and improvement of various aspects of fishery technology - training of fishermen and fishery extension officers, fishing gear technology, fishing methods, fish surveys, boat building and repairs, navigation, marine engineering, fish processing and preservation, fish marketing, aquaculture (including mariculture), etc. FAO has also carried out, in co-operation with other UN organizations or agencies, activities related to the improvement of fisheries in African coastal states, e.g. the monitoring and control of marine pollution.

Actual on-going activities are too many to elaborate on here and it is hoped that the details of these activities in the regions and in individual countries will be obtained during the visits of the country missions through the co-operation of FAO country representatives and the relevant government authorities.

3.4 World Meteorological Organization (WMO)

Important activities of the WMO which are related to marine science and technology development in African coastal states include:

1. Global weather experiments

These are experiments using floating buoys placed in different parts of the world oceans to collect scientific data (e.g., temperature and currents) and transmit it to satellites from which it is in turn transmitted to land-based data collecting stations. This has been one of WMO's most successful activities. Although the main experiment is now over, about 133 buoys at different parts of the world oceans are still transmitting information.

2. Marine meteorology experiments over the sea

Experiments are being designed to observe the upper mixed layers of the atmosphere over the oceans.

3. Long-term world climate programmes

Experiments designed to enable long-term forecasting of the climate of the world.

3.5 World Health Organization (WHO)

The WHO is interested in problems of marine pollution as they relate to: sea food, tourism, fishing and environmental health.

The Organization has been participating in activities in several African coastal states related to:

- sanitary engineering works
- disposal of waste (e.g., sewage) into the sea
- provision of clean and safe water supply
- assessment and prevention of pollution
- water pollution monitoring
- food pollution monitoring
- health criteria, etc.

4. REGIONAL ACTIVITIES RELATED TO MARINE SCIENCE AND TECHNOLOGY IN AFRICA

4.1 The East African Region

In the context of this Project, the East African region coastal states are: Sudan, Djibouti, Ethiopia, Somalia, Kenya, Tanzania, Mozambique, and the Indian Ocean islands - Madagascar, the Seychelles, the Comoro Islands, Mauritius and La Réunion (France).

Important activities related to marine science and technology which were organized on a regional basis include:

4.1.1 International Indian Ocean Expedition (IIOE), 1959-65

When the IOC was established, the IIOE was already under preparation by the International Council of Scientific Unions (ICSU) and the Scientific Committee on Oceanic Research (SCOR). It was conceived as an exploratory programme to allow individual scientists to carry out their own specialized research programme of interest. When the IOC was formed in 1960, it assumed the role of co-ordinating agency, but SCOR continued to play the scientific advisory role. Under the co-ordination of IOC, the following organizational measures were instituted in the programme:

(i) Establishment of an International Co-ordination Group for the IIOE composed of national co-ordinators for the programme and dealing with data exchange, preparation of atlases and processing analysis and publication of results.

(ii) Arrangement of special customs facilities and courtesies for ship and personnel of the expedition.

(iii) Publication of an IIOE Information Paper Series.

(iv) Establishment of International Centres, e.g., the Indian Ocean Biological Centre (responsible for sorting zooplankton samples) at Ernakulam, South India, supported by Unesco and India; and the International Meteorological Centre at Bombay, supported by UNDP and WMO.

(v) Designation of a Fisheries Subject Leader for co-ordination and evaluation of the fisheries aspect of the programme.

(vi) Arrangement for international standardization and inter-calibration tests.

(vii) Agreement upon reference stations at 15 locations throughout the Indian Ocean for intercomparison of methods and for information on seasonal changes.

The IIOE programme provided a stimulus in marine science education to developing countries as a substantial number of such countries participated in the expedition, became interested in marine science, obtained technical assistance and developed national organizations to deal with international oceanographic co-operation.

The two World Data Centres for Oceanography in Washington, D.C. and Moscow were charged with the responsibility of collecting the data obtained during this international co-operative programme and Unesco accepted the responsibility for the publication of the Collected Reprints of the IIOE, which were issued in eight volumes, together with an index.

The observational results of this co-operative investigation have been summarized and published in the form of five comprehensive atlases:

- IIOE Meteorological Atlas, Vol. 1, Surface Climate of 1963 and 1964, edited by C.S. Ramage, F.R. Miller and Chairman Jeffries, Washington D.C. (1972).

- Vol. 2, Upper Air, edited by C.S. Ramage and C.V.R. Raman, Washington D.C. (1972).

- IIOE Oceanographic Atlas edited by C. Wyrтки, Washington D.C. (1971).

- IIOE Phytoplankton Production Atlas, edited by J. Krey and B. Babenerd, Kiel (1976).

- IIOE Geological-Geophysical Atlas, edited by G.B. Udintsev, Moscow (1975).

The more important findings of this expedition include:

(a) The surface current regime in the Northern Indian Ocean is influenced by the seasonally changing monsoon winds, which blow strongly from the south-west in summer and gently from the north-east in winter.

The ocean does not react on the summer monsoon from the south-west by establishing a simple current gyre covering the main part of the northern Indian Ocean, but by establishing a gyre which appears to contain many

relatively strong cyclonic and anticyclonic eddies, with dimensions ranging from 100-1000 km, capable of changing dramatically within two months or less. Numerical models were a great help in the understanding of these current features which certainly affect chemical and biological processes in the ocean.

(b) The biological results indicated that not even 0.1% of the primary production of the Indian Ocean was harvested by man's fishing at that time and that up to a tenfold increase in the fishing yield might be reached with present conventional means, which could be further augmented by new technology. IIOE provided the oceanographic basis for planning a rational exploitation of living resources. From oceanographic considerations the most promising areas for development appeared to be Somalia, South Arabia, Malabar, Madagascar and Java.

(c) In the geological-geophysical field the atlas mentioned above gives ample information including relief maps of the ocean floor; charts showing the depth of the sedimentary layer and of bedrock outcrops, the deep structure of the earth's crust and the upper mantle, as revealed by seismic investigation; magnetic and gravitational anomalies and many other relevant observations which are of paramount significance for current knowledge and further development of the concepts of plate tectonics and sea-floor spreading, all of which add to our understanding of the history of the oceans. Among the discoveries was that of a 'hot spot' of anomalously hot, highly saline water trapped in a deep basin in the Red Sea. It was suggested that it would be worth exploiting the locally rich metaliferous sediments found with this hot brine spring. The Saudi-Sudanese Red Sea Joint Commission for the development of the Red Sea non-living resources was created in 1975. The Commission carried out the first systematic research work for the evaluation and exploitation of the Red Sea deposits in 1976-77.

4.1.2 Co-operative Investigations in the North Central Western Indian Ocean (CINCWIO)

These activities consisted of a Workshop (Nairobi, Kenya, March-April 1976), a Joint Mission by IOC/FAO/SIDA/SAREC to Somalia, Kenya and

Tanzania (3-24 September 1977) and an ad hoc Intergovernmental Meeting of the Countries of the CINCWIO Region^{*} (Nairobi, Kenya, 5-9 March 1979).

All these activities were aimed at finding out the state of marine science development (including research and training, fishery development, human and material resources, infrastructure facilities, etc.) in the Eastern African countries, the need for assistance in improving the situation and the scope for regional and international co-operation. These activities culminated in the Intergovernmental Meeting, which approved the recommendations that were made in all these areas.

References

Report of the Scientific Workshop to initiate planning for a Co-operative Investigation in the North and Central Western Indian Ocean (CINCWIO), Nairobi, Kenya, 25 March - 2 April 1976. IOC Workshop Report No. 7, Unesco, Paris.

Meeting of the Countries of the CINCWIO Region, Unesco Regional Office for Science and Technology for Africa, Nairobi, 5-9 March 1979. Ref. IOC/CINCWIO ad hoc 3.

4.1.3 International Conference on Marine Resources Development in Eastern Africa (University of Dar-es-Salaam, Tanzania, April 1974)

This Conference was organized by the University of Dar-es-Salaam in collaboration with the University of Rhode Island. The main objective of the conference was to explore ways and means whereby the Eastern African countries could develop their marine science research capability through the training of local scientists in all aspects of marine science with a view to enabling these countries to exploit their marine resources more effectively and more rationally. The most important recommendation that was made was that an Institute of Marine Sciences should be established at the University of Dar-es-Salaam which would have a regional and an international outlook in research and training.

^{*} The boundaries of the 'CINCWIO Region' were originally defined by the CINCWIO Steering Committee (meeting in Zanzibar, October 1975) as the area encompassed by the East African coastline out to 60°E, and from latitude 13°N to latitude 15°S.

The ad hoc Intergovernmental Meeting of the countries of the CINCWIO region (Nairobi, March 1979), at the suggestion of the delegate from the Democratic Republic of Madagascar, decided to recommend an extension of the boundary southward to the latitude of the southern border of Mozambique and thus to include Madagascar, Mozambique, Mauritius and La Réunion.

The Institute was established by the University of Dar-es-Salaam in 1974 as an integral part of the University and is located on the island of Zanzibar. Its mission includes training and research in all aspects of marine sciences. Recently, the Institute was allocated enough land on a suitable site on the island for any future expansion and development.

4.2 The West African Region

In the context of this Project, the countries considered to belong to the West African Regional Coastal States are: Angola, Benin, Cape Verde, Cameroon, Congo, Equatorial Guinea, Gabon, the Gambia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Liberia, Mauritania, Morocco, Namibia, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, Togo and Zaire.

Among the most important activities related to marine science and technology organized on a regional basis in West Africa are:

4.2.1 International Co-operative Investigations of the Tropical Atlantic (ICITA), 1963-64

This was a development and an internationalization of an earlier locally conceived programme - the Guinean Year - which was drawn up on the request of the Commission for Technical Co-operation in Africa (CCTA) and the Scientific Council for Africa (CSA) and approved by them in 1961. The project had the following priorities:

- (a) A trawling survey of the demersal resources from Mauritania to Angola;
- (b) A campaign to study the meteorology and physical, chemical and biological oceanography of the Gulf of Guinea;
- (c) An experimental fishing campaign for sardine-like fishes, and
- (d) An experimental fishing campaign for tunas.

Later, the demersal fishery survey was financed by the US Agency for International Development and the US itself undertook the tuna survey and the oceanographic investigation survey of the Gulf of Guinea. In 1962, the IOC adopted the latter project as an official IOC programme and established an International Co-ordination Group for ICITA. The programme then comprised a multi-ship survey of the tropical Atlantic Ocean between latitudes 18°N and 18°S from the West Coast of Africa to South America. The field phase was subdivided into three periods during 1963/64, called Equalant I, II and III, in which up to fourteen research vessels from Argentina, Brazil, Rep. of Congo, German Dem. Rep., Rep. of Ivory Coast, Nigeria, Spain, USA and the USSR participated. The scientific

results were presented at a symposium on the oceanography and fisheries resources of the tropical Atlantic, organized at Abidjan, Ivory Coast, October 1966, through the joint efforts of Unesco, FAO and OAU. The oceanographic data was published in a two-volume atlas. Later, during the International Decade of Ocean Exploration (1971-80), an exploration of the eastern Atlantic continental margin was carried out and revealed the presence of large basins with a sediment thickness of more than 4 km in a belt associated with the Congo and the Niger rivers. These sediments contain many structural features suitable for gas and oil.

References

K.O. Emery: Review of the results from the Eastern Atlantic Continental Margin Programme of the International Decade of Ocean Exploration. In: IOC Technical Series No. 11 (Unesco, Paris, 1975), pp. 52-62.

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Proceedings of the symposium on the oceanography and fisheries resources of the tropical Atlantic. Results of ICITA and of the GTS. Held at Abidjan, Ivory Coast, 20-28 October 1966. (Unesco, Paris, 1969), 430 pp.

H.U. Roll: International Co-operative Investigations of the Tropical Atlantic (ICITA), 1963-64. In: IOC Technical Series No. 20 (Unesco, Paris, 1979), pp. 18-19.

F. Williams: Fishery Resources of the Tropical Eastern-Central Atlantic Ocean: Exploration, Utilization and Management since 1960. In: IOC Technical Series No. 11 (Unesco, Paris, 1975), pp. 33-49.

4.2.2 Co-operative Investigations of the Northern Part of the Eastern Central Atlantic (CINECA), 1968-74 - ICES/FAO/IOC

In the 1960s, the International Council for the Exploration of the Sea (ICES) has been approached for affiliation of West African countries and the Council was interested in strengthening its activities in the southern part of its area through co-operative studies. The rich living resources of the up-welling region brought about an old tradition of Moroccan, Senegalese, Spanish, Portuguese and French fisheries in the Canary Current region, which in the past decades had been fished by many nations from outside the region. It was FAO which pointed out the need for detailed exploration of the living resources of the region in order

The proposal for a Co-operative Investigation of the Northern Part of the Eastern Central Atlantic (CINECA) envisaged a multi-ship survey of the whole area between 10°N and the Straits of Gibraltar, extending up to 25°W into the Atlantic. If possible, aircraft and satellite observations should complement the data base of traditional oceanographic section studies in order to achieve a thorough description of the hydrography and of the biological productivity of the area during two different seasons.

However, the transfer of physical oceanographic results and primary production data into prediction of fish catches proved more difficult than expected.

A terminal symposium on CINECA results was held at Las Palmas, Canary Islands, Spain (April 1978), the report of which recommended future scientific activities to improve the understanding of the complicated mechanisms of inter-actions in oceanic upwelling ecosystems.

References

ICES 1978: Report of the CINECA Symposium on the Canary Current: Upwelling and Living Resources, Las Palmas, Gran Canaria, 11-14 April 1978 (Copenhagen, ICES, 1978), 12 pages, 4 Annexes.

4.2.3 West African Action Plan (WAAP) and related activities

Although UNEP's activities are concerned with problems connected with the human environment generally, its Governing Council has designated the 'Oceans' as a priority area in which UNEP will focus efforts to fulfil its catalytic role. For the convenience of carrying out its major functions in a systematic and integrated way, it has adopted a regional approach - UNEP Regional Seas Programme - in dealing with the main problem areas of the world oceans. By adopting this approach, UNEP feels that it will be able to focus effort on specific problems of high priority to the States of a given region thereby more readily responding to the needs of the governments and helping to mobilize more fully their own national resources. It is hoped that undertaking activities of common interest to coastal states on a regional basis would, in due course, provide the basis for dealing effectively with the environmental problems of the ocean as a whole.

A UNEP regional programme in this concept consists of a carefully worked out 'Action Plan' which is formally adopted by the governments

At present, there are eight regional sea areas in which action plans are operating or are under development. Among these are: the Mediterranean (adopted in 1975), the Red Sea (adopted in 1976), and the West African region (under development, adoption expected in 1981), which are of interest to African countries.

UNEP has, in the past few years, sponsored or co-sponsored several activities aimed at studying existing or potential marine pollution^{1/} problems in the West African coast, especially the Gulf of Guinea, and at finding or suggesting solutions to such problems.

Because of these studies, there is much more information and much more awareness and concern about the problems of marine pollution in the West African region than in Eastern Africa, where hardly any comprehensive studies on the situation have so far been carried out. Among the activities carried out in the region are:

- (i) UNEP Exploratory Mission on Marine Pollution Problems of the West African Coastal Countries of the Gulf of Guinea (25 April - 2 July 1976);^{2/}
- (ii) IMCO/UNEP Workshop on Prevention, Abatement and Combating of Pollution from Ships in the Gulf of Guinea and Adjacent Coastal Areas (Douala, 12-17 December 1977);
- (iii) IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas (Abidjan, 2-9 May 1978);
- (iv) Unesco Workshop on Coastal Ecosystems with Special Reference to Coastal Lagoons and Estuaries on the West Coast of Africa (Dakar, Senegal, June 1979);
- (v) UNEP Meeting of Experts to Review the Draft Action Plan for the West African Region (Libreville, Gabon, November 1979).

^{1/} Marine pollution is defined as:

"Introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries), resulting in such deleterious effects as harm to living resources, hazard to human health, hindrance to marine activities, including fishing, impairing the quality for use of sea water and reduction of amenities".

(Joint Group of Experts on the Scientific Aspects of Marine Pollution [GESAMP], 1972).

^{2/} M.P. Angot and D. Kaniaru. Report of Exploratory Mission on Marine Pollution Problems of the West African Coastal Countries of the Gulf

The West African Regional Plan was discussed and approved by experts from member countries of the West African Region and from UNDP, FAO, Unesco, IOC, WHO and IMCO at a meeting organized by UNEP and hosted by the Gabonese Republic, held in Libreville, Gabon, 5-9 November 1979. It is hoped that the 'Action Plan' will be adopted by an intergovernmental meeting in January 1981.

For the purposes of the Action Plan, the region is defined as including the marine environment and coastal area of the following States: Angola, Benin, Cameroon, Congo, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Namibia, Sao Tome and Principe, Senegal, Sierra Leone, Togo, Zaire.

It is important to note that there is, at present, no action plan contemplated for the Eastern African region.

References

Report of the Meeting of Experts to review the draft Action Plan for the West African Region, Libreville, 5-9 November 1979. (UNEP/WG.27/4), 6 pages and 5 annexes.

4.2.4 Other regional activities

(i) GARP Atlantic Tropical Experiment (GATE), 1974

Sponsored by WMO and ICSU, GATE aimed at studying the convection in cloud clusters and its interaction with large-scale atmospheric circulation over the tropical Atlantic. The oceanographic part of the programme was aimed at investigating the response of the tropical Atlantic to atmospheric forcing on various scales and at determining heat, water and momentum fluxes through the air-sea interface. About forty research vessels participated; in addition, a great number of buoys and aircraft were deployed in summer and autumn 1974.

But the oceanographic part of the programme does not seem to have allowed for active participation by the West African countries. Several workshops and a terminal symposium (Kiel, FRG, 1978) were held, and an oceanographic atlas entitled 'Physical Oceanography of the Tropical Atlantic during GATE' will be published later in 1980.

References

Final Report of the SCOR Working Group 43 on Oceanography related to the GARP Atlantic Tropical Experiment (GATE). (WMO/ICSU GARP Activities Office, Geneva, 1979), 40 pp.

(ii) Global Weather Experiment (FGGE)

FGGE, culminating during the two Special Observing Periods, January/February and May/June 1979, included two sub-programmes which were of special significance to Africa and Asia: the West African Monsoon Experiment (WAMEX), and the Asian Summer Monsoon Experiment (MONEX). They aimed at observing, describing, understanding and predicting the two monsoons' circulations in the respective areas.

Nearly all West African countries participated actively in WAMEX, but only Kenya and Somalia, and probably the Seychelles, participated in the oceanographic programme of MONEX (INDEX).

(iii) Proposed Joint Study of an Oceanographic Area designated 'The Atlantic-Iberian-African (AIA) Region'

The proposal (submitted by the delegation of Portugal) has been considered by the IOC Assembly, but the programme has yet to be developed. Countries of the region likely to participate include: Portugal, Spain, Senegal, Mauritania, Cape Verde Islands, and Morocco.

(iv) Proposed Pilot Ocean Monitoring Study (POMS) in the North Atlantic during the 1980s.

New observing techniques and new theoretical approaches renewed interest in the large-scale circulation of the ocean, as opposed to the nearly exclusive concentration on process studies which marked oceanography in recent years.

Co-sponsored by the Intergovernmental Oceanographic Commission, the Joint Organizing Committee for GARP and the ICSU Scientific Committee on Oceanographic Research organized a Pilot Ocean Monitoring Study Planning Meeting (Miami, U.S.A., 1-5 October 1979) to discuss the oceanographic aspects of the World Climate Research Programme in general and the prospectus for ocean monitoring in particular.

A number of oceanographic institutes in Canada, France, Federal Republic of Germany, United Kingdom, USA and the USSR are planning major experimental programmes relevant to POMS in the North Atlantic Ocean between 20° and 50°N during the early 1980s. This project is sponsored by ICES, IOC, WMO and ICSU, in conjunction with the development of the World Climate Research Programme (WCRP).

The research programmes are quite varied but most relate to the North Atlantic gyre and its associated currents to the North and South. Some of the programmes are to address the problem of studying the meridional heat transport associated with the North Atlantic circulation and related air-sea interaction processes.

References

Report of the Pilot Ocean Monitoring Study Planning Meeting, Miami, USA, 1-5 October 1979 (WMO/ICSU GARP Activities Office, Geneva, 1979), 43 pp., 8 Appendices.

5. TRAINING AND RESEARCH IN MARINE SCIENCES AND FISHERIES

Unesco and FAO have been the UN organizations most connected with training and research in fisheries and marine sciences. Unesco has been mainly connected with the development of training and research at the university undergraduate and postgraduate levels, whereas FAO's role has been mainly in connection with the development of technologies aimed at the improvement of fishing methods and the exploitation of fisheries on a rational basis.

5.1 In many African coastal states, Unesco's assistance has been and is in such activities as the development and strengthening of undergraduate and postgraduate courses and of relevant research activities in marine sciences at universities and research institutions. This kind of Unesco assistance has taken many forms:

- experts to help in the planning of training courses in marine sciences at universities
- experts to help in the teaching and carrying out of research in universities and research institutions
- experts to assess the needs and feasibility of marine science development in the form of training and research in a country or a region
- experts to assess and advise on co-operative regional programmes of research and/or training which are of mutual benefit to the countries concerned
- financial assistance for the purchase of equipment and materials for research and training
- provision of scholarships or fellowships to country nationals, etc.

5.2 On the other hand, FAO's assistance to these countries has been aimed at trying to solve more immediate problems and trying to meet more immediate needs. Thus, FAO's activities have been and are in areas related to the development and improvement of sound management and rational utilization of fishery resources, including the protection and conservation of the marine environment against pollution and destruction. The assistance of FAO has therefore often taken the form of:

- experts to assist in the planning and development of fishery technical centres or schools

- experts to help in the working out of appropriate and relevant training programmes in fishery technology
- experts to assist in the designing and establishment of boat building yards
- experts to assist in the training of fishermen and fishery technologists
- experts to assist in the carrying out of fishery surveys
- experts to assist in the training of national marine engineers, navigators, boat builders and repairers
- training courses, seminars, workshops, etc., in various aspects of fishery technology in its widest sense, etc.

It is clear that the functions of Unesco and of FAO in the field of marine sciences are in many cases complementary and their co-ordination is often very beneficial to the countries concerned.

References

'Marine Science Teaching at the University Level', Unesco technical papers in marine science 19, (Unesco, Paris, 1974).

6. THE STATE OF MARINE SCIENCE AND TECHNOLOGY IN AFRICA

6.1 East African coastal states

SUDAN

The coastline of Sudan lies entirely on the Red Sea and the country is an active member of regional and subregional activities in the area, e.g., the Red Sea Action Plan, the Joint Saudi-Sudanese Commission for the Exploitation of the Natural Resources of the Red Sea and the ALECSO programme on the Environmental Studies of the Red Sea and the Gulf of Aden (PESRGA). During the last decade intensive efforts have been made by the Government of Sudan through the National Council of Research to establish a strong infrastructure for the development of marine science and technology. The need for such an infrastructure arose from the realization of the importance of such problems as: the development and national exploitation of the marine fisheries of the country; the exploration and possible exploitation of the marine mineral resources of the country; the study and monitoring of marine pollution, the possible development of mariculture (e.g., oysters) and the possible development and exploitation of freshwater resources under the bottom of the sea. * All these activities needed a strong scientific research base.

Institute of Oceanography, Port Sudan

Pursuant to the need to establish a marine science research infrastructure, the National Council of Research established an Institute of Oceanography at Port Sudan in 1971. The most important and immediate need was the training of local marine scientists. The NCR felt that as far as possible the training of local scientists should take place locally and that only when such training could not be provided by local institutions should assistance in the form of overseas scholarships and fellowships be sought. In its initial development, the Institute has received various forms of assistance from Unesco. Right from the beginning, the Institute has been working in close collaboration with the University of Khartoum and through a vigorous training programme there is now a good number of local scientists and more are in training.

* Geophysical and remote-sensing studies have indicated that there could be a vast body of fresh water below the sea-bed of the Red Sea.

The intention of the NRC is that the Institute should develop into a fully-fledged oceanographic institution dealing with all aspects of marine science research but at present, because of various limitations - manpower, working space and equipment - research is centered on conservation, ecology of coastal lagoons, and coastal sedimentology. Studies on fishery ecology, hydrography and fresh water below the sea bed are expected to be included soon.

With the assistance of Unesco, a detailed feasibility study was carried out by a Unesco consultant, who prepared a comprehensive Project Document for the development of the Institute during the period 1976-86.

Marine Biology Station of the University of Khartoum, Souakin

The University of Khartoum has had a great interest in teaching and research in marine sciences, dating from the early days of its existence. In 1975, the University established a marine biology station at Souakin on the coast of the Red Sea. The Station is under the Department of Zoology and is used for research and training of students.

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ETHIOPIA

Ethiopia has not been very active in the field of marine science and technology in the past. However, in recent years, the country has been a participant in regional activities, e.g., the ALECSO-supported Programme for Environmental Studies of the Red Sea and the Gulf of Aden (PESRGA).

There is a good account of the Ethiopian marine resources of the Red Sea in a Report (undated) by the African Wildlife Leadership Foundation, prepared by Francis Minot from the Foundation's African Office in Nairobi.

Research and training in marine sciences

The Government of Ethiopia and the University of Addis Ababa have been very keenly interested in the establishment of a marine science research facility in the country. In 1976, at the request of the

Government, Unesco sent a consultant on a mission to the country to study and advise on the feasibility of establishing a Marine Research Station at Assab, on the Red Sea, under the University of Addis Ababa. As a result of this mission, a detailed project document for the establishment of the proposed Marine Research Station was worked out.

SOMALIA

Somalia has the longest coastline of all African countries, i.e. about 2,900 km, 1,000 km are on the Gulf of Aden and about 1,700 km on the Indian Ocean. The country has also one of the richest fishery resources of the continent due mainly to the upwelling phenomenon and the Somali current. Parts of the shore are suitable for harbour development and some parts are suitable for tourism. This great potential of marine resources, especially fishery resources, for the economic development of the country, is fully realized by the government and in recent years great efforts have been made to try and develop the necessary infrastructure for the rational exploitation of these resources.

In common with many African coastal states, there is still a great shortage of trained manpower in marine science and technology, including fisheries. But in recent years, the Ministry of Fisheries has made attempts to establish a unit for research and training in marine biology and fishery science and technology. Recently, an agreement was reached by which such a unit would be established through a technical co-operation programme between the Government of Somalia and Japan, with ALECSO (Arab League Educational, Cultural and Scientific Organization).

Establishment of a Faculty of Marine Sciences and Fisheries at the Somali National University

Perhaps the most important step taken by the Government of Somalia in regard to marine science and technology development in the country is the decision to establish a Faculty of Marine Sciences and Fisheries at the National University. The project has been under consideration for a number of years now and it has been the subject of several Unesco/FAO/IOC missions and discussions, including a series of CINCWIO preparatory exercises. A feasibility study was carried out in 1978 by a Unesco consultant who prepared a project document for the establishment of the Faculty.

It is envisaged that the Faculty, when established, will, in co-operation with other relevant Faculties of the University, and the Ministry of Fisheries, deal with all aspects of marine sciences and technology.

Research and Training in Marine Sciences and Technology

Somalia is an active participant in regional activities related to marine science and marine resources development, e.g., those of CINCWIO, the IIOE, the IOFC and the ALECSO Programme of Environmental Studies of the Red Sea and Gulf of Aden (PESRGA). The offshore fishery resources were surveyed under a UNDP/FAO project by the Swedish research vessel, R.V. Fridjof Nansen (1976-77) and some Russian research vessels have also carried out oceanographic and fishery studies in Somali territorial waters.

Marine pollution problems

There are at present no marine pollution problems in Somalia, but with the possible development in the future of industries, harbours, fish processing, offshore mining, etc., it is most probable that these problems will arise.

References

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KENYA AND TANZANIA

Kenya and Tanzania (together with Uganda) had, until recently, a co-operative research arrangement under the former East African Community, whereby applied research mainly related to the development and exploitation of the marine fishery resources of the two countries was carried out. The centre of these research activities was the East African Marine Fisheries Research Organization (EAMFRO), which was based in Zanzibar, and which in later years established a good field (or branch) laboratory in Mombasa.

In its earlier years, the EAMFRO Laboratory was mainly staffed with expatriates and there were no training programmes for local marine scientists. However, a few years after the East African countries became independent a re-organization took place which involved a vigorous training programme for local scientists and technical personnel for the Institute.

After the break-up of the East African Community in 1977, the co-operative arrangement came to an end. The former EAMFRO Laboratory in Zanzibar was taken over by the Tanzanian Government and subsequently handed over to the University of Dar-es-Salaam to form the nucleus of the Institute of Marine Sciences of the University and the new EAMFRO Laboratory at Mombasa was taken over by the Government of Kenya and subsequently handed over to the Fishery Department to be the main Fishery Research Laboratory of the Department.

The position concerning marine science and technology development generally in Kenya and Tanzania is well described in the reports of the CINCWIO Workshop (1976), CINCWIO Joint Mission to Somalia, Kenya and Tanzania (1977) and the CINCWIO Intergovernmental Meeting (1979).

KENYA

The situation regarding marine science and technology development in Kenya now is that there is a good new research laboratory which is well equipped for all types of research on marine sciences. There is also a new research vessel well equipped for sophisticated oceanographic work.

There is a nucleus of local research scientists and technicians and there are training programmes for more. Among the research projects being pursued are fishery surveys, mariculture, marine pollution and mangrove ecology. There are proposals to establish an Institute of Marine Sciences.

The University of Nairobi has recently introduced undergraduate programmes in marine sciences and intends to introduce postgraduate programmes in this field in the near future.

References

Report of the Joint IOC/FAO/SIDA/SAREC Marine Science Mission to Kenya, Somalia and Tanzania, 3-24 September 1977 (Unesco, Paris).

TANZANIA

The present situation can be summarized as follows:

There is now an Institute of Marine Sciences under the University of Dar-es-Salaam, which was established in 1978 after the break up of the East African Community. The Institute is located in Zanzibar where enough land has been set aside for its re-location at a more suitable site. There are at present 8 scientists (7 local) with higher degrees and more are in training. There is also a nucleus of good technical staff and a modern research vessel well equipped for oceanographic research and fishing. The Institute is experiencing problems in connection with the operation of the research vessel largely due to the lack of a competent local crew and difficulties in obtaining spare parts with hard currency. The development of the Institute at the new site will need a large capital outlay which will require bilateral or multilateral co-operation.

The research activities being carried out at present are mostly ecological and fishery-oriented but the Institute's mission includes all aspects of marine science research.

Apart from the Institute of Marine Sciences, there are Fishery and Fishing Technology Training Schools (diploma level) under the Division of Fisheries, Ministry of Natural Resources and Tourism.

References

Report of the Joint IOC/FAO/SIDA/SAREC Marine Science Mission to Kenya, Somalia and Tanzania, 3-24 September 1977 (Unesco, Paris).

MOZAMBIQUE

Mozambique is known to have rich fishery resources of all types: inshore, offshore, estuarine and inland (fresh water). However, the country is not deriving much benefit from its marine fishery resources, because it does not have the capability to exploit them fully. There is much exploitation of these resources by foreign fishing fleets, some on licence, some on a co-operative arrangement with the Government, and some by poaching. Moreover, these resources are as yet not fully

comprehended because there has not been any strong research programmes to support the fishery industry. Training of local personnel in modern fishing methods and fishing technology generally has been equally wanting. Likewise, there has not been any research and/or training in any other aspects of marine sciences planned and executed by the country itself. There have been oceanographic studies by foreign research vessels with practically no participation by local people. As data from such research activities is usually not made available to the country concerned, only the foreign countries owning the research vessels benefit from these exercises. The 'Servicio de Investigaciones Pesqueras' (SIP) - Fishery Research Service - under the Ministry of Industry and Energy, has been carrying out some fishery surveys mainly to support the artisanal fishery but it has not had any strong research and training programme.

With the co-operation of FAO and the USSR, a comprehensive research and training programme has been planned. This programme will involve re-organization of SIP so as to facilitate the development of a well-balanced fishery research and training programme aimed at making Mozambique self-sufficient in scientific and technological manpower for the fishing industry in the next few years.

SEYCHELLES

The Seychelles Government established a Fisheries Department in 1972 which created a Research Section in 1976. Prior to 1976 there had been several fishery surveys and oceanographic observations by foreign fishing and research vessels. The main activity of the Fishery Department is to carry out fishery surveys to provide data for the development of the fishery industry.

Recently, the Government drew up plans aimed at increasing the national catch considerably to provide for the export market.

Training and research

The Seychelles Technical College has for the past few years been offering specialized courses in Marine Diesel and Electrical Engineering to fishery technical personnel for the Department of Fisheries. There were also plans to establish a School of Fisheries and Seamanship. Research staff are usually trained in overseas universities - U.S.A., Britain and France - while supporting staff are usually trained on the job.

The Royal Society Research Station on Aldabra atoll

The Government of the Seychelles recently established a Foundation to operate the island of Aldabra and the Research Station of the British Royal Society on Aldabra atoll after the termination of the Society's lease. It is intended to use the multi-disciplinary research facilities for externally-funded visiting research scientists.

MADAGASCAR

Being an island, it is natural that Madagascar's economy should rely very heavily on the resources of the sea around it. However, at present, the infrastructures required to develop a viable and healthy economy based on its marine resources are in some cases entirely lacking and in other cases very deficient. There are not many trained scientists and technologists nor the basic facilities (equipment, etc.) necessary for the provision of a scientific and technological base to support a rational exploitation of the country's marine resources to the best advantage. This situation is well realized by the Government of Madagascar, which has been an active participant in regional activities related to marine resources development, e.g., those of CINCWIO, IIOE and IOFC.

Under the French colonial administration, there was an important oceanographic laboratory at Nosy Bé which carried out research in many aspects of marine sciences. However, this laboratory (which was under the French scientific research organization ORSTOM, based in France) did little to train local scientists and technicians in marine sciences. Thus, when the French left after the independence of Madagascar, almost all the activities of the research laboratory came to a halt. Furthermore, some of the basic research equipment and facilities were dismantled.

Reactivation of the Centre National de Recherches Océanographiques (CNRO), at Nosy Bé

In November 1978, in response to a request from the Government of Madagascar, a joint FAO/Unesco mission was sent to Madagascar to study the situation and work out and recommend a comprehensive programme for UNDP funding aimed at developing and strengthening marine science infrastructure including a strong element of research and training. The most important recommendation made by the mission concerned a reactivation and development of the CNRO into an important centre of research and training in marine science and technology.

The University of Madagascar

The University of Madagascar offers some courses in marine biology as part of the undergraduate programme in general biology. The University has a Marine Biology Station at Tuléar, which is used as a field station for students taking the marine biology course. After their course at the University, students selected for further training and specialization in marine sciences are sent to overseas universities, usually in France. This arrangement is being used to train scientists for the CNRO.

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DJIBOUTI, COMORO AND MAURITIUS

There seem to be no important activities related to marine science and technology in these coastal states.

6.2 West African coastal states

MOROCCO

Morocco is bordered by the Mediterranean in the North and the Atlantic in the West. The country has rich marine fisheries in its Atlantic Ocean waters which need fuller and more rational exploitation. As a member of the Mediterranean group of countries, Morocco has an interest in the UNEP Mediterranean Action Plan.

In order to be able to benefit fully from its marine resources and to be able to participate more actively in regional marine-science-oriented programmes, e.g., marine pollution, the country needs trained manpower in marine science and technology.

Training and research in marine science and technology

There is a Marine Geology Laboratory attached to the Department of Fisheries, but there are no research or training programmes. For the past few years, there has been a proposal to establish an Institute of Marine Sciences at Mohammed V University in Rabat, but the project is still under discussion.

Institut de Pêches Maritimes (IPPM), Casablanca

The Institute has good facilities for research including a public aquarium and research laboratories. But at present there is a problem of understaffing.

Marine pollution problems

The country's marine pollution interests in the Mediterranean are tied up with the Mediterranean Action Plan.

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MAURITANIA

Mauritania's coastal and open sea economic waters are within the upwelling area of the North Central Atlantic and they are consequently very rich in fishery resources. However, the fishery industry is not making any notable contribution to the economic development of the

country because the fishery resources are being exploited mostly by fishing fleets of foreign countries (USSR, Japan, Spain, France, Portugal, South Korea, Poland, etc.) under licence, which involves the payment of a small fee. It is estimated that about 300,000 tons of fish are caught each year in the fishing grounds of the country but only about 30,000 are landed for the local market and export to other African countries.

There are two main factors that have contributed to the underdevelopment and underexploitation by the country of its fishery resources:

1. The population of the country is small (about 1.5 million) and the main occupation is animal husbandry involving a semi-nomadic existence. The people therefore have no long tradition of life at sea or of eating fish.

2. There are not many local people trained in fishery technology (including fishing or fishery sciences). Attempts have been made in the past few years to try and remedy the situation: the fishing harbour at Nouadhibou was enlarged recently and has fish processing facilities; a new ministry was created in 1976 - Ministère des Pêches et de la Marine Marchande - to deal with:

- artisanal fisheries
- industrial (commercial) fisheries
- protection of the marine environment
- conservation of marine resources.

Recently, the Ministry was re-organized to include a Directory of Oceanography.

Marine science research and training

Laboratoire des Pêches, Nouadhibou

The Laboratory carries out activities in oceanographic research and fishery technology.

Centre des Sciences et de Recherches d'Economie des Pêches,
Nouadhibou (Cansado)

This Centre was established recently with the aid of the USSR. When fully functional, the Centre is planned to have eight departments dealing with all aspects of marine science research.

There is as yet no University in Mauritania and no institution of higher learning. The training of marine scientists takes place abroad, mainly in the USSR, France, Spain, Portugal, Romania and Bulgaria.

Unesco and FAO have had some activities related to the development of marine sciences and fisheries.

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SENEGAL

Senegal is very rich in fisheries and the inshore artisanal fishery is very productive. In 1975, the fish catch of the country amounted to 352,000 tons and had been steadily increasing for the previous five years. The Senegalese are good fishermen and have a long tradition of eating and trading in fish.

The fishery industry, therefore, forms an important part of the economy of the country and there is much scope for improvement and development.

There are several institutions which carry out research and training in fisheries and marine sciences and the training of fishermen and fishery technologists. The most important of these institutions are:

Institut Sénégalais de la Recherche Agronome (ISRA)

This is a large and advanced multi-disciplinary research centre with a strong bias towards the agricultural sciences. It has several Departments, one of which is the Centre for Oceanographic Research (see below).

Centre de Recherches Océanographiques de Dakar-Thiaroye (CRODT)

This is an important oceanographic research centre and has several good research programmes mainly related to fisheries development and exploitation, and environmental protection. There are also some programmes in biological and physical oceanography. At present, the Centre has a scientific staff of 18 of whom 3 are Senegalese. There is a programme to train more Senegalese scientists to strengthen the local

scientific staff. Some of the fishery research programmes are regional, e.g., the sardinella fishery research programme involving Senegal, Ivory Coast, Guinea Bissau and Mauritania.

Institut Fondamental d'Afrique Noire (IFAN)

An old institute established in 1936. It has a marine biology department.

The University of Dakar

The University carries out some research activities in marine biology and marine chemistry and runs courses in marine environment.

Most of the research activities, e.g., those of ISRA and CRODT, receive technical support from France through the Office de la Recherche Scientifique et Technique d'Outre Mer (ORSTOM).

Most of the research scientists are French but there are a number of local scientists and a programme of training more of these abroad, mostly in France.

Marine parks: There are three national marine parks - Lagune de Barbarie, Ile de la Madeleine and Parc du Delta de Saloumi.

Marine pollution problems

The UNEP mission to the West African coastal states of the Gulf of Guinea (1976) concluded that there were no serious marine pollution problems in the country but there was some oil pollution arising from oil refinery and port operations. There is also a potential danger of increased sewage pollution of the beaches and lagoons.

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GUINEA

There is very little development of marine science in Guinea and the marine fishery resources of the country are little understood. Artisanal fishery on the wide continental shelf is not very productive and the

annual catch has been estimated to be of the order of only about 5,000 tons. This may be due to the fact that there is little knowledge about the exploitable species found in the area and the appropriate fishing gear to use. It is however said that foreign fleets are exploiting the offshore resources and therefore these might be economically exploitable with appropriate technology. The coastal estuaries are said to be suitable for mariculture but coastal erosion and silting and the danger of industrial pollution might exclude this possibility.

Marine science training and research

These activities are almost non-existent. In 1974, the FAO (Project GUI/74/024) carried out a fishery survey aimed at an assessment of the fishery potential of the Guinean coastal waters but it would appear that not much useful information was obtained. There was also a plan to establish an Oceanographic and Fishery Institute through a technical co-operation arrangement with the USSR (1973-78), but there is no information about the progress, if any, that was made in this regard.

Institut Polytechnique des Pêches

This Institute trains technicians and marine engineers for open sea fishing.

The University of Conakry

The Biology Department and the Biology Section of the Fisheries Department of the university carry out some fishery surveys and mapping of fishery grounds.

Marine pollution problems

A UNEP mission on Marine Pollution Problems of the African Coastal Countries of the Gulf of Guinea (1976) reported that marine pollution was not a serious problem in Guinea. But there are fears that industrial pollution from the aluminium industry and possibly from oil refinery and oil exploitation might in future reach problematic proportions.

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SIERRA LEONE

Marine science activities in Sierra Leone go back to 1952 when the West African Fisheries Research Institute was established by the British colonial government to serve the fishery interests of the four British colonies of West Africa: Sierra Leone, Gambia, the Gold Coast (Ghana) and Nigeria. The Institute was abolished after the independence of Ghana in 1957, and was replaced by the Fisheries Development and Research Unit (FDRU), jointly financed by the U.K. and Sierra Leone Governments. After the independence of Sierra Leone, in 1961, the FDRU was dismantled and its research and equipment facilities were given to the Fourah Bay College Marine Biology Laboratory, under the charge of the Zoology and Botany Departments. In 1967, an Institute of Marine Biology and Oceanography was established at Fourah Bay College, University of Sierra Leone.

Institute of Marine Biology and Oceanography, Fourah Bay College, University of Sierra Leone

With financial and technical assistance from UNDP and Unesco, the Institute has developed into an important centre of research and training in marine sciences and technology.

In collaboration with other university departments, the Institute undertakes undergraduate and postgraduate training in marine sciences. There are also regular diploma courses in marine biology and fishery technology for fishery extension officers.

In research, priority has up to now been given to fishery-oriented investigations, but there are plans to establish an Environmental Study Centre. The Institute is an active participant in regional research activities in fishery biology and stock assessment, fishery survey, mariculture (oysters), biological oceanography and the hydrography of coastal waters.

In recent years, and after the termination of the UNDP/Unesco Project, the Institute has been experiencing some financial constraints which have hampered its development.

Marine pollution problems

There are no serious marine pollution problems at present, but coastal erosion at some places on the coast is quite serious.

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IVORY COAST

Fishery development and fishing are not at present priority activities in the economic development of the Ivory Coast. There is more emphasis on agriculture, mining and oil drilling and exploration. However, the country is strongly involved in research in the artisanal fishery and its development, especially in lagoons.

Research and training in marine sciences

The most important institution concerned with marine science research is the Centre de Recherches Océanographiques (CRO).

This Centre, which was founded in 1959, is administered by the Government of the Ivory Coast, but under the running and management of the Office de la Recherche Scientifique et Technique d'Outre Mer (ORSTOM) - a French organization specializing in scientific and technological research in developing countries. Most of the research is financed by the French government with some contribution from the Ivory Coast government. Many of the research scientists are French nationals, some on short term visiting assignments. At the beginning, research priorities were centered on the demersal and pelagic fisheries of the continental shelf of the country, but they have now been expanded to include the ecology of lagoons and estuaries and pollution monitoring. There is a new research programme in physical oceanography involving remote sensing of the physical parameters of the sea (e.g., surface temperature) using satellites, buoys and aircraft equipped with infra-red sensors.

Local scientists are recruited for research but there are as yet no concrete training programmes for marine scientists or technologists at the Institute or at the University of Ivory Coast. There are few contacts between the University and CRO.

There have been several activities undertaken by Unesco and FAO aimed at the development of marine sciences and fisheries.

Marine pollution problems

Oil pollution originating from external sources and industrial and sewage pollution of the coastal areas are quite serious problems. Secondary effects of pollution on fisheries have already appeared especially on lagoon fisheries with a sharp decrease in the shrimp catch. There is also considerable shore erosion at several places along the shore. Exploration for oil has given positive results and this might lead to offshore oil exploitation in the near future with the accompanying pollution risks. The country is aware of the pollution problems and a special Department of the Ministry of Mines has been set up to deal with industrial pollution, entitled 'Direction de l'Environnement Industriel'

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GHANA

Ghana has had a strong and balanced educational system for a long time and the standard of general education and the literacy rate are among the highest in black Africa. In recent years, great emphasis has been placed on technical and professional education in many areas, including science teaching, scientific instrumentation, mining, sanitary engineering, fishery science and technology, meteorology, etc. With the assistance of UNDP and Unesco, there are several projects aimed at enhancing scientific and technical training, e.g. the establishment of a school of mines (university level) and a scientific instrumentation centre, both scheduled for 1979-81.

In the field of marine sciences, Ghana has evinced a long-standing interest, as witnessed by its membership of the Intergovernmental Oceanographic Commission (IOC) which goes back to 1961 when the Commission was established. This interest probably arises from the fact that the country has very rich marine fishery resources which make a substantial contribution to the general national economy. Furthermore, Ghanaian fishermen are among the best in Africa, with a long tradition of life at sea. They carry out efficient fishing using modern fishing vessels and gear, and covering long distances - as far south as Angola and as far north as Mauritania. In 1977, the catch landed by the local fishermen amounted to about 177,000 tons.

Training and research in marine sciences

During the past 15 years, several institutions with interest in marine science research and training have been established.

Institute of Aquatic Biology, Council for Scientific and Industrial Research

This institute was established in 1965 with the main aim of carrying out limnological research on the man-made lake (Akosongu Dam) resulting from the Volta Hydro Electric Power Station. The Institute has also carried out some ecological studies on estuaries and coastal lagoons.

Environmental Protection Council

Ghana played an active part in the UN Conference on the Human Environment meeting (Stockholm, June 1972). In 1973, the Government established an Environmental Protection Council to advise and co-ordinate all activities (including research) on the environment. With the co-operation of UNEP, there have been studies on pollution and coastal erosion.

Fisheries Research Unit

In an effort to modernize the fishing industry, a Fishery Research Unit was established at the new port at Tema with UNDP assistance. The laboratory is well staffed with local scientists and technicians. Apart from fishery-oriented research, there have also been a few investigations on physical and chemical oceanography and marine geology. An FAO mission (1978) recommended the upgrading and strengthening of the Fishing Gear and Technology Section of the FRU into a Fishery Technology Unit.

University of Ghana

The University of Ghana initiated postgraduate studies in Aquatic Biology in 1974 and there are plans to establish an Institute of Marine Science and Oceanography.

Ghana Nautical College

Ghana has a Nautical College, but this lacks a fisheries component which could provide specialized training in fisheries.

Pollution problems

An FAO/UNEP consultant mission in 1978 found that there was a potential danger of coastal area pollution from various sources - oil tanker traffic, faulty sewage discharge into the sea, industrial waste discharge into the sea, possible offshore oil exploitation.

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TOGO AND BENIN

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NIGERIA

Marine resources including fisheries have not figured very prominently in the economy of Nigeria in the past, and in common with many African coastal states, there were not until recently any important research and training programmes in fisheries or in marine sciences generally. However, in recent years, as a result of a general realization of the importance of science and technology in economic development, the country has developed an active interest in marine sciences and marine affairs generally. Nigeria has been and is an active participant in many regional activities related to marine science and technology development organized by Unesco, FAO and UNEP. The country has now long-distance fishing fleets and there are research programmes in several institutions in the country dealing with many aspects of marine sciences including fishery biology, chemical oceanography, pollution, mariculture and coastal area development.

Development and training in marine sciences in Nigeria

Most of the earlier work in research and training in fisheries was carried out at the Nigerian Institute of Oceanography and Marine Research (NIOMR). In recent years, several universities in the country, notably the University of Lagos, have developed an interest in marine science research.

Nigerian Institute of Oceanography and Marine Research (NIOMR)

The Nigerian Institute of Oceanography and Marine Research was created from the Marine Biology Division of the Federal Department of Fisheries and came into being in 1975. Its terms of reference were broad and could be summarized as: to conduct research into all aspects of marine sciences relevant to marine resources development in the Nigerian territorial waters and the 'high seas beyond', i.e., in the whole 'Exclusive Economic Zone' area of the country.

After the creation of NIOMR, Unesco, in collaboration with IOC, assisted in getting the Institute established on a firm basis by advising on its future development and on its research and teaching programmes. Perhaps the most important contribution on the part of Unesco so far, in regard to the future development of NIOMR, is the Unesco mission report written by two consultants which was very

comprehensive, and which, because of its far-sightedness, would be found a useful reference guide for a considerable length of time during the future development of the Institute.

At present, most activities in research and training in marine sciences are centered at NIOMR and the University of Lagos where there are good facilities and active research and training programmes in marine sciences especially in respect to the ecology of lagoons, mariculture and pollution. There is also some research work in some aspects of marine sciences in other Nigerian Universities, e.g., the University of Nsukka and the University of Ibadan.

With its healthy economy and many university institutions, Nigeria is well placed for great advancement in marine science and technology.

Marine pollution problems

A UNEP mission (1976) reported that there were pollution problems related to oil exploitation in the Calabar area around Port Harcourt, oil transportation along the Nigerian sea-shore and at Lagos and the dumping of wastes, especially sewage, at sea and in lagoons. There was also a potential danger of pollution from pesticides drawn from agricultural areas by rivers flowing into the coastal lagoons. It would seem that enough precautions are being taken to guard against oil pollution from oil exploitation.

References

U. Stefansson and J. Wickstead. Development and Training in Marine Sciences in Nigeria. Serial No. FMR/SC/OCE/77/178 (Unesco, Paris, 1977). 52 pp.

C.I.O. Olaniyan. A report of a Unesco mission to countries along the coast of West Africa to assess coastal lagoon research and management in member countries. May 1978. (Unesco, unpublished manuscript).

There are not many activities in marine science and technology in the following countries:

ANGOLA: There is a good research laboratory established by the Portuguese; good fisheries;

CAPE VERDE ISLANDS;

CONGO: There used to be a research laboratory under ORSTOM, but it has been closed. (See: A. Klingebiel. Rapport de mission dans quatre pays francophones de l'Afrique. 6-21 novembre 1978. (Unesco, unpublished manuscript);

EQUATORIAL GUINEA;

GABON: The country hosted a UNEP Meeting of Experts to review the draft Action Plan for the West African Region, Libreville, 5-9 November 1979. (See: Report of the Meeting of Experts to review the draft Action Plan for the West African Region. Ref. UNEP/WG.27/4. 6 pages and 5 annexes; also: A. Klingebiel. Rapport de mission dans quatre pays francophones de l'Afrique, 6-21 novembre 1979. (Unesco, unpublished manuscript);

GAMBIA: There is a fishery laboratory with one or two scientists;

GUINEA BISSAU;

LIBERIA: See: C.I.O. Olaniyan. A report of a Unesco mission to countries along the coast of West Africa to assess coastal lagoon research and management in member countries. May 1978. (Unesco, unpublished manuscript);

NAMIBIA: Very good fisheries being exploited by foreign fleets;

SAO TOME AND PRINCIPE;

ZAIRE.

DEVELOPMENT OF MARINE SCIENCE AND TECHNOLOGY
IN AFRICA

Information required from research and training institutions
in marine science and technology

1. Name of institution:

2. Full postal address of institution (including POB, telephone and telex numbers and telegram abbreviation):

3. Name and title of Institution's Executive Officer (Director, Head, Chairman, etc.):

4. Type of institution (governmental, independent, university, industrial or other):

5. Type and scope of research activities (oriented or unrestricted research in physical, chemical, geological or biological oceanography):

6. Brief history of institution:

7. Aims and objectives of the institution:

8. Extent to which the research activities of the institution are related to the country's needs in marine science and technology development:

9. Organizational structure of institution (division into departments, research units, services, etc.):

10. Research activities accomplished in the last three years:

11. Major current research, and its scientific leaders:

12. Future research programmes:

13. Mechanisms for dissemination of research results to production sectors, and for utilization of these results:

14. Linkages between the Institution and government Departments/
Divisions dealing with marine resources development:

15. Mechanisms for co-ordination and co-operation between the
institution and other institutions carrying out related activities,
e.g., research institutes and university departments:

16. Co-operative programmes with other institutions and international
organizations:

17. Provision for visiting scientists (laboratory space and living
accommodation, fees charged) and experience in 'on-the-job training':

18. Scientific personnel of institution (only full-time staff members)
by name, academic degree (Ph.D., Doctorat d'Etat, M.Sc., etc.) and
speciality:

19. Supporting staff (technical, administrative and other):

20. Present laboratory space in m² (excluding corridors, photolaboratories, storerooms, lavatories, workshops, etc.):

21. Ships currently owned by the institution (name, length, hull construction, GRT, hp, speed, size of the crew, laboratory space, operating range, cruising range in days, number of berths, special facilities such as winches, stabilized current, permanent scientific equipment on board, etc.):

22. Present capital equipment at the research centre (only items that cost more than \$500):

23. Aquarium open to the public maintained by the institution (number of tanks, total volume, average number of specimens exhibited, specialities) and available experimental aquaria:

24. Library maintained by the institution: number of volumes (books) and periodicals (journals):

25. Journal or other periodical publication issued by the institution (title, language used, number of issues per year, last issued volume, available on an exchange or purchase basis):

26. Lectures at university by staff of the institution (undergraduate or graduate level, title of the courses):

27. Instructional programmes at the institution (type of courses, undergraduate, postgraduate, diploma):

28. Facilities for student courses (laboratories and their equipment, number of students that can be accepted):

29. Places available for external students:

30. List of publications of the institution relevant to marine sciences:

31. If it is a training institution:
 - (i) Type of training given: (e.g., a certificate or diploma course in oceanography, fishery biology, fish technology, navigation, boat building, etc., or a first degree or postgraduate course in marine biology, chemical, physical or biological oceanography, marine geology, marine engineering, marine meteorology, etc.):
 - (ii) Duration of the different types of training:
 - (iii) Employment opportunities of the trainees after qualification:

32. Major constraints facing the institution:

33. Measures being taken or planned for overcoming these constraints:

34. Assistance received from the United Nations system (e.g., Unesco, FAO, UNEP, UNDP, etc.):

35. Assistance received from sources other than the UN system:

DEVELOPMENT OF MARINE SCIENCE AND TECHNOLOGY
IN AFRICA

Information required from Government Ministries, Departments and
Institutions on marine science and technology in African coastal states

1. Name of country:

2. Area:

3. Length of coastline:

4. Population:

5. Ministry/Department responsible for marine resources development:

6. Title and address of Head of the agency responsible for the activities in 5 above:

7. Departments/Divisions dealing with marine resources development activities:

<u>Name of Department/ Division</u>	<u>Address</u>	<u>Main Activity</u>	<u>Title of Executive Head</u>
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8. Co-ordination and linkage mechanisms between the above Departments/Divisions and training and research institutions in marine science and technology in the country:

9. National activities in marine science and technology:

9.1 Ongoing activities in:

1. Fisheries:

2. Oceanography:

3. Conservation and protection of the marine environment:

4. Pollution:

5. Mineral exploration and exploitation:

6. Boat building and marine engineering:

7. Oil exploration and exploitation:

8. Harbour development:

9. Coastal area development:

10. Tourism development:

9.2 Planned activities:

1. Fisheries:

2. Oceanography:

3. Conservation and protection of the marine environment:

4. Pollution:

5. Mineral exploration and exploitation:

6. Boat building and marine engineering:

7. Oil exploration and exploitation:

8. Harbour development:

9. Coastal area development:

10. Tourism development:

9.3 Extent and use of the Exclusive Economic Zone:

9.4 Facilities for training of professional personnel in:

1. Fishery biology:

2. Biological oceanography:

3. Chemical oceanography:

4. Physical oceanography:

5. Marine geology:

6. Marine mineralogy:

7. Marine engineering:

8. Navigation:

9.5 Need for professional personnel in:

Annual
Production
Capacity

Annual
Requirement

1. Fishery biology:

2. Biological oceanography:

3. Chemical oceanography:

4. Physical oceanography:

5. Marine geology:

6. Marine mineralogy:

7. Marine engineering:

8. Navigation:

9. Fish technology (including fishing, fish processing and preservation, fish marketing and economics, gear technology):

10. Ministry responsible for external relations and co-operation in matters concerning marine science and technology development:

11. Co-operation with other countries in marine science and technology (including activities within the UN system):

1. Bilateral co-operation:

2. Sub-regional co-operation:

3. Regional co-operation:

4. International co-operation: